Efficiency of selected risk management instruments

An empirical analysis of risk reduction in Kazakhstani crop production

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An empirical analysis of risk reduction in Kazakhstani crop production

by

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Summary

Kazakhstan’s agricultural sector plays an important role in the country's economy. Not only does it function as an economic output producer, it also serves as a social buffer in times of transition to a market economy. The restructuring process had a strong impact on the economic performance of agricultural enterprises. As the state no longer functions as a back-up financier in times of economic downturn, farmers have to find their own sustainable instruments to manage business risks, which are significant in Kazakhstan due to the acute continental climate and the resulting revenue fluctuations.

This thesis is an integral part of the research project "Crop Insurance in Kazakhstan – Options for Building a Sound, Institution Promoting Agricultural Production".
It aims at shedding light on the question, how farm income can be efficiently stabilized under transition conditions. Furthermore, it will be attempted to answer following sub-questions by employing a utility-efficient risk programming model to three typical study farms in North, East, and South Kazakhstan:

- What are the most efficient income stabilization mechanisms for different farm types in Kazakhstan?
- How do climatic conditions and yield variability influence the efficiency of income stabilization instruments?
- How do assumptions about the decision-maker behaviour influence the choice and efficiency of selected farm income stabilisation instruments, e.g. to which extent risk aversion affects the choice of risk management instruments in a less developed country with extremely high coefficients of yield variation and often little diversified production systems?

Although insurance solutions to agricultural risk suffer from being prone to asymmetric information problems, their possible impact on risk reduction will be investigated. Therefore, insurance products, which are able to limit the extent of moral hazard problems will be described and analysed.

Additionally to the programming model, a farm survey as well as a stakeholder survey among political decision-makers, representatives of insurance companies and public administration and researchers have been carried out. The rationale for these empirical studies, particularly the farm survey, was to obtain information about production risks Kazakhstani farmers face, their attitude towards risk, and the risk management instruments they apply.

Furthermore, answers will be provided to the question how the actual law on crop insurance in Kazakhstan can profit from findings generated in the course of this research.

Considering the utility-efficiency of different risk management instruments, we can conclude that the separate regional analysis was a reasonable procedure, because no general recommendations can be derived from the efficiency results. Therefore, conclusions regarding the utility-efficiency of the considered insurance instruments will be drawn regionally.

A large number of insurance products stabilises income efficiently as can be derived from the utility rankings. However, weather index insurance seems to be more appropriate in Northern Kazakhstani grain production. Area-yield insurance might be a reasonable alternative to weather insurance, since it provides a number of advantages in fighting moral hazard compared to farm yield insurance. Efficiency results as well as the analysis of variation coefficients show its applicability for East and South Kazakhstan conditions. However, the advantages providing better access to symmetric information should be evaluated against the potentially lower risk reduction. When introducing area-yield insurance, smaller areas (rayons) as the basis for the calculation of the underlying yield index are supposed to provide higher risk reductions than larger areas (oblasts).

A central conclusion can be derived for all considered study farms simultaneously. The choice of the production technology is the decisive factor in risk management. The result can be connected to the evaluation of risk management responses of the farm survey. According to the interviewed farmers, the maintenance of capital reserves and production with low costs are two of the most important objectives in risk management. As results from the normative decision model show, these strategies are not ‘first best solutions’ for all considered farms. When crop production is insured, more intensive production technologies (with higher costs) might be more appropriate than low input technologies.

For further research, we can conclude that decision-making conditions and criteria vary across geographic regions and by farm type; thus, subsequent risk models should be adapted to the unique conditions of the research domain because standardized modelling formulations can produce spurious results. Obviously, a natural extension of this work is the investigation of other crops and regions.

Future research should test the long-term economic potential of alternative crops under changing natural conditions and prices. Furthermore, different combinations of insurance with hedging products can be tested.

The hypothesis that crop insurance often supports only large-scale farmers cannot be rejected when investigating the data on crop insurance market development. One of the reasons for introducing mandatory crop insurance in Kazakhstan was to provide all farmers with access to insurance, disregarding their risk exposure or the size of their enterprises. However, insurance companies have less incentives to insure small, risk-prone farms. The future task of the government will be to find appropriate enforcement mechanisms to motivate insurance companies to provide insurance to small farms or to transform the mandatory system into a voluntary one.

A further government task involves breaking up the path dependence of crop insurance. The bad image of the entire insurance industry could be primarily overcome by setting right the legal framework, the incentives, and enforcement mechanisms. The objective would be to create an insurance system, in which insurance companies can generate profits with their clients experiencing justice and income stabilisation that provides a sound base for the development of economic activities.

To strengthen the link between on-farm risk management and risk-sharing strategies, the government could promote research in agronomic methods to mitigate the effects of difficult growing conditions. Differences in agro-climatic environments such as soil type and fertility, moisture availability, distribution of weeds, and susceptibility to erosion should be better taken into consideration when developing new technology recommendations.

Zusammenfassung

Kasachstans landwirtschaftlicher Sektor spielt eine wichtige Rolle in der Wirtschaft des Landes. Die Rolle der Landwirtschaft liegt nicht ausschließlich in der Produktion ökonomischen Outputs, sondern dient vielmehr als ein sozialer Puffer in der Transformationsphase. Der Restrukturierungsprozess hat einen großen Einfluss auf die ökonomische Leistung landwirtschaftlicher Unternehmen. Der Staat fungiert nicht länger als ein natürlicher Rückversicherer in wirtschaftlichen Krisenzeiten, so dass die Landwirte eigene, nachhaltige Instrumente finden müssen, um ihre Geschäftsrisiken abzusichern. Diese Risiken sind erheblich in Kasachstan.

Diese Arbeit ist ein integraler Bestandteil des Forschungsprojektes "Ernteversicherung in Kasachstan: Optionen zum Aufbau einer nachhaltigen Institution in der Landwirtschaft". Dieser Beitrag möchte die Frage beleuchten, wie landwirtschaftliche Einkommen unter Transformationsbedingungen effizient stabilisiert werden können. Mit Hilfe der Anwendung eines Programmierungs-models auf drei typische Betriebe in Nord-, Ost- und Südkasachstan wird versucht, die folgenden drei Fragen zu beantworten:

- Welches sind die effizientesten einkommensstabilisierenden Instrumente für verschiedene Betriebstypen in Kasachstan?
- Wie beeinflussen klimatische Bedingungen und Ertragsschwankungen die Effizienz der Instrumente?
- Wie beeinflussen Annahmen über Entscheidungsträgerverhalten die Wahl und Effizienz ausgewählter Instrumente zur Einkommensstabilisierung?

Obgleich Versicherungslösungen zur Minderung landwirtschaftlicher Risiken anfällig für Probleme asymmetrischer Information sind, wird ihr möglicher Beitrag zur Risikoreduktion untersucht. Vor diesem Hintergrund werden Versicherungsprodukte beschrieben und analysiert, welche in der Lage sind das Ausmaß von *Moral Hazard* zu begrenzen.

Über das Programmierungsmodel hinaus, wurden eine Betriebsbefragung sowie eine Befragung unter politischen Entscheidungsträgern, Repräsentanten von Versicherungsfirmen und öffentlicher Verwaltung sowie Wissenschaftlern durchgeführt.

Die Zielstellung dieser empirischen Studien, insbesondere der Betriebsbefragung, ist die Beantwortung der folgenden Fragen: Welchen Produktionsrisiken stehen kasachstanische Betriebsleiter gegenüber? Welche Risikoeinstellung besitzen sie? Und welche Risikomanagementinstrumente wenden sie an?

Des Weiteren, werden Antworten gegeben auf die Frage, wie das aktuelle Gesetz zur Ernteversicherung in Kasachstan von den Ergebnissen dieser Arbeit profitieren könnte.

Hinsichtlich der Nutzeneffizienz verschiedener Risikomanagementinstrumente können wir schlussfolgern, dass die separate regionale Analyse eine vernünftige Vorgehensweise darstellt, weil nur schwer generelle Schlussfolgerungen aus den Ergebnissen gezogen werden können.

Eine größere Anzahl verschiedener Versicherungsprodukte stabilisiert Einkommen auf effiziente Art und Weise, wie aus erarbeiteten Ranglisten geschlossen werden kann. Allerdings erscheinen wetterbasierte Indexversicherungen besser geeignet für die Absicherung von Risiken in der nordkasachstanischen Getreideproduktion. Versicherungen von Rayon-, Oblast- oder nationalen Erträgen stellen eine sinnvolle Alternative zu wetterbasierten Versicherungen dar, da auch sie einige Vorteile hinsichtlich der Bekämpfung von *Moral Hazard* aufweisen. Allerdings sollten die Vorteile in bezug auf einen besseren Zugang zu symmetrischer Information abgewägt werden gegen die möglicherweise geringere Risikoreduktion. Für den Fall einer Einführung einer sogenannten *Area-Yield-Versicherung* bieten Underlyings, die sich auf kleinere Flächenausschnitte (Rayonebene) beziehen, höhere Risikoreduktionen als solche, die größere Flächen (Oblastebene) zugrunde legen.

Eine zentrale Schlussfolgerung kann für alle Untersuchungsbetriebe gezogen werden. Die Wahl der Produktionstechnologie ist der entscheidende Faktor im Risikomanagement. Dieses Ergebnis steht in engem Zusammenhang zu den Ergebnissen der Betriebsbefragung. Den befragten Betriebsleitern zufolge, gehören die Akkumulation von Kapitalreserven sowie die Produktion zu möglichst geringen Kosten zu den wichtigsten betrieblichen Zielen. Allerdings zeigen die Modellergebnisse auch, dass diese Strategien nicht die *First-Best-Lösungen* für alle untersuchten Betriebe ergeben. Wenn die Erträge versichert werden, kann eine Anwendung intensiverer Technologien (mit höheren Kosten verbunden) sinnvoll sein.

Für die weitere Forschung können wie schlussfolgern, dass die Bedingungen unter denen Entscheidungen, beispielsweise hinsichtlich eines Versicherungsabschlusses, getroffen werden, stark zwischen einzelnen Regionen und Betriebstypen variieren.

Demzufolge sollten zukünftige Risikomodelle an die besonderen Bedingungen des Forschungsobjektes angepasst werden, weil standardisierte Modellformulierungen zu falschen Ergebnissen führen können. Eine natürliche Erweiterung dieser Arbeit stellt die Untersuchung anderer Regionen und Kulturen dar. Zukünftige Forschung sollte das langfristige Potential alternativer Früchte unter veränderten natürlichen Bedingungen und Preisen erkunden. Darüber hinaus können verschiedene Kombinationen von Versicherungs- und Hedginginstrumenten getestet werden

Betrachtet man den Versicherungsmarkt in Kasachstan, kann die Hypothese, dass Ertragsversicherungen oft größere Betriebe unterstützen, nicht verworfen werden. Einer der Gründe für die Einführung einer Pflichtversicherung ist die Schaffung eines gleichberechtigten Versicherungszugangs aller Betriebe, ungeachtet ihres Produktionsrisikos oder der Betriebsgröße. Nichtsdestotrotz haben Versicherungsunternehmen zur Zeit weniger Anreize, kleine, risikobehaftete Betriebe zu versichern. Zu den Zukunftsaufgaben der Regierung gehören deshalb, einen angemessenen Mechanismus zu finden, der die Versicherung von kleineren Betrieben im Rahmen eines Pflichtversicherungsprogramms gewährleistet bzw. die Umwandlung zu einem freiwilligen Versicherungssystem voranzutreiben.

Eine weitere Regierungsaufgabe beinhaltet das Aufbrechen der negativen Pfadabhängigkeit von Ernteversicherungen in Kasachstan. Das schlechte Bild der gesamten Versicherungswirtschaft könnte primär verbessert werden durch die Setzung eines zuverlässigen Rechtsrahmens sowie der Schaffung von zusätzlichen Anreiz- und Durchsetzungsmechanismen. Das Ziel sollte der Aufbau eines Versicherungssystems sein, das Versicherungsunternehmen Gewinnerwirtschaftung ermöglicht sowie ihren Klienten den Zugang zu fairer Einkommensstabilisierung eröffnet, welche die Basis für eine Entwicklung wirtschaftlicher Aktivitäten herstellt.

Zur Stärkung der Verbindung zwischen produktionstechnischen und finanziellen Risikomanagementinstrumenten sollte die Regierung die Erforschung geeigneter pflanzenbaulicher Verfahren zur Minderung der Effekte schwieriger Anbaubedingungen fördern. Unterschiede in klimatischen Bedingungen, wie Bodenart und -fruchtbarkeit, Wasserverfügbarkeit, Verbreitung von Unkräutern und die Erosionsanfälligkeit, sollten mehr als bisher bei der Erarbeitung neuer Technologieempfehlungen berücksichtigt werden.

Table of contents

List of figures

List of tables

1 Introduction

1.1 The role of agricultural income stabilisation in the transition process

In past decades, economists have been changing their understanding of the relative contribution of agriculture and industry to economic growth. There has been a shift – away from an earlier "industrial fundamentalism" to an emphasis on the significance of agricultural development and productivity for the overall development process.

Marx was highly impressed by the efficiency of large-scale farming in England and regarded the elimination of peasant farming as an essential step in agricultural development. His theory had strong impact on the structural developments in many former socialist countries, especially in the countries of the former Soviet Union. Large-scale cooperatives and state farms were created which were oriented towards output maximization.

Increasing agricultural output by means of expansion of areas cultivated or grazed has played a dominant role throughout history. The most dramatic example in the Western history was the opening up of new continents as sources of food and agricultural raw materials for the Metropolitan areas in Western Europe. In the Eastern hemisphere, the largest project of crop area expansion was the Virgin Lands Campaign which took place between 1954 and 1964 and cultivated about 30 million hectares of steppe in Western Siberia and Kazakhstan. This policy which was designed under Chrustchov extended grain production to marginal areas with extremely low and fluctuating precipitation. Since then, crop production has played an important role in the gross domestic product of Kazakhstan and serves as the most important base of living for about 43 per cent of the population that live in rural areas. However, agricultural business is risky and incomes from crop production are particularly prone to strong income fluctuations. Income stabilization in the agricultural sector plays an important role for overall economic sustainability and might justify income stabilising governmental policies. Stabilisation of agricultural incomes might significantly reduce incentives for rural-urban and international migration and human capital degradation.

The justification for agricultural income stabilisation finds a good repetition in the multifunctional character of agricultural production. This means that agriculture produces jointly primary and secondary products. Primary products are food and fibre. Secondary products can be summarised as shaping the landscape, providing environmental benefits, such as land conservation, the sustainable management of natural resources, the preservation of biodiversity and last but not least a contribution to socio-economic development. Finally, agricultural income stabilisation might contribute to the narrowing of the rural-urban income gap and the fight against rural poverty, which are predominant problems in many transition countries[1].

Worldwide, crop insurance is seen as an important instrument of farmers' income stabilization. For politicians the introduction and promotion of crop insurance promises voters' support and success in elections. An indicator of the political topicality in post-soviet countries are frequent headlines in recent press releases (INTERFAX AGRICULTURE AND FOOD REPORT, 2003, 2004a, 2004c, 2005b, 2005c, 2006a). However, there might be more efficient income support mechanisms in place that would fulfil the same objective and better support smaller farmers. This contribution focuses on risk analysis on the farm-level and discusses the welfare implications of risk management instruments as a side aspect.

From a normative point of view, policy objectives should be based on societal needs[2]. The need for income stabilization in Kazakhstan's agriculture is particularly reflected by the extreme crop output fluctuations caused by adverse weather conditions. The analysis of affordable and efficient risk management instruments in a transition country seems scientifically and practically rewarding. From a scientific point of view, unique data has to be collected and analysed to reflect the situation of decision-makers appropriately. Methods will have to be developed to account for structural breaks and uncertainty caused by transition.

1 For a recent review of rural poverty in transition countries, see MACOURS and SWINNEN (2006).

2 GÓMEZ-LIMÓN and ATANCE (2004) discuss the importance of agricultural policy objectives from a society point of view by analysing the relative weights that people assign to the various potential objectives of the Common Agricultural Policy (CAP) in the European Union (EU). Two of the identified societal objectives are directly related to rural income stabilisation, i.e. "to maintain villages and improve the quality of rural life" and "to provide an adequate income for farmers". Under the assumption of coupled direct payments as defined in Agenda 2000, both objectives were ranked important to very important compared to other objectives in a survey among 321 residents of the region "Castilly y León" in Spain. This indicates the relative political importance of income stabilisation measures in rural areas. There is no such evidence how comparable policy objectives would be evaluated in Kazakhstan. However, the fact that the support of rural areas is a major objective of Kazakhstan's agricultural policy might show their societal importance, e.g. expressed in a programme on development of rural area, which was implemented in the years 2003-2005.

From a practical point of view, innovative risk management instruments can be tested on a pilot-basis and results and recommendations disseminated to political decision-makers, farmer organisations and insurance companies.

1.2 Motivation and focus of the study

As an area of research, the topic of risk management and crop insurance has seen a dramatic increase in popularity during the past decade. A search of the *Ingenta Connect* database indicates that during 2001-2005 the number of crop insurance related articles published in refereed journals was double that of the previous five-year period. COBLE and KNIGHT (2002) believe that a number of forces have attracted researchers to this seemingly narrow research topic. Primary among these is the fact that issues arising in crop insurance are at the interface of sub-disciplines within the agricultural economics profession. Crop insurance has attracted the interest of researchers interested in models of risk and risk behaviour. The topic fits also within the broader framework of farm management decision-making. Furthermore, it has appeal to those scientists who are interested in information economics and deal with adverse selection and moral hazard. Crop insurance is in most parts of the world a government-subsidised programme and thereby touches the research areas of welfare and constitutional economists. The analysis of crop insurance and risk management in a transition country, where political and economic structures are in dynamic change processes might be rewarding from a scientific and practical point of view. MISHRA and GOODWIN (2006) put forward two reasons, why the discussion on crop insurance has gained momentum in recent years. First, the liberalisation of agricultural markets may be associated with greater price instability. Second, under agreements with the World Trade Organisation (WTO), crop insurance qualifies under certain conditions as ‘green box’ policies.

This contribution aims at shedding light on the question, how farm income can be efficiently stabilized under transition conditions. Furthermore, it will be attempted to answer following sub-questions:

a) What are the most efficient income stabilization mechanisms for different farm types in Kazakhstan?

b) How do climatic conditions and yield variability influence the efficiency of income stabilization instruments?

c) How do assumptions about decision-makers on the farm-level behaviour influence the choice and efficiency of selected farm income stabilisation instruments, e.g. to which extent risk aversion affects the choice of risk management instruments in a less developed country with extremely high coefficients of yield variation and often little diversified production systems?

Although insurance solutions to agricultural risk suffer from being prone to asymmetric information problems, their possible impact on risk reduction will be investigated. Therefore, insurance products, which are able to limit the extent of moral hazard problems will be described and analysed. Furthermore, answers will be provided to the question how the actual law on crop insurance in Kazakhstan can profit from findings generated in the course of this research.

1.3 Chapter organization

The thesis is organised in five chapters. *Chapter 2* provides a theoretical discussion of risk sources and effects in agricultural production as well as possible risk management instruments. The chapter furthermore discusses obstacles to effective insurance market development. Finally, it motivates risk programming as the conceptual framework for analysing behaviour under risk and uncertainty.

After the theoretical background for risk analysis in agriculture has been explained, *chapter 3* describes the development of the agricultural sector in Kazakhstan during transition with special emphasis on the role of risk management in crop production. This chapter provides a detailed description of the three research regions *Akmola*, *East Kazakhstan*, and S*outh Kazakhstan*, which have been selected for an in-depth analysis. It consolidates the discussion of risk management instruments started in the preceding chapter by investigating on-farm and financial measures to manage risk efficiently under the described conditions. A special focus in this chapter is the critical discussion of the actual crop insurance system in Kazakhstan and the role of public support for crop insurance.

Chapter 4 presents the empirical analysis of risk management instruments. First, the results of different surveys on the development of an adequate risk management framework are discussed. Interviews were conducted with farmers, scientists and representatives of insurance businesses, government institutions and agricultural lobby groups. The aforementioned results provide the background for the modelling of on-farm and financial risk management instruments from a whole-farm point of view. The applied utility-efficient programming model investigates the impacts of different risk management instruments on utility and income of the considered case farms. Sensitivity analysis is carried out and results are supplemented by findings of stochastic dominance and mean-variance analyses of insurance products.

Finally, *chapter 5* summarises the thesis. It places the obtained results within the context of policy design. Implications for current theory are pointed out as well as possible directions of future research.

2 Analytical framework of risk and risk management analysis in agricultural production

This chapter presents the most important risk sources and effects in agriculture. The following description of risk management strategies focuses on the management of production risk. Chapter 2.3 discusses obstacles to effective insurance market development. Finally, the main methodological approaches to decision-making under uncertainty will be described.

2.1 Risk sources and effects in agriculture

Agriculture is typically a risky business. Farmers as well as policy-makers have for long tried to cope with those risks. The most important risks can be categorized in the following way (BAQUET et al., 1997; BOEHLJE and TREDE, 1977; FLEISHER, 1990; HARDAKER et al., 2004; ODENING, 2005):

– *Production or yield risk.* The particular characteristic that distinguishes agriculture from many other types of business is the high degree of production risk. This can be due to technological change, machinery failure, resignation of workers, weather effects, and other factors. Production technology plays a key role in influencing the extent of uncertain consequences. Production and yield risk in agriculture depends significantly on the farm type. Whereas yield risk in the livestock sector is less influenced by meteorological factors, crop farmers' dependence on weather is greater, but varying across specialisations. For example, crop yield variability in irrigated cotton farming in South Kazakhstan is relatively unimportant compared to grain farmers in northern Kazakhstan regions. Equivalent results are presented by BLANK et al. (1997) for Californian farmers.

– *Price or market risk* results from changes in prices of outputs or of inputs after a production decision has been taken. The price changes result from different sources, such as variable interest on working funds, supply and demand variations on domestic and world markets, shift in agricultural policy, change of consumer behaviour, and deficient quality. In a survey conducted in Kazakhstan (HEIDELBACH et al., 2004), price risk seems to play a predominant role in farmers' decision-making. Comparable studies for the U.S. by PATRICK et al. (1985) and PERRY (1997) confirm the high importance of price risk, especially for wheat and cotton farmers. For farmers in developing and transition countries without access to futures and options markets, trustworthy information on prices as well as price forecast is important to make decisions on crop portfolio and storing or selling. Farmers in the developed world who are well-integrated into the market can progressively rely on price information provided by futures markets.

– *Institutional risk* reflects changes in policies and regulations negatively affecting the financial result of a farmer. For example, regulations[3] restricting the use of pesticides may alter production costs or foreign trade arrangements might affect output prices. The risk caused by policy measures might be partially reduced by increasing market liberalisation and decreasing subsidy levels.
– *Human or personal risk* is common to all business operators and relates to death or poor health of a principal or employees.
– *Asset risk* is also common to all businesses and involves theft, fire and other loss or damage of equipment, buildings and other agricultural assets.
– *Financial risk* comprises rising cost of capital, exchange rate risk, insufficient liquidity and loss of equity.
– A growing importance is attributed to *contracting risk* – A type of risk that involves opportunistic behaviour and reliability of contracting partners.

The different types of risk are interrelated and become relevant in different economic situations. The empirical analysis of risk management instruments in chapter 4 focuses mainly on the analysis of production risk (as an effect of weather and technology changes) and price risk. Some scenarios of the risk programming model will highlight the effects of financial (variations in interest rates) and contracting risk (moral hazard).

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[3] A recent example of institutional risk in German agriculture are the newly evolved debates about limiting the amount of foreign seasonal labourers in agriculture (*Frankfurter Allgemeine Zeitung*, 2005). In Germany foreign farm labourers are mainly used by labour-intensive vegetable and fruit producers during the harvest season. Political decision makers discuss a potential positive effect on the domestic labour market, when the German unemployed will replace the foreign seasonal labourers who come since 15 years annually mostly from Central and Eastern Europe. German agricultural employers are concerned about negative consequences of the "job-creating campaign" of the federal government since they know about the often low motivation and physical condition of the unemployed. Farmers state that they would have to give up production, if they had to employ comparatively the less productive German unemployed (MDR, 2006).

2.2 Management of production risk in agriculture

"Risk management is the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring risk" (HARDAKER et al., 2004). Two types of risk management strategies are normally distinguished: (1) on-farm measures and (2) risk-sharing with others (MEUWISSEN et al., 1999).

On farm strategies concern farm management and include production portfolio selection, holding sufficient liquidity and diversification. *Risk-sharing strategies* include marketing contracts, production contracts, vertical integration, hedging on futures markets, participation in mutual funds and insurance. *Other strategies* include relying on public assistance and increasing the share of non-agricultural income.

2.2.1 On-farm strategies

On-farm risk management measures aim at avoiding or limiting the impact of different types of risk. The following sections discuss the two most important on-farm strategies, which are the selection of less risky technologies and the diversification of enterprises.

2.2.1.1 Selecting less risky technologies

KIM and CHAVAS (2003) investigated technological change and risk management based on data from Wisconsin research stations. They analysed the effects of technology on risk exposure. Their empirical results indicate that technological progress contributes to reducing the exposure to risk as well as downside risk in corn production. They reported that the technological change has contributed to a lowering of the risk premium, which they use as the criterion to measure risk exposure

The technology diffusion debate has elicited a vast amount of economic literature[4], with much of it focusing on the explanation of slow diffusion rates of profitable technologies. The different identified factors imply different policy strategies for the promotion of new technologies. FOLTZ (2003) mentions four hypotheses for how and why new agricultural technologies diffuse throughout a region. These include resource scarcity, capital constraints, learning costs, and risk aversion.

[4] For a review of the literature, see FEDER, JUST and ZILBERMAN (1985).

Adopting technical innovation depends not only on the entrepreneurial skills and willingness of the decision-maker, but also on the availability and the price of the new technology. The protection of domestic agricultural sectors by means of tariffs, quotas and other trade barriers has in many countries positive external effects for domestic agricultural machinery producers, such as high import duties for imported machinery. In the case of Kazakhstan, there is a 40 per cent import duty on tractors. DYKER (2005) assumes that if Kazakhstan manages to negotiate a significant degree of protection for the agricultural sector in the course of WTO negotiations, some of the benefits of this protection might be passed on to the domestic agricultural machinery sector, to the extent that Kazakhstan farms buy equipment from domestic agricultural machinery firms. However, restriction of competition weakens technological innovations and might be an impediment for the competitiveness of the agricultural sector as such.

2.2.1.2 Diversification

The idea of diversification is to reduce the dispersion of the overall return by selecting a mixture of activities that have net returns with low or negative correlations. The diversification approach indirectly follows the thoughts of PENROSE (1995), who developed the resource-based theory of growth and diversification.

Enterprise diversification is a traditional approach to risk management in agriculture (BARRY et al., 1995). In general, farmers will diversify more with increasing degree of risk aversion (HARDAKER et al., 2004). However, diversification can be costly if it means foregoing the advantages from specialisation through better command of superior technologies and closer attention to the special needs of one particular market. The merits of diversification are widely recognized. However, it was not practiced under the very specialised large-scale agriculture in the Soviet Union. Gradually, a stream of the scientific community in the CIS countries seems to acknowledge the advantages of enterprise and product diversification (SAFRONOV et al., 2005)

YACOUBI et al. (1998) discuss farmer’s risk management measures in the case of drought, which is the most important natural hazard in Kazakhstan. They list following points as relevant in drought risk management:

- Water conservation
- Use of drought-resistant seeds
- Diversified farming systems
- Development of off-farm sources of income
- Low input strategy
- (Micro-)financial services

Prospects of agricultural diversification will be discussed for the case of Kazakhstan in chapter 3.5.1.2.

2.2.2 Risk sharing

A holistic approach to risk management requires to investigate the effects of financial risk management alternatives. Fisher's separation theorem (FISHER, 1933) implies that it is better to diversify through capital markets than through a combination of enterprises. Therefore, risk analysis in agriculture should consider on-farm risk management instruments AND financial instruments for coping with risk. The empirical analysis includes marketing responses to risk (futures), credit and insurance as financial risk management responses. These measures are described in further detail in the following sections. Special emphasis is given to crop insurance products. A more comprehensive discussion of financial risk management measures can be found in HARDAKER et al. (2004) and ODENING (2005).

2.2.2.1 Marketing responses

TOMEK and PETERSON (2001) group marketing alternatives to risk management into three alternatives: First, spot-market strategies, i.e. diversifying the frequency of marketing of annually produced crops. Second, individual forward contracts, e.g. between traders of agricultural commodities and producers. Third, hedging via standardized futures and options contracts. In finance, a futures contract is a standardized contract, traded on a futures exchange, to buy or sell a certain underlying instrument[5] at a specified future date at a predefined price. Futures are quite similar to forward contracts, but with some important differences to be explained: In contrast to a forward contract between a single farmer and a single merchant, futures are standardized instruments with usually competitively determined prices. That implies that futures are always traded at an exchange, whereas forward contracts are traded over the counter. The credit risk of futures is lower than that of contracts, because the profit or loss on a futures position is exchanged in cash every day, whereas the profit or loss on a forward is only realised at the time of settlement. Thus, the forward contract credit risk exposure can keep increasing and a farmer might be better off with futures compared to a forward contract. The price of a future represents the expected value of the underlying discounted at a risk-free interest rate[6]. The

[5] Frequent underlyings are assets, pensions or indexes.

[6] The risk-free interest rate is the assumed interest rate that can be obtained by an investment with no risk.

value of a future *F(t)* will be found by compounding the present value *S(t)* at time *t* to maturity *T* by the rate of risk-free return *r*:

$$F(t) = S(t) * (1 + r)^{(T-t)}$$

2.2.2.2 Credit

Credit is an important instrument of enterprise financial management. The adoption of a new technology as well as the ongoing production processes requires investments, with payoffs and revenues realized at a later point in time.

To receive credit, a borrower usually has to fulfil several preconditions depending on the credit contract. In formal credit markets, the most important precondition is the existence of collateral for the case of loss of the ability to repay the loan in another way. Many farmers in transition and developing countries suffer from a lack of collateral and therefore do not get access to formal credit markets. The second problem that contributes to the failure of credit markets is strategic default, i.e. a situation in which the borrower is able but not willing to pay back the loan (RAY, 1998). The probability of loan default is especially prevalent where the legal enforcement system is weak (RAY, 1998). For these reasons, many informal credit markets exist based on different concepts that reach from mutual self-help initiatives to informal lenders, such as landlords, shopkeepers, and traders. During the past twenty years, the importance of smallholder access to credit has been recognised by international organisations, national governments and newly evolving credit organisations, such as the Grameen Bank in India that provides micro-credits to mostly poor rural people (GRAMEEN BANK, 2006).

There is an opportunity to closely link the establishment of rural credit markets and crop insurance. It has been recognised that the development of crop insurance could help to improve borrower repayment discipline by diminishing farmers' inability to repay low yields after occurrence of natural hazards. In Morocco, the *Caisse Nationale de Crédit Agricole* (CNCA) made the purchase of drought insurance a mandatory condition for obtaining an agricultural loan in the areas covered under the current drought insurance scheme (SKEES et al., 2001). Insurance is also compulsory in Mexico for those farmers who borrow from agricultural banks. Crop insurance will be extensively discussed in the following section.

2.2.3 Insurance

There are various types of insurance contracts available to agricultural enterprises, such as hail and fire insurance, death and disability insurance for farmers and family members, different types of insurance for machines and buildings as well as crop insurance that in contrast to the other forms of insurance mentioned before, is mostly provided under subsidized government schemes.

The functioning principle of insurance can be formulated as follows (RAY, 1998): Usually a farmers' income at each date consists of three components, i.e. first, the average income (A), second, a random shock (ε) that may have the same distribution across farmers, but affects each one independently[7], and third, a component (θ), which incorporates all aggregate income variation that affects all farmers in a region at the same time. Aggregate or systemic income variations in agriculture can be often drawn back to adverse weather effects or infectious diseases that spread over space. The stated relationship can be algebraically expressed as:

$$Y = A + \varepsilon + \theta$$

With the establishment of a (formal or informal) insurance funds with no administrative costs, the idiosyncratic component (ε) can be diversified away, when farmers pay the expected value of ε, E(ε), as the insurance premium. Thereby farmers with positive values of ε support other farmers with negative realised values of ε at a specified point in time. At another specified point in time contributors and recipients of the fund might change due to a change in idiosyncratic factors that influence individual income. The comparison of the situation with insurance $\overline{Y} = A + \theta$ to the case without insurance reveals that the income with insurance carries less risk because the idiosyncratic component is removed.

There are two main preconditions for the establishment of a perfect insurance market: First, the insurance provider must be able to pool the risks of a number of clients. Second, the insurance provider has access to information about the characteristics of the insured and is able to assess the future loss potential of the insurance pool in an appropriate way (RAY, 1998).

The thesis is focused on risk management in crop production. Therefore, the following further discussion on insurance will be confined to crop insurance solely.

Crop insurance – An International perspective

Given the diversity of natural hazards, crops, and political systems worldwide, the experience of crop insurance policies is varied. Though the majority of the

[7] This component is also called idiosyncratic factor and is influenced by e.g. disease infestation of plants and animals or an inappropriate production technology.

examples discussed in the literature stems from Northern America[8], a significant focus of the agricultural economics profession lies on the stabilisation of agricultural incomes in developing countries. Insuring farmers' production and price risk has long attracted governments' attention. The motivation for insurance and other income stabilisation programmes often originates in governmental concern about catastrophic risks such as drought, which might have an impact on national food security, or the desire to reduce loan defaults to banks (HAZELL et al., 2001). However, many different insurance schemes have been tried with modest success. In practice, many of the larger crop insurance programmes are state-subsidised by 50 per cent of insurance premiums. Even at these high levels of subsidy, many farmers are still reluctant to purchase insurance. As a result, some crop insurance programmes have been made compulsory, e.g. in Japan, Mexico, and Kazakhstan. HARDAKER et al. (2004) question the utility-efficiency of compulsory schemes for farmers unwillingly forced to join. However, reluctant farmers may not insure under a facultative scheme, because of non-transparent information provided by the state or the insurance company.

The diversity of insurance products makes it difficult to draw a clear distinction between them. Before starting an analysis of different insurance products, the most important ones will be presented and systemized to provide an overview (Table 2-1).

Table 2-1: 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	Actual production history	Catastrophic Coverage Level (CAT)

Source: BOKUSHEVA and HEIDELBACH, 2003.

[8] See BERG (2001) for a comprehensive overview about the crop insurance system in the USA and European Commission (2001) for an overview of crop insurance in industrialized countries.

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[9]. At the same time, two mechanisms of crop insurance can be distinguished. The first mechanism is based on the actual production history (APH) of the farm. APH provides the base for premium and indemnity 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 designing insurance contracts. By this technique, insurance payoffs are subject to the occurrence of a special event or result, which can be described by an 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). Weather index insurance will be described in more detail below.

The next distinction can be drawn between 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 (who evaluates losses and how?);
– Re-insurance regulations (state as a backup-financier or international re-insurance?);
– Deductibles (yes or no and if yes, what percentage of insurance sum), and
– Prices and costs, which are used to calculate indemnities and premiums.

Another 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. VALENTINOV and HEIDELBACH (2006) discuss the advantages and disadvantages of alternative institutional mechanisms of agricultural insurance,

[9] Parametric insurance products are based in indexes such as weather indexes. Catastrophic insurance is defined as insurance against catastrophic events such as severe droughts, floods, and hurricanes.

such as the role of civil society and institutions in the organisation of agricultural insurance.

This short overview shows that, although there exists a variety of insurance products at the moment, many of them bear a resemblance to each other and are based on the same features or functioning principles. However, there may be considerable differences in purchase decisions and risk reduction between crop insurance products. MISHRA and GOODWIN (2006) investigate revenue insurance[10] purchase decisions. They motivate their research on revenue insurance by citing several studies on comparative advantage of revenue insurance compared to price support programmes or pure crop yield insurance. E.g. TURVEY (1992) compared public expenditures per monetary unit (dollars in this case) of risk reduction and found revenue insurance was the best at promoting self-insurance through diversification. Similar results were obtained by GRAY et al. (1994), HARWOOD et al. (1994, 1999) and HENNESSEY et al. (1997). STOKES et al. (1997) show that insuring for the whole farm's revenue is more efficient than insuring each crop by a different revenue insurance policy. COBLE et al. (2000) demonstrate that revenue insurance may be a substitute for alternative risk reduction strategies, such as hedging with futures and options. MAHUL and WRIGHT (2003) indicate that revenue insurance contracts might be complementary to typical hedging instruments. However, all mentioned studies do not include weather index insurance (WII) [11], which is a relatively new insurance instrument. The following section will compare weather index insurance to other available insurance products. A special focus lies on the applicability of insurance products under transition conditions.

2.2.3.1 Comparison of crop insurance products with regard to their applicability in a transition economy

In order to support the development of sound crop insurance, alternative insurance products should be considered for discussion. The following comparison will shed some light on the design of adequate insurance products for a transition country like Kazakhstan.

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10 Revenue Insurance programmes, such as RA, IP, and CRS provide coverage to producers against lost revenues or incomes caused by low prices, low yields, or a combination of both. An indemnity is paid when any combination of yield and price results in revenues that lie below a pre-defined guarantee level.

11 WII is a type of parametric insurance. Parametric insurance uses triggers that describe the naturally occurring event such as the intensity and location of a storm, the number of millimetres of precipitation, or the height of flood. These parameters are outside the control of the parties to the hedge contract.

BOKUSHEVA (2004) compares different crop insurance products regarding their applicability in transition countries. She finds that index-based insurance provides some important advantages compared to other insurance types, primarily due to their capacity to reduce transaction costs on the insurance market. In the case of transition countries, 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[12] are prevalent during transition, using area-yield as a reference value for risk pooling should be considered with caution. Thus, WII can be viewed as a preferable insurance product under these circumstances. Like other crop insurance products, weather-based insurance cannot solve the problem of systemic risk pooling. An important precondition regarding the establishment of a WII product is the provision of reliable and affordable weather information for insurance market participants. This issue underlines the importance of institutional frameworks.

At the initial stage of insurance market development, a great deal of attention must be paid to educating potential customers on insurance matters. In the light of bad experiences with insurance during the Soviet era, farmers in transition countries might be sceptical about crop insurance. Hence, pilot projects must be started to convey farmers 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 is indicated.

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. BOKUSHEVA's analysis (2004) shows that area-yield insurance (AYI) and WII provide more advantages compared to multi-peril crop insurance and revenue insurance in a transition context. These advantages include:

- Insurers can more accurately assess the actuarial fairness of premiums, and thus reduce the adverse selection problems, because only systemic risk is to be insured;
- Both schemes have relatively low transaction costs;
- AYI is better applicable given prevailing data limitations on the farm level;
- WII is less bureaucratic, and thus provides less scope for corruption[13];

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[12] Table 3-16 shows productivity differences expressed in the correlation of farm yields of main crops for the three rayons investigated in chapter 4.4.3. Chapter 3.1 discusses the development of the agricultural sector in Kazakhstan before and after transition.

[13] Precondition is the establishment of a dense net of telemetric weather stations that are not possible to manipulate.

- WII is better positioned to avoid moral hazard because of objective nature of parameters that trigger indemnity payments.

WII is a promising alternative also in the eyes of the Worldbank. MAHUL (2006) sees two other advantages of WII, i.e.

- Quick disbursement. WII claims can be settled right after the occurrence of an insured event, as weather data is usually available on a daily basis. This immediate claim settlement allows farmers to get access to quick liquidity.
- Availability. WII could be made available to a wide variety of parties (including farmers, agricultural lenders, traders, processors, input suppliers, agricultural workers) who have an insurable interest, i.e. adverse weather events create monetary losses.

The World Bank plans to support the establishment of a network of weather stations in Kazakhstan. Furthermore, it is planned to test WII in some pilot regions.

Nevertheless, some important issues remain unresolved despite introducing these advanced insurance schemes (BOKUSHEVA, 2004):

- AYI and WII do not solve the problem of risk pooling;
- Both products generate a higher basis risk compared to individual insurance products;
- Neither of them provides protection against price risk;
- There exists a danger that risk-averse farmers may change their production patterns in a way that increases systemic risk;
- AYI can lead to adverse selection since it is based on average yields of a region;
- WII 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 WII might be more attractive for them compared to AYI.

MAHUL (2006) discusses other challenges related to WII, i.e.:

- *Imperfect coverage*. Careful design of the terms and conditions of the weather index insurance policy is critical to ensure that the indemnity payment is commensurate with the incurred loss. However, by definition, the index is a proxy of the real loss and thus one cannot exclude that the indemnity may slightly under-estimate (or over-estimate) the actual loss.
- *Measurements*. WII relies exclusively on the index measurements reported by the weather stations. It is thus critical to further develop more secure,

tamper-proof stations and instruments and, whenever it is possible, to double-check these measurements with nearby stations or satellite data (e.g., remote sensing data).

- *Actuarial modelling*. The modelling and rating of WII differ from those used for standard lines of insurance business. They mainly rely on recent catastrophe risk modelling techniques. In particular, it is critical to identify any possible downward trend, such as inter-temporal decreasing rainfall due to climate change, because such trend may jeopardize the viability of such products.
- *Securitization*. WII is a new type of financial product where the underlying asset is a weather index. Financial market institutions are attracted by those types of products not correlated with their asset portfolio and thus which allow them to increase the performance of their portfolio. While they are sometimes reluctant to invest in insurance and reinsurance companies because they do not fully understand the risks faced by these companies, the products focusing only on specific insured events (rainfall, temperature) are more transparent and thus more attractive. This may facilitate the access of the reinsurance market to the capital markets through securitization.
- *Education*. WII is a combination of insurance concepts and financial concepts. Education campaigns and training should be organized by government agencies to explain these concepts to potential providers (insurers) and potential customers (farmers, banks, etc.) (s. a. VALENTINOV, 2006).

Although it is an old idea (HALCROW, 1949) WII received in recent times global attention, which can be concluded from the number of worldwide projects related to that topic. The World Bank and other institutions have been piloting weather-based index insurance contracts in Morocco, Mongolia, Peru, Vietnam, Ethiopia, Guatemala, India, Mexico, Nicaragua, Romania, and Tunisia (SAWADA, 2006; NIETO et al., 2006; SKEES et al., 2001)

A further indicator of the actuality of the topic is the number of presentations on the IAAE conference 2006 dedicated to it. There were two complete sessions dealing with the introduction and implementation of weather-index insurance (BREUSTEDT and LARSON, 2006; BERG et al., 2006; KARUAIBE et al., 2006; TAKAHIRO and KUROSAKI, 2006; MUßHOFF et al., 2006; GOODWIN and MAHUL, 2006; GINE et al., 2006; SARRIS, 2006) as well as a session on drought as the most important hazard affecting agricultural production (PANDEY et al., 2006; HERTZLER et al., 2006; GAUTAM, 2006; ANDERSON, 2006). Additionally one poster has been presented, which is directly related to this thesis (BOKUSHEVA et al., 2006)

Whereas most models on optimal hedging/insurance of a single risk investigate only one type of risk management instrument, MAHUL (2003) combines individual and index-based insurance contracts. Mahul illustrates the role of an index-based contract as a market-enhancing instrument using two representative wheat farms located in France. The efficient frontiers show the efficiency gain provided by an optimal combination of the two hedging instruments. The author shows that this gain decreases as the individual yield variability increases and/or the degree of correlation decreases.[14]

2.2.3.2 New developments

Another new development is the emerging of traded weather derivatives. Though weather derivatives and weather-index insurance have many things in common, there are differences between the two: The Chicago Mercantile Exchange (CME, 2006) defines weather derivatives in contrast to weather insurance as follows: "…weather derivatives cover low-risk, high probability events. Weather insurance on the other hand, typically covers high risk, low probability event." This is true as long as weather insurance covers events like floods and hurricanes. In the case of rainfall-based crop insurance the probability of drought occurrence might be higher, while the risk involved is lower than in the definition above.

Furthermore, satellite imagery offers new opportunities for agricultural insurance. The new generation of crop index-based insurance products will be based on the combination of available historical ground data and high precision remote sensing data (MAHUL, 2005). The use of advanced remote-sensing technology for monitoring purposes offers the opportunity to obtain independent, reliable information about field sizes, date of sowing and yields. The first crop insurance programme based on this technology is the pasture-satellite imagery insurance programme in Canada. The use of this technology for crop insurance is under investigation in some developing countries. According to expert statements, first tests were conducted for Kazakhstan (SPIVAK, 2003). DORAISWAMY et al. (2002) tested a satellite imagery system for crop yields assessment in the spring wheat belt of north Kazakhstan. Results show that the system works in general, but would have to be calibrated to the natural conditions in Kazakhstan. Although, multiple-peril crop insurance is not yet introduced in Germany, the insurance industry has already designed applicable insurance products. These products consider the specific risk potential by accounting for regionally specific weather risks, crop-specific risks and soil conditions. For the evaluation of the drought risk of a regional soil, a database of the Federal Institute for Geosciences and

[14] The applied risk programming model (s. chapter 4.4.3) also offers the opportunity to combine different insurance products at the same time. However, the allowed combination is not in the sense of Mahul as a buy-up for the total area. The model rather considers different insurance products for different parts of the total crop area.

Natural Resources (BGR) is being used (BÖHME, 2006). This approach could be exemplary for other countries.

2.2.3.3 Insurance in the light of WTO negotiations

Both, income and crop insurance schemes are part of the green box, which is defined in Annex 2 of the Uruguay Round Agriculture Agreement[15]. In order to qualify, green box subsidies must not distort trade, or at most cause minimal distortions. They have to be government-funded and must not involve price support. In the current negotiations, some countries argue that some of the subsidies listed in Annex 2 might not meet the criteria of the annex's first paragraph – because of the large amounts paid, or because of the nature of these subsidies, the trade distortion they cause might be more than minimal. Among these subsidies is government financial participation in income insurance and income safety-net programmes as stated in paragraph 7 of Annex 2. The regulations stated here and in paragraph 8 (payments for relief from natural disasters) have to be taken into consideration when designing agricultural insurance (WTO Uruguay Round Agreement on Agriculture).

2.2.4 Political considerations

As mentioned in the introduction, the formulation of policy objectives and recommendations should be led by societal needs. From a normative point of view, financial risk management products should increase overall welfare. Concretely, we might raise the question, how insurance market development influences overall economic development. KUGLER and OFOGHI (2005) discuss in their recent paper the relationship between insurance market development and overall economic growth. In contrary to WARD and ZURBRUEGG (2000), their results show for most insurance types a positive relationship between insurance market development and economic growth.[16]

Under the assumption that insurance market development positively contributes to welfare, the question arises, how insurance should be designed. For the agricultural insurance context, one has to keep in mind that farmers' incomes are more variable than incomes of non-farmers (MISHRA et al., 2002). In the same context, INNES (2003) discusses the effects of ex ante crop insurance versus ex post disaster relief in a political economy. The applied model depicts how crop insurance

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[15] <http://www.wto.org/english/docs_e/legal_e/14-ag_02_e.htm#annII>.

[16] Although KUGLER and OFOGHI (2005) are not considering agricultural insurance, the results might apply for it as well.

can deter relief payments and improve production incentives by countering moral hazard problems. Under several assumptions (see INNES, 2003), an optimal ex ante farm policy (a) insures farmers against the distress that otherwise prompts ex post government disaster relief, (b) offers an output subsidy that counters the underproduction incentive created by the government revenue guarantee, and (c) limits government programme costs by charging farmers for the programme.

BABCOCK and HART (2005) investigate the effect of premium subsidies on farmers' insurance coverage decisions. Investigating U.S. data, they come to the conclusion that subsidizing higher coverage levels induced farmers to buy crop insurance at greater than 65 per cent coverage levels. However, the subsidy became necessary to reduce disincentives caused by inappropriate ratemaking procedures. The authors estimate that acreage with higher coverage would decrease significantly if subsidies were decoupled. The positive effect of the introduction of coupled subsidies on the decision to buy additional coverage will make it difficult to find arguments to change this policy after ratemaking was adjusted. This relationship highlights the importance of the sound establishment of a crop insurance system. When having the chance to build up a new system from scratch, particular effort should be put in a sound ratemaking procedure.

As the legislative power, the government and the parliament of a country can choose between a compulsory or voluntary insurance system. Compulsory insurance solves the misallocation of risks in the economy and the organisation of a system to compensate the victims (GOLLIER, 2005). However, Gollier is more sceptical than optimistic about compulsory insurance. He states that compulsory insurance has been funded by a flat, non-discriminatory, non-incentive compatible insurance tariff. The policy holders investment in loss prevention would not be observed by the fund because it is difficult to get information on it or because the fund did not get a positive incentive to organise an incentive-compatible system.

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. It violates free decision-making and factor allocation. Additionally, a compulsory insurance scheme is usually regulative, which prevents insurance companies from setting actuarially fair premiums.[17]

[17] At this point, we might ask, why the Government of Kazakhstan chose to introduce a ompulsory crop insurance. One of the reasons is definitely the political will to offer an insurance to all farmers in Kazakhstan and not to compensate high-risk farmers in certain

2.3 Obstacles to effective insurance market development

A necessary condition for a demand for risk management instruments is risk-averse preferences of potential risk managers. A risk management instrument increases the users' welfare only when their income is less prone to risk with than without the respective instrument. This assumption is restrictive, in the sense that farmers might change their production depending on the risk management instruments in place. For instance, under subsidised insurance, it is conceivable that the part of relatively risky crops will be increased, since the insurance compensates the additional risk. In such a case, the total risk of the producer stays constant, but the expected value of profit increases. Availability of financial risk management measures (risk-sharing strategies) influences decisions on diversification and technology choice.

The main precondition for insurance market development is insurability, which hinges on whether individually rational insurance policies are available, i.e. policies which make both, clients and insurance companies better off than in the absence of insurance (CHAMBERS, 1989). More specifically, rational insurance policies have to be available for a sufficient number of individuals to realise the law of large numbers. In addition, the literature specifies two further aspects that have an effect on insurability: Asymmetric information and systemic risk. In assessing the insurability of risks in agriculture, MIRANDA and GLAUBER (1997) identify both as basic conditions for risk insurability: First, the insurer and the insured should have very nearly symmetric information regarding the probability distribution of the underlying risk; second, the risks should be nearly independent across insured individuals. The following two sections discuss these obstacles to insurability.

2.3.1 Asymmetric information in insurance markets

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. Thus, under asymmetric information, low risk individuals may not be able to obtain an equilibrium insurance contract, resulting in a market failure (CHAVAS, 2004). Moral hazard is a result of hidden actions of the

regions only. As results from a farm survey show, there is a strong disapproval of compulsory crop insurance in Kazakhstan. Although 64.4 per cent of the respondents would like to be insured, only 37 per cent of this number believe that crop insurance should be compulsory (HEIDELBACH et al., 2004).

insured, which increase the risk of loss of the insurer. In the context of the principal-agent model, this means that the principal cannot observe the agent's effort level. It implies that the effort level cannot be specified in the contract terms. When effort is costly, this gives an incentive for the agent to apply little effort, which may be detrimental to the efficiency of resource allocation (CHAVAS, 2004). 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) demonstrates 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.

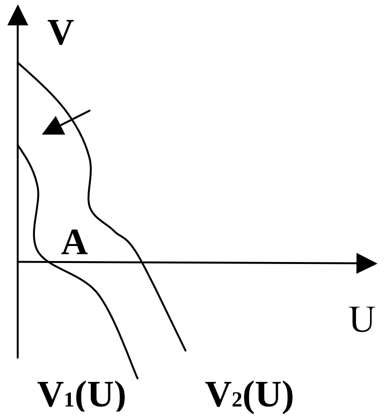
Past experience suggests that most popular crop insurance schemes, particularly multi-peril yield insurance and revenue insurance, are prone to adverse selection and moral hazard. Both prevent the emergence of commercial, all-risk agricultural insurance. Therefore they will be discussed in the following sections.

2.3.1.1 Accounting for moral hazard

Moral hazard has several economic implications. According to KOTOWITZ (1987) moral hazard enclose "actions of economic agents in maximizing their own utility to the detriment of others, in situations where they do not bear the full consequences or, equivalently, do not enjoy the full benefits of their actions due to uncertainty and incomplete or restricted contracts which prevent the assignment of full damages (benefits) to the responsible agents." DOHERTY and MAHUL (2006) explain the occurrence of moral hazard in an empirically more applicable way. They state that the occurrence of catastrophic events (so-called frequency risk) is beyond the control of individuals, while the economic impact (risk severity) is not. An agent can reduce the severity of given events by applying risk mitigation strategies. By reviewing the literature, this section will explain economic impacts of moral hazard and mention some of the countermeasures that can be taken to reduce the negative impacts. Several references to the empirical part of this contribution will show how impacts and countermeasures were investigated for the case of Kazakhstan.

BORCH (1990) discusses moral hazard as a possible explanation for insurance markets failures. First of all, it might reduce insurability of crops by shifting the insurer's expected utility curve inwards, as depicted in Figure 2-1 (see CHAMBERS, 1989). For the Pareto-optimal expected utility frontier, the relevant region is the portion lying to the northeast of A where both, insurers and farmers are better off than in autarky. For an insurable agricultural market, A lies on or below the Pareto-optimal expected-utility frontier. If moral hazard shifts the curve to the origin (V_2 to V_1), the probability that agricultural risk is not insurable rises.

Figure 2-1: Expected utility frontiers and insurability



Source: Own figure based on CHAMBERS (1989).

Note: U=Utility, V=Expected profit of insurers.

Second, moral hazard leads to less than full insurance with the effect that the insured retains some incentive to reduce losses. Thus, moral hazard causes deadweight losses that may prevent the development of profitable agricultural insurance markets without state subsidies[18].

As we have learned from the literature cited above, moral hazard has several negative economic effects. What can be done to reduce or abandon these effects? According to a part of the literature, countermeasures are deductibles and co-insurance[19]. The introduction of deductibles or limited coverage is a traditional argument to stimulate self-protection of the insured (HUBERMAN et al., 1983).

CHAMBERS (1989) disagrees on this point and states that increasing deductibles is a bad strategy because high deductibles make the highest revenue states less attractive for producers and thus provide a disincentive for self-protection. Chambers recommends that agricultural insurance policies should include outcomes for which the farmer bears the entire burden of revenue risk. Furthermore, the asymmetric information problem should be solved directly, e.g. insurance companies

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18 An empirical investigation in chapter 0 quantifies the arising deadweight losses from moral hazard for investigated farms.

19 The simplest type of indemnity payment is one in which the insurer pays a fixed proportion of the loss. This type of insurance indemnity is often referred to as coinsurance, since the individual retains (or "co-insures") a fraction of the loss (SCHLESINGER, 2000).

should collect as much a priori information about farmers as possible. If available, insurers may also use any contemporaneous information on farming practices.

Another measure against moral hazard are multiyear contracts, i.e. the contracts have a memory and the insurance company is able to sanction the insured for high indemnity payments in the past. Multiyear contracts are more widely distributed in life insurance. However, the willingness to sign multiyear contracts was tested in the farm survey and will be discussed in chapter 4.4.2.2.

In recent times, HALCROW's (1949) historic proposal for a crop insurance contract where indemnities are based not on a producer's individual yield, but instead on the aggregate yield of a risk pool was intensively discussed in literature. Several studies (e.g. MIRANDA, 1991; BOURGEON and CHAMBERS, 2003) stressed the advantages of area-yield insurance as compared to farm-yield insurance. Miranda, in particular, emphasises its ability to prevent adverse selection problems associated with farm-yield insurance. Moreover, area-yield contracts can help eliminate moral hazard if the pool is large enough and a single farmer cannot influence the area yield and treats it as given.

There are other empirically relevant studies that investigate measures in insurance design that help to control moral hazard. DOHERTY and MAHUL (2006) examine how multiple triggers in recently launched insurance securitisations trade off between moral hazard and basis risk. Several case studies of objective, informative of the action triggers are being investigated. The idea to use multiple triggers to address moral hazard stems from HOLMSTRÖM (1979). Moral hazard is controlled by linking the payout to an objective trigger. DOHERTY and MAHUL (2006) give three examples of triggers that are used in insurance securitisations: First, the Chicago Board of Trade (CBOT) catastrophe derivatives are triggered by an index of aggregate insurance industry losses. Second, weather derivatives are triggered by physical descriptions of a weather event. Third, over-the-counter instruments (OTC), such as catastrophe bonds, have various triggers, though predominantly, they are triggered by a market index or a parametric description of the event.

2.3.1.2 Adverse selection

Adverse selection refers to the implications of insurers' inability to identify the risk types of individuals. JUST et al. (1999) analysed U.S. cross-section data at the farm level to understand incentives to participate in crop insurance programmes. The results suggested that farmers participated mainly to receive the associated subsidy or because of adverse selection. The risk-aversion incentive was small.

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 must 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 are rather heterogeneous. In this respect, 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.

2.3.2 Systemic risk

A special type of risk that is not explained by a certain source, but rather describes a certain risk quality is called *systemic risk*. Contrary to automobile or fire risks, which tend to be independent, systemic risk in agriculture means that crop-yield risk exhibits a substantial degree of correlation across space (MIRANDA and GLAUBER, 1997). Insurers often face the possibility of all the insurance contracts they write making large losses simultaneously. If individual insurers face credit rationing, as it is often the case in developing and transition countries, they may not be able to indemnify large losses simultaneously (CHAMBERS, 1989). If agricultural markets are non-insurable for this reason, Chambers suggest that they can be made insurable by broadening the risk pool to encompass less covariate risk sources, e.g. by introducing financial market products such as weather derivatives, and removing the limits of credit rationing. When markets fail, mutual insurance might be another solution.

Much attention has to be paid to the economic viability of agricultural production in individual regions. If long-term farm profitability is not achievable due to unfavourable weather and production conditions in a region, risk pooling would not be an appropriate mechanism of farm income stabilisation, since it would imply an income redistribution from profitable to unprofitable farms and, respectively, from more productive to less productive sectors of the economy.

2.4 Analysis of decision-making under uncertainty – Basic approaches

The classical approach to decision-making under uncertainty is the Expected Utility Model, which is a classical mathematical theory of decision making with associated procedures for measuring subjective desires and beliefs. The Expected Utility Model has been used as the framework theory in many textbooks on decision-making, risk analysis, and risk management (e.g. ANAND, 1993; BISWAS, 1997; CHAVAS, 2004; EECKHOULDT and GOLLIER, 1995; and HARDAKER et al., 2004). At the same time, there exist some paradoxes which induce certain limitations on application of expected utility framework for approximating actual behaviour of a decision maker. Several contributions have shown alternative ways of modelling decision-making under risk and uncertainty, e.g. GOLLIER and MACHINA, 1995. Nevertheless, the Expected Utility Model remains the best model at hand for prescriptive analysis and will be used as the theoretical framework in this thesis.

2.4.1 The Expected Utility Model and its axiomatic foundation

The Expected Utility Model is based on the expected utility hypothesis, which states that a decision-maker has risk preferences represented by a utility function *U(x)* and makes decisions to maximise expected utility *EU(x)*. However, some assumptions have to be made under which human behaviour would always be consistent with expected utility hypothesis. These assumptions include[20]:

[20] Note that the choice between x_1 and x_2 is denoted as follows:

$x_1 \approx^* x_2$ denotes indifference between x_1 and x_2,

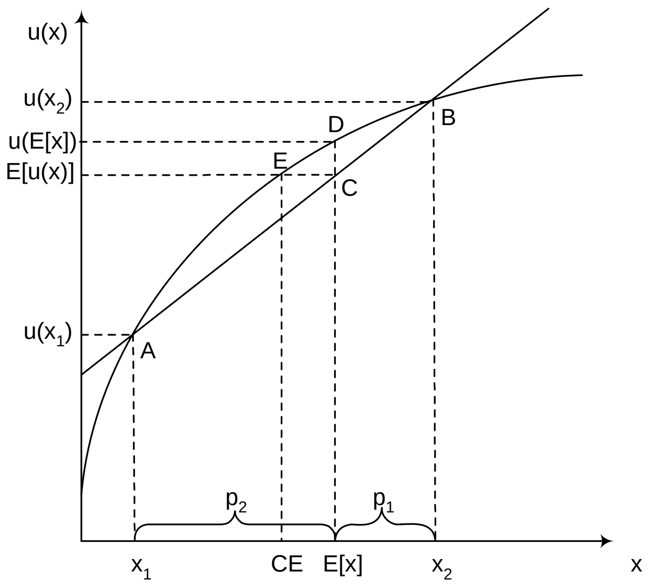
$x_1 \geq^* x_2$ denotes that x_2 is not preferred to x_1,

$x_1 \succ^* x_2$ denotes that x_1 is preferred to x_2.

- Ordering and transitivity:
- *for any random variables* x_1 *and* x_2, *exactly one of the following must hold* $x_1 \succ^* x_2, x_2 \succ^* x_1$, *or* $x_1 \approx^* x_2$, *and if* $x_1 \geq^* x_2$ *and* $x_2 \geq^* x_3$, *then* $x_1 \geq^* x_3$,
- Independence:
- *for any random variables* x_1, x_2, x_3, *and any* $\alpha(0 \prec \alpha \prec 1)$, *then* $x_1 \leq^* x_2$ *if* $[\alpha x_1 + (1-\alpha)x_3] \leq^* [\alpha x_2 + (1-\alpha)x_3]$
- *, i.e. the preferences between* x_1 *and* x_2 *are independent of* x_3. *It implies that indifference curves are always parallel and probabilities are linear,*
- Continuity:
- *for any random variables* x_1, x_2, x_3, *where* $x_1 \prec^* x_3 \prec^* x_2$, *there exist numbers* α *and* β, $0 \prec \alpha \prec 1, 0 \prec \beta \prec 1$, *such that* $x_3 \prec^* [\alpha x_2 + (1-\alpha)x_1]$ *and* $x_3 \succ^* [\beta x_2 + (1-\beta)x_1]$, *i.e. a sufficiently small change in probabilities will not reverse a strict preference (s.a. CHAVAS, 2004).*

Figure 2-2 presents a graphical interpretation of the expected utility concept: When income increases, 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 a person would take to avoid a certain 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).

Figure 2-2: Determination of Expected Utility and Certainty Equivalent



Source: Own figure.

When considering certainty equivalent as a criterion in a normative decision model it is important to prove that the model holds true in an expected utility framework. CHAVAS (2004) has shown that the maximisation of certainty equivalent is equivalent to the maximisation of expected utility, i.e. $max\ EU(x) \equiv max\ [E(x)-R]$, where R is the risk premium[21].

2.4.2 Alternatives to the Expected Utility Model

From a theoretical point of view, one might question expected utility theory (RABIN and THALER, 2001; The Economist, 2001). Several pieces of literature demonstrated the shortcomings of the expected utility model (ALLAIS, 1953; TVERSKY and KAHNEMAN, 1981). The Allais paradox (CHAVAS, 2004) is grounded on the empirical evidence that the indifference curves are not always parallel. This has been interpreted as evidence that the independence assumption is inconsistent with observed risk behaviour. MACHINA (1982) shows that the expected utility model would provide a good approximation to risk preferences for small changes in the probability distribution

PAPON's (2004) experimental study investigates insurance behaviour in low-probability high-loss risk situations. The study reveals that insurance behaviour may depend on the individual prior experience towards risk. The author favours non-additive decision models such as Dual Theory (YAARI, 1987) and Cumulative Prospect Theory (TVERSKY and KAHNEMANN, 1992) that seem to have a higher descriptive power than Expected Utility Theory when explaining subjects' behaviour. In particular, Papon's paper provides new explanations of the fact that people usually fail to obtain insurance against disaster-type risks such as natural disasters, even when premiums are close to actuarially fair levels. According to the author's results, the deficiency of insurance demand for natural disasters may be due to the lack of individual prior experience towards such risks; as well as the relatively short commitment period of insurance policies (usually one fiscal year) compared with the empirical frequency of major natural hazards (centennial and even more).

Despite criticism, leading economists still consider the expected-utility model as best suited for prescriptive analysis of risky choices (MACHINA, 1987; EDWARDS, 1992). Among agricultural and resource economists this view is supported by MEYER (2001), JUST (2003), and HARDAKER and LIEN (2005).

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[21] The risk premium (RP) measures the largest amount of money that a decision-maker is willing to pay, to replace a random revenue by its expected value.

2.4.3 The importance of accounting for risk aversion

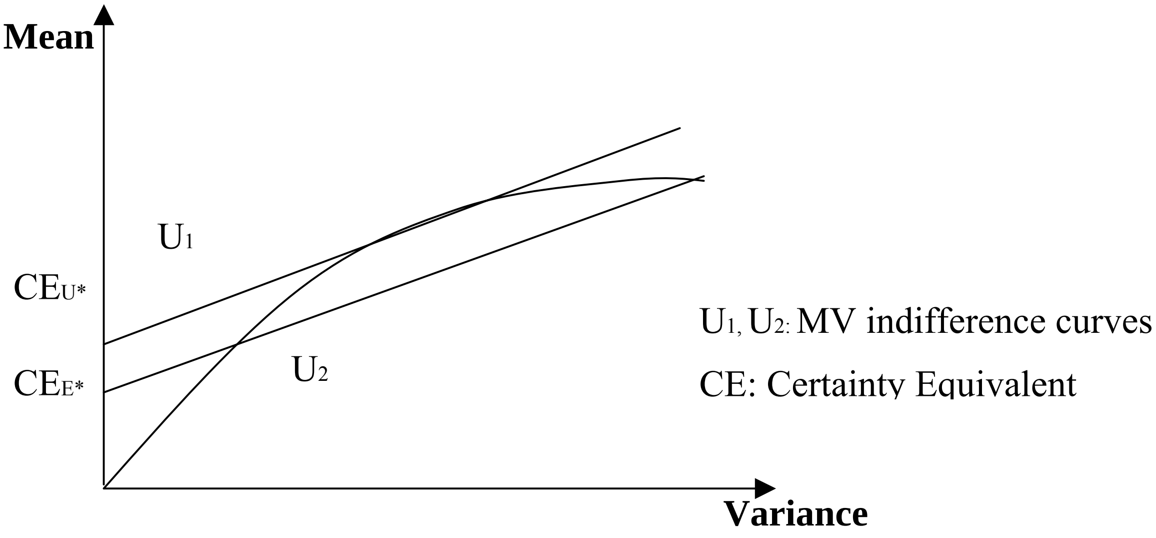
The discussion above shows different approaches to explain behaviour under risk and uncertainty. However this behaviour is explained, not accounting for it and assuming risk-neutral behaviour might be misleading. JUST and POPE (2002) conclude in a conceptual paper that risk behaviour is most important for long-term inter-temporal decisions because instabilities cannot be mitigated by standard risk management tools. More empirical work has to be done to understand how decision-maker preferences weigh consumption versus wealth accumulation, and how those preferences affect long-term decisions related to consumption versus investment decisions, financial planning, insurance, etc. However, the technical, physical, and financial structure of agricultural production and the inter-temporal dependence of income shocks and marginal utilities is crucial to understanding the magnitude and implications of risk-aversion. HARDAKER et al. (2004) support the view that risk aversion is often not nearly as important as getting the expected income value right, at least in commercial farming in more developed country. The authors argue that the focus on risk aversion may have been a source of confusion in that attention has been directed to reducing variability of returns rather than on finding the most risk-efficient option (erroneously minimizing the risk premium rather than maximizing the certainty equivalent).

Figure 2-3 depicts schematically the cost of ignoring risk aversion (CIRA). In a Mean-Variance context, CIRA is defined as

$$CIRA = CE_{U*} - CE_{E*},$$

where CE_{U*} is determined assuming a risk averse decision maker and CE_{E*} is certainty equivalent defined under assumption that the decision maker is risk-neutral. The magnitude of CIRA depends on the risk aversion coefficient, which explains the slope of the MV indifferent curves U1 and U2. The gradient of these curves declines as risk aversion diminishes. As a result CIRA decreases. No general conclusions can be drawn on the impact of risk aversion on operational farm management decisions. CIRA has to be measured before drawing conclusions about its importance in the respective model.

Figure 2-3: Costs of ignoring risk aversion in prescriptive analysis



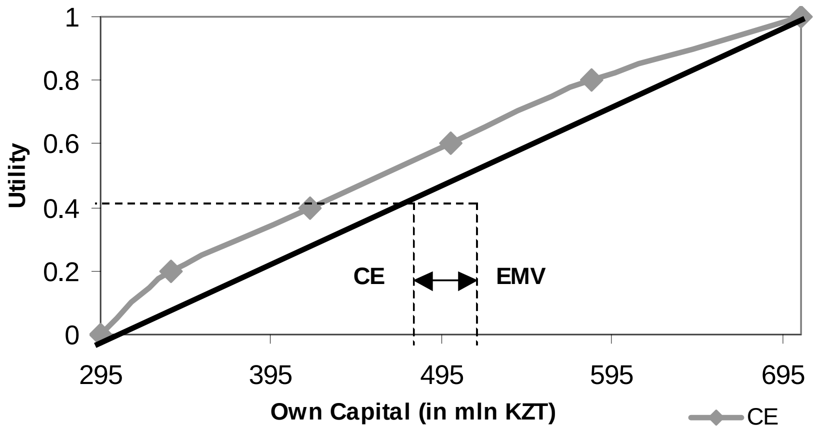
Source: HARDAKER et al., 2004.

HUDSON et al. (2005) prove in their study on consistency of risk premium (RP) measures the difficulty of selecting a single RP measure to employ in applied analysis. None of the tested measures exhibited superior explanatory power. From a broader perspective their results suggest that the multidimensionality of risk inhibits the efficient capturing of risk for applied research.

Nevertheless, for the assessment of individual risk aversion different methods were tested. Besides Likert-scale questions in the farm survey, the ELCE (equally likely risky outcomes) method was used. This method, which was first described by ANDERSON et al. (1977), enables to elicit a utility function directly by comparing two prospects, one of which is risky and the other not. If the decision-maker has an aversion to, or a preference for, gambling the method allows depicting this bias. HARDAKER et al. (2004) propose this method for its advantage to be based on the ethically neutral probabilities of 0.5. However, this method has also disadvantages. First, if the decision maker has aversion or a positive attitude towards gambling, bias will be introduced. Second, the ELCE method cannot be applied to discrete cases, where outcomes cannot be varied continuously.

The ELCE method is illustrated in Figure 2-4. It shows the results of an application of this method to a crop farmer, whose wealth (measured by own capital) varied strongly across the last five years, i.e. future wealth accumulation cannot be forecasted and is subject to uncertainty. The farmers initial wealth *wi* was 295 Mio KZT, his final wealth *wf* 706 Mio KZT. The utility values attributed to *wi* and *wf* are 0 and 1 assuming that the farmer cannot gain any utility from wealth levels below the initial one. The slope of the utility function indicates the properties of a typical risk-averse decision-maker.

Figure 2-4: Wealth and respective utilities for a crop farmer in Akmola

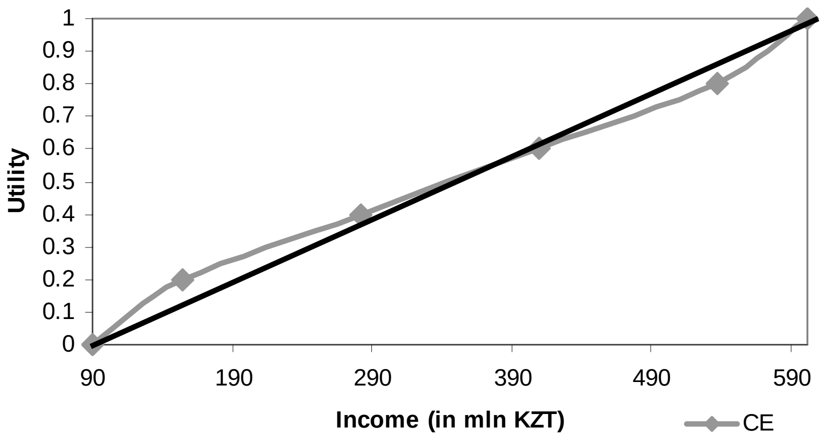


Source: Own figure.

Note: CE=Certainty Equivalent, EMV=Expected Monetary Value.

However, when considering income instead of wealth, the curve looks somewhat different (see Figure 2-5). At higher income levels, risk aversion decreases and the risk-averse decision-maker becomes a gambler. Behaviour towards risk is not always consistent with expected-utility theory as the discussion above shows. HUDSON et al. (2003) record this behaviour in experiments.

Figure 2-5: Income and respective utilities for a crop farmer in Akmola



Source: Own figure.

Note: CE=Certainty Equivalent.

In this context, the study aims also at clarifying the question, to which extent risk aversion influences the choice of risk management instruments in a less developed country with extremely high coefficients of yield variation and often little diversified production systems.

2.4.4 Methods for risk analysis at the enterprise level

There are different ways of how to implement the expected utility framework in a model that analyses risk efficiency of different production activities and risk management instruments. In the literature, two main methodological approaches can be identified that analyse risk reduction of risk management measures on the farm level.

First, normative programming models provide exact solutions and flexibility to represent different scenarios. These models have been numerously applied to empirical problems. Well known examples are MOTAD (Minimisation of Total Absolute Deviations), Expected Utility, and Mean-Variance models.

Second, econometric models make few assumptions about the decision makers' objective function and preferences, technology parameters and about 'representative' conditions that reflect different states of nature. They are strongly data-driven and must contain a sufficiently great number of economic units.

Additionally, a relatively new theoretical model, which allows integrating production adaptations under risk – the so-called state-contingent approach – stems from CHAMBERS and QUIGGIN (2001). However, empirical applications are limited as the authors assume that production technology is dependent on the state of nature, which appears at a period and is stochastic between the periods.

The following discussion of advantages and disadvantages of different approaches as well as some empirical applications will concentrate on the first two of the methodological approaches.

2.4.4.1 Mean-variance analysis

Most empirical applications determine the agent's optimal hedging strategy following the mean-variance (MV) approach. Mean-variance analysis uses the first two moments of a distribution to determine risk-efficient solutions to a problem. It is based on the proposition that, if the expected value of alternative A is greater than or equal to the expected value of alternative B, and the variance of A is less than or equal to the variance of B, with at least one strict inequality, then A is preferred to B by a decision-maker who fulfils following conditions. First, the decision-maker is risk-averse or risk-neutral. Second, the decision-maker must have an outcome distribution that is normal or an utility distribution that is quadratic. Since the second condition is very restrictive and seldom holds in practice, the mean-variance criterion has to be perceived as an approximation rule.

One popular application of MV efficiency analysis are portfolio models (MARKOWITZ, 1952) on the firm level to support decision-making regarding different investment alternatives or production activities. Table 2-2 describes the contributions of BERG (2003), NANSEEKI and MOROOKA (1991) and PETRICK and DITGES (2000) as applications of the MV criterion, which support its usefulness and practicability. When carrying out portfolio analysis in a MV framework it has to be kept in mind that the MV criterion is an approximation of the expected utility model. HARDAKER et al. (2004) conclude that where direct maximization of expected utility is possible, it is to be preferred to the MV approximation.

There are alternative methods to MV analysis when analysing portfolio risk and hedging decisions. Stochastic efficiency analysis is a well-known approach defined as follows.

A risk programming model seems to be best suited to test the risk efficiency of on-farm instruments and risk-sharing strategies simultaneously. Furthermore, the effects of changes in technology, credit access, and interest rates can be analysed in the framework of a programming model. The following section tests the adequateness of different risk programming approaches to fulfil the research objectives.

2.4.4.2 Risk programming

Since FREUND (1956) wrote his paper on introducing risk in a programming model and developed a quadratic risk programming (QRP) model, many alternative risk programming models have been developed. QRP is commonly used to generate the mean-variance efficient set of plans. It has the advantage of being simple. Unfortunately, the approach requires restrictive assumptions of either a quadratic utility function or normally distributed net income. Quadratic utility functions assume positive marginal utility within a bounded range (HANOCH and LEVY, 1970) and increasing absolute risk aversion (ARROW, 1965). Both characteristics are inconsistent with the expected nature of true preferences (PATTEN et al., 1988). There have long been available methods for approximating the effects of risk aversion in an LP model, including chance-constrained programming (KIRBY, 1970), MOTAD (HAZELL, 1971) and Target MOTAD (TAUER, 1983). See BOISVERT and MCCARL (1990) and HARDAKER et al. (1991) for useful reviews of these and other techniques. These last mentioned models have been developed at a time when software to handle non-linear objective functions was less available and less reliable.

However, another group of methods, such as the direct maximization of expected utility (LAMBERT and MCCARL, 1985) and Utility Efficient Programming (UEP) (PATTEN et al., 1988) is superior to these in that it involves a lower level of approximation and is more consistent with the expected utility analysis (HARDAKER et al., 1991). For our problem, given some knowledge about the shape of the utility function and risk aversion, UEP seems to be well suited, because assumptions about the shape of the utility function and risk attitudes are made.

UEP is a simple extension of the direct maximization of expected utility developed by LAMBERT and MCCARL (1985). In a UEP the activity net revenue vectors for different states of nature, s_n, represent the uncertainty in activity returns. Therefore, there is no need to assume any standard form of distribution. It rather permits the incorporation of a number of different probability distributions, which can be derived from past observations that are treated as a sample of equally likely outcomes or as states with subjectively assessed probabilities. CHAMBERS (1989) differentiates between states of nature and result states. States of nature are often difficult to determine. This is particularly true in agriculture, when the state of nature is a combination of many different risk sources, such as drought, wind, rain, hail, pest infestation, etc. As a result agricultural insurance contracts are often specified in terms of result states, i.e. yield states, rather than the underlying state of nature. The applied determination of states will be discussed in chapter 4.5.2.

The UEP procedure allows the identification of all farm plans that are efficient for a set of decision-makers whose risk attitudes can be represented by a particular class of utility functions, defined over an interval of degrees of risk aversion. The identified farm plans will be first, second, third and n-th degree stochastically efficient for those particular decision-makers (PATTEN et al., 1988).

HARDAKER et al. (2004) report on the difficulties of evaluating correctly the net effect of introducing new risk management instruments such as insurance. They conclude that such decisions can be best considered in a whole-farm portfolio selection model. A utility-efficient programming approach would be especially suitable for evaluating the merits of crop insurance in a farm plan since this method is implemented via a states of nature matrix that can capture the effects of insurance on the distribution of returns.

2.4.4.3 Stochastic efficiency analysis

In contrast to MV analysis and other moment-based methods, stochastic efficiency analysis is based on the direct maximisation of expected utility. There are different stochastic efficiency criteria, such as first-, second-, and third-degree stochastic dominance. An application of second-degree stochastic dominance (SSD) analysis will be presented in the empirical part of the thesis (see chapter 1.1.1) and is therefore conceptually described here.

The SSD criterion can be summarised as follows: A risky alternative A described by the cumulative distribution function G(w) is preferred to another risky alternative described by the cumulative distribution function H(w) if

$$\int_{-\infty}^{x} H(w)dx \geq \int_{-\infty}^{x} G(w)dx$$ for all $x \in \Re$ and at least one strict inequality

If the farmer's utility function is concave in w, SSD is consistent with expected utility (MOSCHINI and HENNESSY, 2001). However, SSD sometimes is not a good decision-making tool because high degrees of risk aversion are excluded. Empirical applications of the SSD criterion in agricultural economics are income comparisons of different policy scenarios (TOLLEY and POPE, 1988) and the efficient reduction of crop production risk by insurance (BREUSTEDT, 2004). Breustedt combines the MV and the SSD approach and concludes that the model results in terms of risk reduction vary significantly among the two. In chapter 1.1.1 different insurance instruments for Kazakhstani crop production will be tested based on Breustedt's approach. A detailed description of stochastic efficiency concepts can be found in LEVY (1992).

Table 2-2 gives an overview of selected recent empirical applications of different risk analysis models on the farm-level. It describes briefly the methodology and data used for analysis and presents the main findings of the applications.

Table 2-2: Selected empirical analyses of risk reduction on the farm-level

Author(s)	Subject	Methodology	Region, data & time	Main results and findings
BERG (2003)	Modelling the impacts of uncertainty and attitudes towards risk on production decisions in arable farming	Mean variance analysis, stochastic production model	German arable farm, 150 ha	Mean variance approach has proven its usefulness because of its deductive strength and the straightforward applicability in optimisation models.
BREUSTEDT (2004)	Efficient risk reduction in arable farming by means of crop insurance	Combination of traditional mean-variance (MV) analysis with the criterion of second degree stochastic dominance (SSD)	767 Western German wheat farms, 1989-1998	Previous methods may have overestimated the risk reduction of area yield crop insurance for more than one-half of the farms. For every fifth investigated farm, the EU consistent minimum relative variance reduction can be overrated by more than ten percentage points by means of MV. Bootstrapping shows that even many expected variance reductions above 50% are not significant and that area yield insurance seems to perform significantly better than farm yield insurance for many farms.
LIEN et al. (2001)	Whole-farm planning under uncertainty: Impacts of subsidy scheme and utility function on portfolio choice in Norwegian agriculture	Two-stage utility efficient programming model	Norwegian farm business data for 7 years (1992-1998	Farmers' risk attitudes have no significant impact on the choice of enterprise mix. Subsidy schemes, market conditions and available farm labour are more important determinants of optimal plans than risk attitudes or the form of the utility function.
MUßHOFF, HIRSCHAUER (2006)	Benefits derived from systematic statistical analyses of empirical data and improved production planning approaches	Systematic time series analysis and stochastic optimisation model,	4 German cash crop farms, 1998-2004	The method shows clear advantages in terms of realised gross margins compared to farmers' observed empirical programmes.

Author(s)	**Subject**	**Methodology**	**Region, data & time**	**Main results and findings**
NANSEEKI, MOROOKA (1991)	Risk preference and optimal crop combinations	Stochastic programming,	25 soybean-based farm households Upland Java, Indonesia, 1982-1985	Changes in risk preference affect the optimal crop combination. The typical cropping pattern is rational under observed risk attitudes.
PETRICK and DITTGES (2000)	Theoretical implications of portfolio selection for rural banking and risk management in agriculture; Impacts of liquidity constraints on risk and expected profit; Methodological comparison between quadratic programming (QP) and minimisation of total absolute deviations (MOTAD)	QP and MOTAD for the analysis of whole-farm risk	North-Western Kazakhstan (Aktyubinsk Region), 1993-1998	Even relatively small amounts of credits could reduce whole-farm risk if a middle course is found which ensures a sufficient return on capital and thus attracts banks' interest. In order to reduce risk in the short-run at given resource stocks, a strategy of diversifying the production programme can be pursued. QP vs. MOTAD: Close to the risk-neutral solution, results of both are nearly identical, while substantial differences in activity levels exist for less risky farm plans. With regard to the computed combinations of expected profit and standard deviation, MOTAD produced a systematically higher variation than quadratic programming.'

2.4.4.4 Sensitivity analysis

A methodology for conducting a sensitivity and stability analyses of solution behaviour with respect to problem changes is a well-established requirement of any scientific discipline. It should be an integral part of any solution methodology because the status of a solution cannot be understood without such information (FIACCO, 1983).

Sensitivity analysis is broadly defined as the investigation of the responsiveness of conclusions to changes or errors in parameter values and assumptions (BAIRD, 1989). Sensitivity analysis can be used to determine whether output changes significantly, when one or more inputs are changed (LAW and KELTON, 1991). FIACCO (1983) emphasises the importance of sensitivity analysis. They demand that sensitivity and stability analysis should be an integral part of any solution methodology. The status of a solution could not be understood without such information. The sensitivity analysis of the later discussed programming model will be carried out by varying assumption about risk aversion and input factors, such as liquidity and credit availability.

3 Development of the agricultural sector during transition and the role of risk management in Kazakhstan

3.1 Economic situation in Kazakhstan

Taking into account the Human Development Index (HDI) (UNDP, 2005), Kazakhstan ranks in the group of countries with ‘medium human development’ on place 80 out of 177 countries. Since the first HDI recording for Kazakhstan shortly before independence in 1990, the index remained relatively stable (between 0.767 in 1990 and 0.721 in 1995). Since 1995 the index value is steadily increasing to 0.761 in 2003.

In the years between independence in 1991 and the year 1995 the GDP fell by almost one third. The reason for this sharp decline was mainly the disintegration of the Soviet Union economic system with all the accompanying negative circumstances, mainly hyperinflation and the disappearance of important markets (ECONOMIST INTELLIGENCE UNIT, 2005). The government could stop the downward trend of the economy in the second half of the 1990s by pursuing a strict monetary policy, the consequent opening of the economy and the beginning of a reform process that allows for limited private ownership. Compared with other former Soviet republics in Central Asia, Kazakhstan was a precursor towards a market-friendly economic policy and could attract foreign direct investment (ALAM and BANERJI, 2000). However, Kazakhstan is still a relatively closed economy compared to Central and Eastern European countries. Crude oil and other natural resources are its main export products (BROADMAN, 2005). Economic growth driven by the exploitation of natural resources like oil and gas is risky to some extent. Rapid increase of oil exports is causing an appreciation of the domestic currency and draining financial and human resources out of other economic sectors (Dutch disease).

Characteristically for Kazakhstan is the strong and steady increase of GDP mainly caused by the growth of the oil industry. GDP was growing in average by 10.4 per cent in the period between 2000 and 2004. However, the rapid GDP growth does not say much about the income distribution. MACOURS and SWINNEN (2006) investigate rural and urban poverty across transition countries as related to differences in land privatization and farm restructuring Rural-urban poverty differences are very high for Kazakhstan. As in Russia, the ratio of rural and urban headcount is more than 50 per cent higher in rural than in urban areas[22]. In Kazakhstan, agricultural growth and rural poverty reduction between 2001 and 2002 occurred in the oblasts[23] that had a stronger shift to small-scale agriculture. A regional example for such a pattern is South Kazakhstan with an agricultural structure that resembles structures in Albania, Azerbaijan, Armenia, and Kyrgyzstan. According to Macours and Swinnen, this group of countries shows a pattern of small-scale agricultural-led growth in rural areas characterized by a shift towards labour-intensive crops (horticulture) and livestock production. Little restructuring and maintenance of social functions of large-scale enterprises in northern Kazakhstan might explain why rural-urban differences are larger for income than for non-income poverty.

3.2 Development of the agricultural sector before and during transition

Writing about agricultural production in Kazakhstan, it is important to describe its historical background in order to understand problems and perspectives of its modern agriculture. Living from nomadic herding activities, Kazakh herders were brutally collectivised by the Soviet ruling power in the 1920s and 1930s. Millions of people lost their lives in the aftermath of a huge famine following the collectivisation campaign.

In 1954, as a response to an increasing dependence on imported grain and unstable yields in existing grain producing regions, Khrustchev ordered a vast expansion of Soviet cropland by ploughing the virgin lands located beyond the lower Volga and north Caucasus and extending into Eastern Siberia. Although a number of large-scale regional development programmes were implemented during the Soviet era (STADLBAUER, 1996) the *Virgin Lands Campaign* is historically unique. The first scientific information about intensity, dimensions and effects of the campaign was made available outside of the former Soviet Union by to the authors EULE (1962), BREBURDA (1965), and WEIN (1980, 1983).

In April 1954, only two months after the decision for the virgin lands campaign was taken, ploughing and seeding activities started. About 17 million ha of previously untouched steppe were tilled in the first year (GEORGIEV, 1955). 492 sovkhozes were established until 1963, encompassing about 19 mln ha of newly developed crop area, with the average sovkhoz covering around 25,000 ha.

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22 There are strong regional differences. Whereas the 2002 poverty rate in rural areas varies from 12 per cent in Akmola, the rate is about 76 per cent in Mangystau.

23 An oblast is an administrative region comprising several rayons (smaller administrative districts).

Henceforth, in a nine-year period, new cropland larger than that of Germany was created. Although privatised, many of these large farms still exist today and lug the problems of marginal productions areas that were created in the 1950s. Most of the farms are situated in the north of the Republic of Kazakhstan.

Figure A-4 shows the share of crop production in total agricultural production from the times of the Virgin Lands Campaign until 2004. With the successive development of the livestock sector in the 1960s, the share of crop production fell to values below 40 per cent. With the breakdown of the Soviet Union, the livestock sector suffered from a strong crisis until recent years. Since 1996 gross agricultural product consists mainly of crop production (except the drought year 1998). The droughts in 1963, 1965, and 1998 can be clearly identified in the diagramme. As can be perceived in Table 3-1, transition supported the specialisation on certain crops and thereby reduced the crop portfolio diversification possibilities.

Table 3-1: Change in cropping structure and crop ranking as affected by transition to market economy

	1990			2001		
Ranking	Crop	Sown area ('000ha)	% of total sown area	Crop	Sown area ('000ha)	% of total sown area
1	Wheat	14,070	40	Wheat	10,850	64.6
2	Perennial forage	4,568	13	Perennial forage	2,222	13.2
3	Barley	3,660	10.4	Barley	1,751	10.4
4	Annual grasses	3,498	9.9	Oilseeds	347	2.1
5	Maize for forage	2,282	6.5	Annual grasses	267	1.6
6	Millet	781	2.2	Oats	183	1.6
7	Rye	769	2.2	Millet	115	0.7
8	Oats	382	1.1	Maize for forage	72	0.4
9	Oilseeds	266	0.8	Buckwheat	57	0.3
10	Buckwheat	218	0.6	Rye	44	0.3
11	Pulses	159	0.4	Pulses	24	0.1

Source: AGENCY OF STATISTICS, 2002.

According to statements of the Ministry of Agriculture, it is planned to further reduce the grain area. Nevertheless, regional administration plans to increase grain area even in marginal areas like Aktubinskaya Oblast (Krestyanskie Vedomosti, 2006). The transformation of the economy had severe implications for the agricultural sector. The following table shows some of the characteristics of this period and its implications for the agricultural sector.

Table 3-2: Characteristics of transition and their implications for the agricultural sector

Feature	Implications for the agricultural sector
Disintegration of the soviet market	Loss of input and output markets
Hyperinflation	Revenue loss between harvest and sowing, barter trade
Market liberalisation	Input prises increase faster than output prices
Privatisation	Removal of assets from co-operative shareholders (e.g. by foundation of holdings)
Redistribution of land ownership rights	Total number of farms increased, farm restructuring and ownership changes are beginning to yield increases in farm productivity and profitability
Removal of subsidies	Abrupt decline of enterprises in marginal production areas
Insufficient functioning of formal institutions	Informal institutions may act not according to societal needs and overall welfare objectives

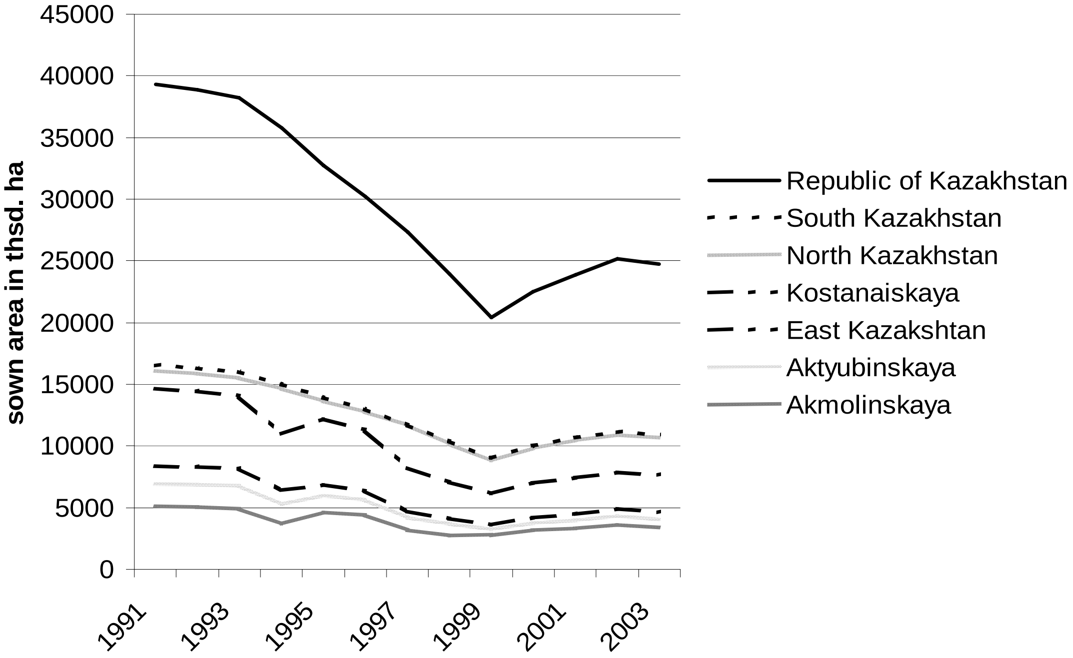
Source: Own table based on LENK, 2005; CSAKI and KRAY, 2005.

In the first years after the declaration of independence in 1991, agricultural policy was a stepchild of national economic policy. More lucrative fields of the economy such as the oil industry were in the centre of reforms. This decision might have been reasonable in the short-run from an economic point of view, however, it became increasingly problematic in view of the fact, that 43 per cent of the population live in rural areas. The share of agriculture in gross domestic product decreased in the 1990s from more than 30 per cent (1990) to less than 10 per cent (since 1998).

Most agricultural enterprises found themselves in a steady decline that was amplified by bad harvests (1994-98) and the financial crisis in 1998. In economically weak years, deficits from crop production were compensated partially by livestock sales, which contributed to the drastic decline in livestock numbers. Since enterprises were short on cash at this time, resources were mostly exchanged for the nearest harvest. In the case of harvest loss, assets were used as a means of payment. In this way, in fertile areas numerous companies passed into the possession of the lenders within short time. In marginal areas, machinery was transported off in many cases and crop production ended to a large extent.

The decline in cultivated grain area since 1991 (Figure 3-1), reflects the successive abandoning of marginal sites. After the grain yield doubled in 1999 compared to the previous year, the reduction of the sowing area came to a standstill and even slightly increased since then.

Figure 3-1: Development of grain areas 1991-2003



Source: AGENCY OF STATISTICS, 2004a.

While total crop areas declined sharply, the agricultural area used by private farms is more than 40 times higher than 1991. The number of registered private farms rose even faster than the area by 21 per cent annually since 1995 (Table 3-3).

Table 3-3: Number of private farms, area of land and average size of farms, 1991-2004

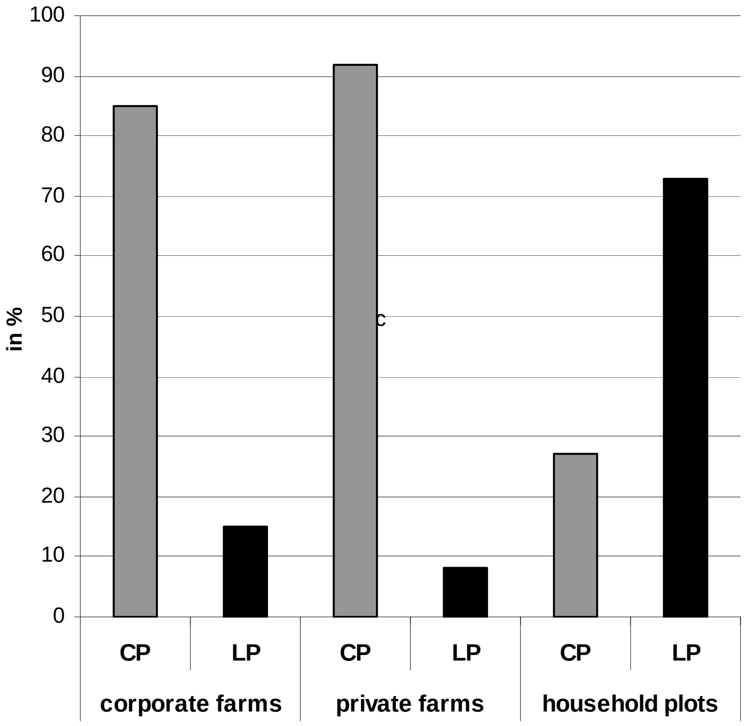
	1991	1995	1996	1997	2000	2001	2003	2004
Number of private farms, thsd.	0.3	22.5	30.8	42.5	68.2	76.4	111	122
Area of land plots, mln. ha	0.8	7.8	12.7	20	26.8	29.4	31.5	32.8
Area of land per private farm, ha	238	348	412	452	393	386	283	269

Source: AGENCY OF STATISTICS, 2005c.

The production share measured as value of production of different farm types changed drastically alike. While corporate farms were the most important market player at the beginning of transformation in 1993, private farms and household plots produce nowadays a higher value than the large successors of former sovkhozes and kolkhozes.

On the one hand, the distribution of income sources between production sectors is rather similar between private and corporate farms. It involves a high share of relatively labour-extensive crop production and an income contribution from livestock production of 8 and 15 per cent, respectively (Figure 3-2). Household plots have specialized on livestock production and more labour-intensive crops, like fruits and vegetables.

Figure 3-2: Relative share of crop (CP) and livestock production (LP) in corporate, private farms and household plots, 2004

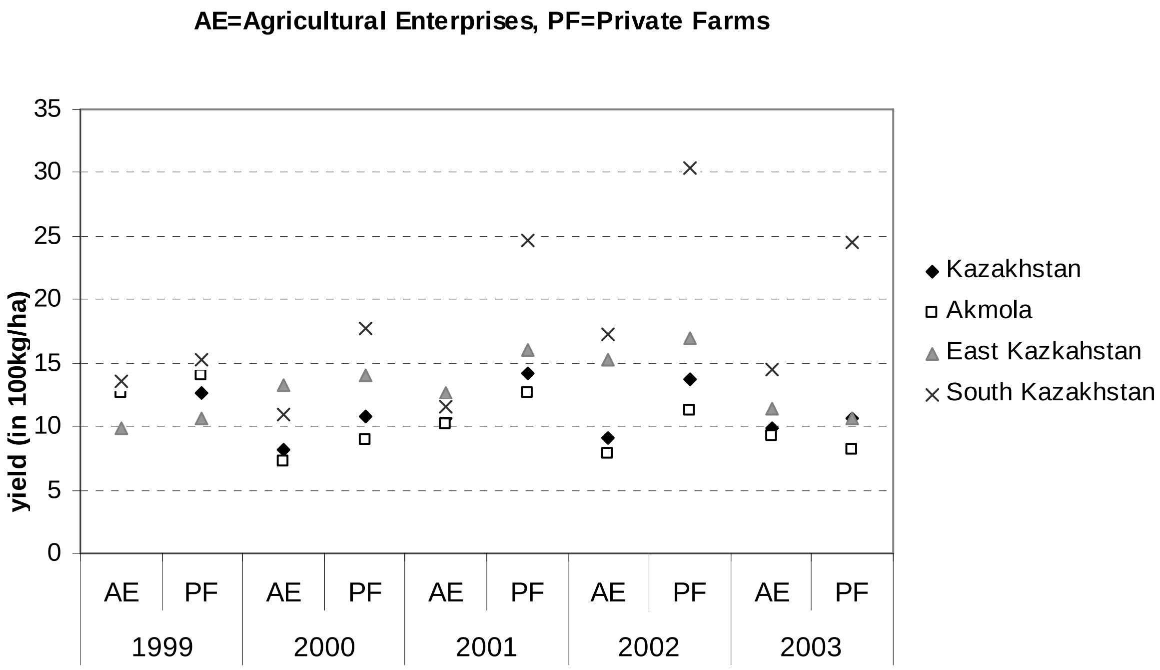


Source: Own figure based on AGENCY OF STATISTICS, 2005c.

3.2.1 Productivity trends

Interviews with experts as well as examination of the current agricultural policy priorities convey the impression of inferiority of small private farms to large corporate enterprises in many respects. However, the yield statistics for the period 1999-2003 draws a different picture. Particularly, in South Kazakhstan, small private farms demonstrate their competitiveness through higher productivity in wheat production. After a productivity decline during the transition period, both crop and livestock productivity seem to stabilise in recent years. For the harvesting period 2006, the Ministry of Agriculture forecasts a grain productivity increase of about 10 per cent mainly through the intensification of plant protection and fertilisation (Agra-Europe, 2006b).

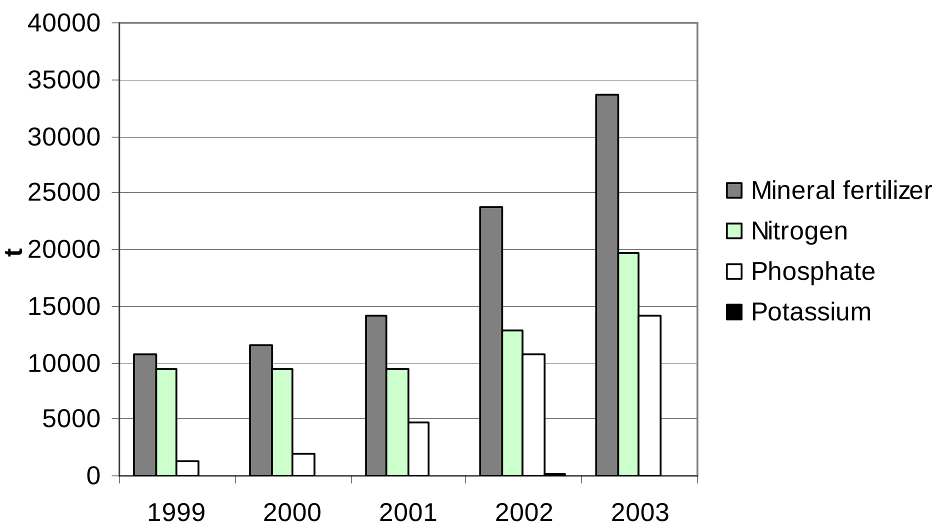
Figure 3-3: Regional wheat yields of agricultural enterprises and private farms



Source: AGENCY OF STATISTICS, 2004a.

As Table A-2 demonstrates, there is a huge potential for stabilising yields by application of pesticides, because many areas are not treated with pesticides (only 41 per cent of the grain area was sprayed). However, parallel to the positive overall economic development, input use has been increasing in recent years. The amount of fertilisers used by agricultural enterprises tripled in the period 1999-2003 (Figure 3-4). In the same period, the area used for crop production by agricultural enterprises decreased by one million ha.

Figure 3-4: Total use of mineral fertiliser by agricultural enterprises



Source: AGENCY OF STATISTICS, 2004a.

Still, the productivity of the agricultural sector is relatively low in comparison to other sectors. This is reflected in the differences between agricultural wages and wages in other sectors of the economy. As following table shows, the monthly salary in agriculture and forestry is only about one third of the average salary.

Table 3-4: Monthly salary in different sectors (as of April 2005)

Sector	KZT	Euro
Agriculture and forestry	11,535	70.34
Industry	38,520	234.88
Exploitation of natural resources	59,521	362.93
Processing Industry	33,062	201.60
Construction and building	43,018	262.30
Trade	31,845	194.18
Transport and communication	45,716	278.76
Banking	75,861	462.57
State administration	25,448	155.17
Mean	30,852	188.12

Source: AGENCY OF STATISTICS, 2005c.
Note: Exchange rate 1 €=164 KZT.

3.2.2 Capital endowment, collateral, and investments:

According to data presented in OSTRIKOVA (2005), more than 50 per cent of the fixed assets in the agricultural sector are machinery and equipment. After stagnation in investments in fixed assets, the value of assets put into operation increased significantly in 2003 and 2004, which reflects the overall economic trend in Kazakhstan. In agriculture, this development has been stimulated by the governmental programme for the development of rural areas 2003-2005. Table 3-5 shows the relative density of investments into agriculture in all regions.

Table 3-5: Relative density of investments into fixed capital (Agricultural sector as percentage of the entire regional economy)

Area, city	**2000**	**2001**	**2002**	**2003**	**2004**	**Mean**
			Eastern region			
East-Kazakhstan	0.89	0.72	1.34	1.51	4.33	1.76
			Western region			
Aktubinskaya	0.29	0.61	0.30	3.37	5.01	1.92
Atyrayskaya	0.01	0.09	0.09	0.11	0.14	0.09
Mangistauskaya	0.19	0.06	0.12	0.17	0.21	0.15
West-Kazakhstan	0.09	0.16	0.13	0.27	0.20	0.17
			Northern region			
Akmolinskaya	31.30	19.85	23.64	0.31	2.90	15.60
Kostanayskaya	11.65	13.12	16.24	12.44	14.28	13.55
Pavlodarskaya	0.37	0.96	3.43	2.69	3.79	2.25
North-Kazakhstan	53.15	45.48	29.85	29.76	30.64	37.78
			Central region			
Karagandinskaya	0.47	0.80	0.75	0.94	1.16	0.82
			Southern region			
Almatinskaya	3.77	5.12	4.86	3.44	4.72	4.38
Djambulskaya	4.66	1.55	1.05	0.58	1.70	1.91
Kyzilordinsskaya	0.58	1.29	0.18	0.60	0.92	0.71
South-Kazakhstan	2.10	2.85	2.16	2.35	2.58	2.41
Astana	0.39	0.52	1.07	0.77	1.05	0.76
Almaty	0.10	0.23	0.72	0.71	0.82	0.52

Source: Own table based on OSTRIKOVA, 2005.
Note: Research regions selected for the farm survey are marked in italics.

The main crop production regions Akmolinskaya oblast, Kostanayskaya oblast, and North Kazakhstan show the highest shares of agricultural investments among all regions. Investment numbers show no identical pattern across time. Whereas investment share in North Kazakhstan fell from 2001 to 2002 by about one third, it almost doubled in East Kazakhstan. Similar developments occurred in other regions and different years.

The sources of investment in agriculture are rather diverse, the most important of which being own capital. Its share in financing is about 78 per cent, which is about 26 per cent more than the average of all economic sectors including agriculture. The share of external capital lies around 22 per cent, of which the largest share is financed by bank credits and state budget. The share of external financing as well as the total amount of investments is much higher in other sectors of the economy. While the agricultural sector contributed to GDP by about 8.4 per cent in 2003, agricultural investments amounted only 1.5 per cent of total investments, representing an urgent need to invest. The low rate of external financing in agriculture can be partly explained by limited credit-access of agricultural firms.

Table 3-6: Sources of investments into fixed capital 2003

Parameter	All economic sectors		Agriculture	
	in million KZT	%	in million KZT	%
Own capital of the enterprises	433786	52.6	9818	78.3
Revenue	412402	50.0	9746	77.7
Depreciation	21384	2.6	72	0.6
External capital	391132	47.4	2723	21.7
State budget	46022	5.6	1038	8.3
Bank credits	153431	18.6	1301	10.4
Private credits	75066	9.1	122	1.0
Other investments	116613	14.1	262	2.0
In total	824918	100	12541	100

Source: Own formation after OSTRIKOVA, 2005.

3.2.3 Farm restructuring[24]

Contemporary farm structure in Kazakhstan is a consequence of intense restructuring which was initiated by privatisation and the introduction of new legislation (LERMAN et. al., 2004). Like in other transition countries, former collective and state farms have practically disappeared, to be replaced by limited liability partnerships, joint stock companies and other corporate forms. Since farm privatisation began, the cultivated grain area has been reduced by more than a third. In contrast, the number of new farm governance structures has been increasing. In 1991, the agricultural sector comprised 2120 state farms and 430 collective farms.

Between 1992 and 1997, the sector went through several evolutionary stages, which can be summarized as follows: After the dissolution of former state and collective farms and creation of collective farm entities, a majority of theses entities were converted into Producer Co-operatives (PCs) with the land and property shares retained under the common ownership of the co-operative. In 1997, PCs were encouraged to reallocate shares to structure ownership more defined. The most common method for share concentration was the creation of one or more Partnerships with Limited Liability (PLL), by leading members of the PC, with the accompanying transfer of some or all property and land shares to the director of the PLL (GRAY, 2000).

In 2002, the total number of farms, including household plots was reported to be 116,290 compared to 57,450 five years and 16,936 ten years before (AGENCY OF STATISTICS, 2004b). The share of peasant farms in the total number of farms during the transition period rose from initially 30 per cent in 1991 to 96 per cent in 2002. During the same period the share of large agricultural enterprises and organisations decreased from 53 per cent to four per cent. Land ownership clearly favours large enterprises. Whereas peasant farms cultivate 36.4 per cent of total agricultural land, large-scale organisations do so for 63.1 per cent of the land. The sharply dual farm structure was a dominant feature of the Soviet model of agriculture with an even more dramatic concentration of land than today: 98 per cent of Soviet household plots controlled less than two per cent of land, while two per cent of the largest farm enterprises controlled 98 per cent of land (LERMAN et al., 2004). LERMAN et al. (2004), based on World Bank surveys from the 1994 to 1998 period, evaluate the farm structure in Kazakhstan nowadays as sharply dual, where 99 per cent of agricultural land is controlled by top 10 of the largest agricultural enterprises.

LERMAN et al. (2004) provide explanations for the high share of co-operatives among farms in CIS countries: First, the burden to transform enterprises from a sovkhoz/kolkhoz to a producer co-operative is lower than to transform it to an organisational form that digress even more from socialist farm structures (see also VALENTINOV and CURTISS, 2005).

Second, Soviet-time management and administration tried to maintain old structures. This path-dependency[25] along with failure of labour markets can serve as explanation for the maintaining of organisational structures.

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[24] This section is based on HEIDELBACH, 2005.

[25] For a definition of the term path-dependence and its discussion related to change in agricultural structures see BALMANN (1994).

3.2.4 Agricultural policy

MACOURS and SWINNEN (2005) as well as CSAKI and KRAY (2005) in evaluating the progress in agricultural reforms sort Kazakhstan in the same group as Russia and Ukraine. Especially the land privatisation process was slow and instrumental in keeping large farm structures in place because it was implemented through shares.

WTO accession plays an important role for the future development of the agricultural sector. Kazakhstan's minister of industry and trade, Vladimir Shkolnik expects WTO accession for 2007. He confirmed that the process would be synchronized with Russia's accession to the WTO. Currently bilateral negations with 14 WTO members including the EU, the US, Australia and Brazil have to be closed. The WTO accession would require the current systematic fuel and diesel export bans to be abolished. As an alternative mechanism, the provision of direct subsidies for farmers is being considered (East Europe, 2006).

The current agricultural policy is characterised by an increasing amount of subsidies, which is much criticised by international experts (CSAKI and KRAY, 2005). Key points of the actual governmental programme for the development of the agricultural sector is the active increase of competitiveness of agricultural products on the world market by using comparative advantages and export potential. According to Agricultural Minister Daniel Akhmetov, the state will support this process by improvement of research infrastructure and dissemination of innovative technologies (Agra-Europe, 2006a)

3.3 Natural conditions

Based on soil, climatic and economic conditions, Kazakhstan may be subdivided into 5 major regions: Northern, Central, Western, Eastern and Southern. 71 per cent of the wheat area is situated in the northern region, 10 per cent in the Western part, 5 per cent in the East, and the Central and Southern parts each account for 7 per cent. Another subdivision can be made following the ecological zones. Table 3-7 describes 9 different zones and gives an overview about the amount of annual precipitation and the potential agricultural use. The zones reach from forest steppe in the North at the Russian border with the most favourable conditions for rainfed grain farming to the mountain meadows at the bottom of Tien Shan in the South and Altai in the East.

Table 3-7: Natural zones and their possible agricultural use

Zone	Cumulative rainfall, mm	Possible agricultural use of territories	Tilled area	
			Mio. ha	%
Woodland (forest) steppe	320-340	Non-irrigated farming	2.1	9.3
Steppe	270-310	Semi-non-irrigated farming	10.2	44.7
Dry steppe	230-250	Insufficient non-irrigated farming and livestock breeding	6.5	28.5
Semi-steppe	200-230	Livestock breeding, drove, rainfall deficit for cropping, selective irrigation farming	0.5	2.2
Desert	120-150	Livestock breeding, drove, irrigation farming	0.4	1.8
Foothills-desert-steppe	200-300	Irrigation and dry farming, livestock breeding, drove	1.4	6.1
Foothills-desert	120-170	Livestock breeding, drove, selective irrigation farming	0.8	3.5
Mountainous-steppe	300-400	Irrigation farming, horticulture, drove, mowing	0.9	3.9
Mountainous	730-750	Drove, mowing in the bottom of mountain	–	–
Total	120-750	–	22.8	100

Source: MINISTRY OF AGRICULTURE, 2003.

The largest share of grain is produced under highly vulnerable conditions in the steppe and dry steppe zone, where the wheat production border lies. This border follows a 250 mm precipitation line, a so-called Isohyet (LENK, 2005). The same figure is found in MEINEL et al. (2003) for the Kulunda-step in Western Siberia. The informative value of such mean values must not be over-estimated against the background of the enormous variation of individual parameters. Those parameters which depend directly on the sun, such as radiation and vaporization, are subject to relative small variations. For instance, the dates for snow melting and spring high water are well predictable. The parameters influenced by the actual weather events like precipitation and extreme temperatures deviate considerably from mean values. For agriculture, this means a hardly estimable drought risk. That is the most important explanation for the strong yield variations. The already short vegetation time is limited even further in some years by autumnal early frosts and spring frost.

While black soils and dark chestnut soils show useful features for crop production, such as crumbling structure, humus contents, and nutrient availability, temperature and precipitation circumstances limit the production. Wheat is one of the few cultures, which can be cultivated under these conditions. A decisive factor of ecological tolerance of wheat is its frost resistance of up to -22 degrees Centigrade. Since temperatures fall below this boundary in the most years in northern Kazakhstan, the farming of high-yielding winter wheat hardly comes into consideration. Most water is required during the haulm shoot, ears shift and blooming, i.e. in the late spring and early summer. Spring frosts lead to the extension of the soil, which leads to a destruction of roots and finally to the drying up of the younger plants. The drought during the wheat blossom often leads to emergency maturity. Too much moisture during the maturity stage delays it, which increases the risk of early frosts.

In the continental-climatic vegetation conditions of Kazakhstan, plant production carries a particularly high risk burden. This manifests itself predominantly in the considerable inconsistency in yields. Table 3-8 gives an indication of the extent of these fluctuations, using regional variation coefficients for different plants.

Table 3-8: Coefficients of variation for different crops and regions based on yield data from 1974 to 2003

Crop	Region (Oblast)	Min	Max	Median
Wheat	Akmola	0.34	0.41	0.38
	Kostanai	0.23	0.61	0.44
	North Kazakhstan	0.24	0.39	0.33
	East Kazakhstan	0.23	0.47	0.23
	Aktobe	0.43	0.68	0.53
	South Kazakhstan	0.32	0.54	0.43
Barley	Kostanai	0.39	1	0.52
	North Kazakhstan	0.28	0.49	0.35
Cotton	South Kazakhstan	0.20	0.26	0.23

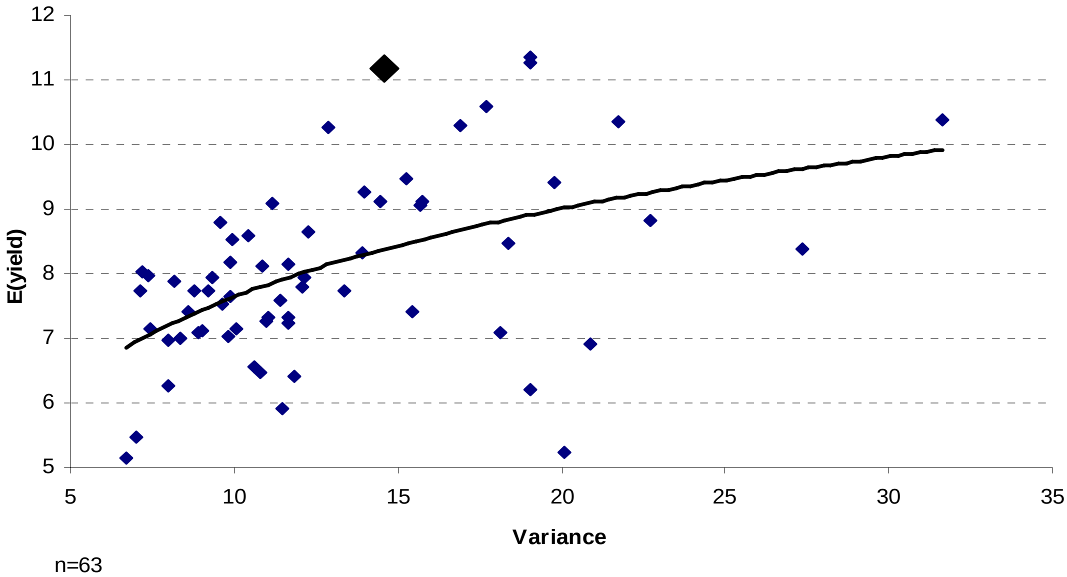
Source: Own calculations based on survey data.

Note: The coefficients of variation (quotient of standard deviation and arithmetic mean) measure the distribution of yields in the investigated period on the rayon level. Minimum, maximum and median values refer to variation coefficients of rayons within the same oblast.

The coefficients for the investigated regions of Kazakhstan are much higher than those of the comparable studies from various European countries, in which their values for wheat, for example, vary between 0.19 and 0.28 (MEUWISSEN et al., 1999).

Figure 3-5 gives an overview about the distribution of grain yields (wheat and barley mostly) in 6 selected rayons of Akmolinskaya Oblast in the period between 1980 and 2002. It shows a strong concentration of mean grain yields between 0.7 and 0.9 t/ha with a variance between 7 and 12.

Figure 3-5: Boxplot of expected values and variance of farm grain yields in Akmola region (1980-2002)



Source: Own figure, the bold point depicts the Akmola study farm.

Own international comparison of coefficients of variation[26] comprising data from various sources (1980-2003) depicts Kazakhstan's relative comparative disadvantage in rainfed crop production. For wheat as well as for sunflowers Kazakhstan ranks last in a list of important producer countries. In both cases, Kazakhstan produces the lowest yields with a standard deviation that is comparable to other transition countries (Russia, Ukraine) that produce the double mean yield. The control of yield variation looks much better from a comparative perspective for irrigated crops, such as cotton. Cotton yields are relatively high with an acceptable standard variation, which secures Kazakhstan's third place in the variation coefficient ranking after the United States and Uzbekistan. However, irrigated cotton production in Kazakhstan and Uzbekistan is strongly connected to the Aral Sea catastrophe. Irrigation projects can damage the environment to a large extent. Sustainability impacts, esp. ecological ones, have to be carefully evaluated beforehand.

[26] Chapter 4.4.3 will discuss the effect of insurance on the variation coefficients of income.

Table 3-9: An international comparison of yield variations of selected crops

	Yield (dt/ha)		
Wheat	**Mean**	**Standard deviation**	**Coeff. of variation**
United States of America	25.5	2.2	0.086
France	63.7	7.4	0.117
Germany	64.4	8.6	0.133
Russian Federation	17.1	2.5	0.144
Canada	20.8	3.1	0.150
Spain	23.7	5.2	0.219
Kazakhstan	9.1	2.8	0.303
Sunflower seed			
France	22.6	1.8	0.079
Russian Federation	10.0	1.8	0.179
Germany	24.9	4.5	0.181
Ukraine	13.3	2.9	0.218
Kazakhstan	6.7	3.0	0.441
Seed cotton			
United States of America	18.4	1.9	0.102
Uzbekistan	25.5	3.3	0.128
Kazakhstan	22.1	3.4	0.154
China	25.9	5.0	0.193
India	6.5	1.4	0.213
Pakistan	16.1	3.6	0.227

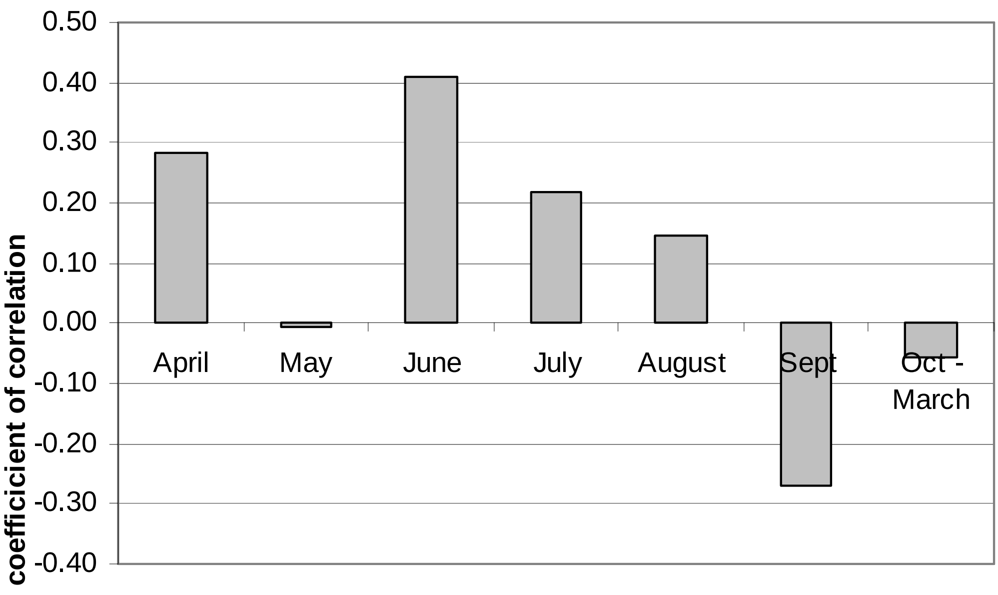
Sources: FAOSTAT Database (Production, 15. 7. 2005; STATISTICAL YEARBOOK USSR 1985, p. 210; 1987, p. 89; 1990; p. 472; STATISTICAL HANDBOOK 1995; STATES OF THE FORMER USSR, pp. 259, 587; STATISTICAL YEARBOOK CIS COUNTRIES, 1994, pp. 226, 345, 498; STATISTICAL YEARBOOK KAZAKHSTAN, 1984, p. 89; 1987, p. 70; 1990, p. 315; NATIONAL STATISTICAL AGENCY, Almaty.

Note: Data from 1980-2003.

To get a feeling for the frequency of drought events and their regional impact, i.e. the systemic risk component in crop production, revisiting Soviet statistics might be helpful, because production technology and conditions were fairly comparable due to central planning. For that purpose, RAUNER's (1977 drought catalogue of the main grain growing regions of the Soviet Union was considered. The detailed summary of all drought events in the main grain regions of the former USSR, including the Volga region, the Central Tshernosem region, the Northern Caucasus, Western Sibiria and the Altai, and North and Central Kazakhstan, during the time period 1861-1975 gives an impression about frequency and correlation of yield losses caused by drought. A short survey of Rauner's data for the time period 1950-1975 (table A-7) shows following results: In 16 of 26 years two or more regions, in eleven years three or more regions, in nine years four or more regions, in six years five or more regions and in three years all regions were affected by drought. This effect did not influence grain prices during socialist times. However, this strong correlation among vast grain growing regions had an effect on producer prices after these regions transformed into market economies.

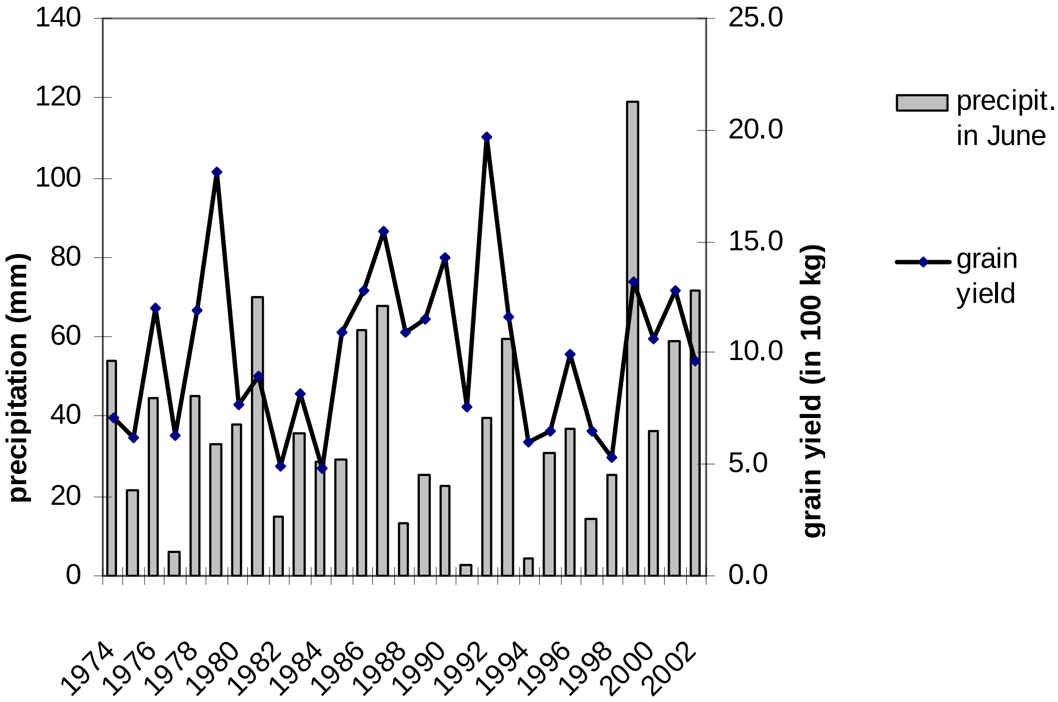
As Table 3-9 shows, for non-irrigated crops, yield deviations seem to be extremely high in Kazakhstan compared to other countries. Rainfed agriculture is extremely dependent on the volume and distribution of rainfalls. Figure 3-6 and 3-7 show the correlation of monthly precipitation and grain yields for an exemplary weather station (Astana) and its surrounding crop area (Tselinogradski rayon). The data for the period 1974-2002 demonstrates a strong correlation of June rainfall and grain yields. The strong dependence on rainfall in a certain period of time prompted us to think about alternative insurance products in the form of parametric rainfall insurance. The results are presented in chapter 4.5.3.

Figure 3-6: Correlation of monthly precipitation and grain yields for the period 1974-2002 (weather station Astana, grain yields for Tselinogradski rayon



Source: Own figure based on survey data.

Figure 3-7: Grain yields and precipitation over time in Tselinogradski Rayon



Source: Own figure based on survey data.

Another strongly limiting factor for wheat yields is the date of sowing. Because the soil humidity is quickly used up with the beginning of the vegetation period, the sowing date is decisive as a field experiment in Kostanaiskaya oblast demonstrates (KRANZ, 2000).

Table 3-10: Wheat yields according to sowing date, fertilisation, and pest management

	Sowing date 10th of May (-12 days)	Sowing date 22nd of May	Sowing date 5th of June (+14 days)
Yield (t/ha) without fertilisation and pest management	1.03 (-28%)	1.43	0.98 (-31%)
Yield (t/ha) with fertilisation and pest management	1.48 (-28%)	2.04	1.53 (-25%)

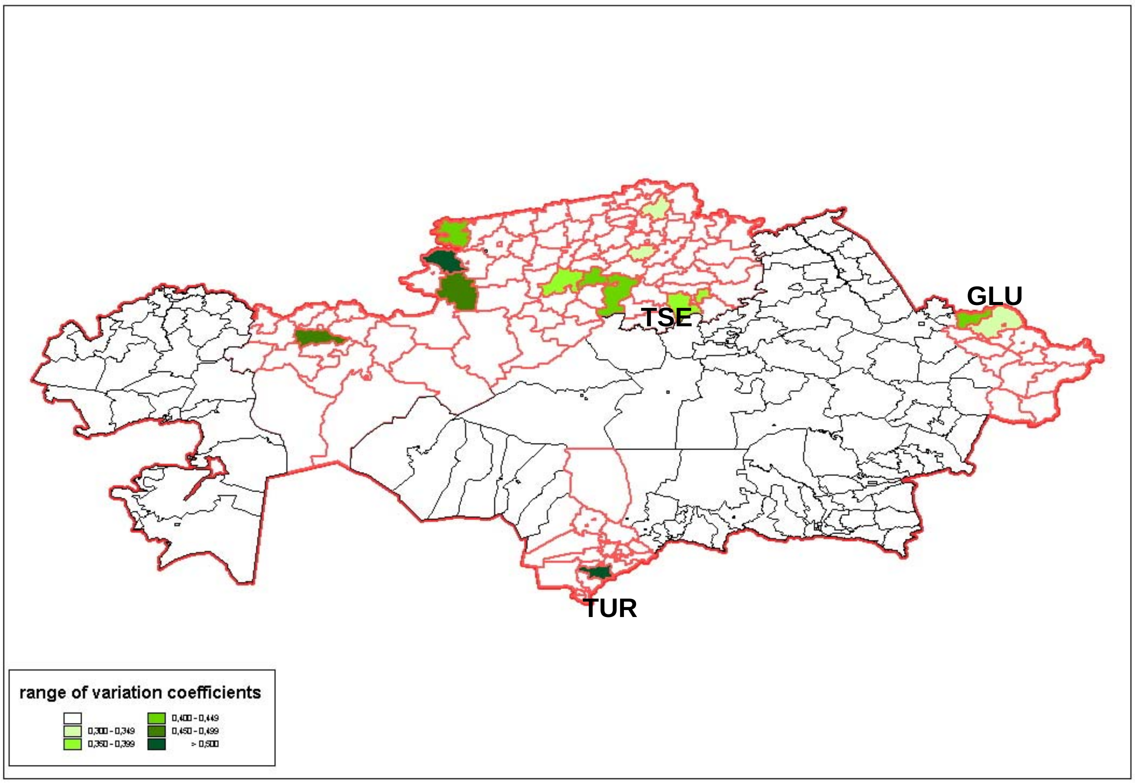
Source: Based on KRANZ (2000).

3.4 Description of research regions

Akmola, North Kazakhstan and Kostanai in the North, Aktobe in the West, South Kazakhstan and East Kazakhstan were chosen as research regions for the farm survey, which will be presented later on. These regions will be described to give the reader an insight in the background of the research objects. Study farms in the regions Akmola, East Kazakhstan and South Kazakhstan have been considered for further analysis of risk management instruments to represent a spectrum of different natural conditions, farm sizes, organisational forms, and and specialisations. The three research regions will therefore be described more extensively in this section.

Map 3-1 gives an overview of all investigated research regions (marked red) and depicts different levels of wheat yield variation on the rayon-level.

Map 3-1: Research regions with variation coefficients for wheat yields (1980-2002)

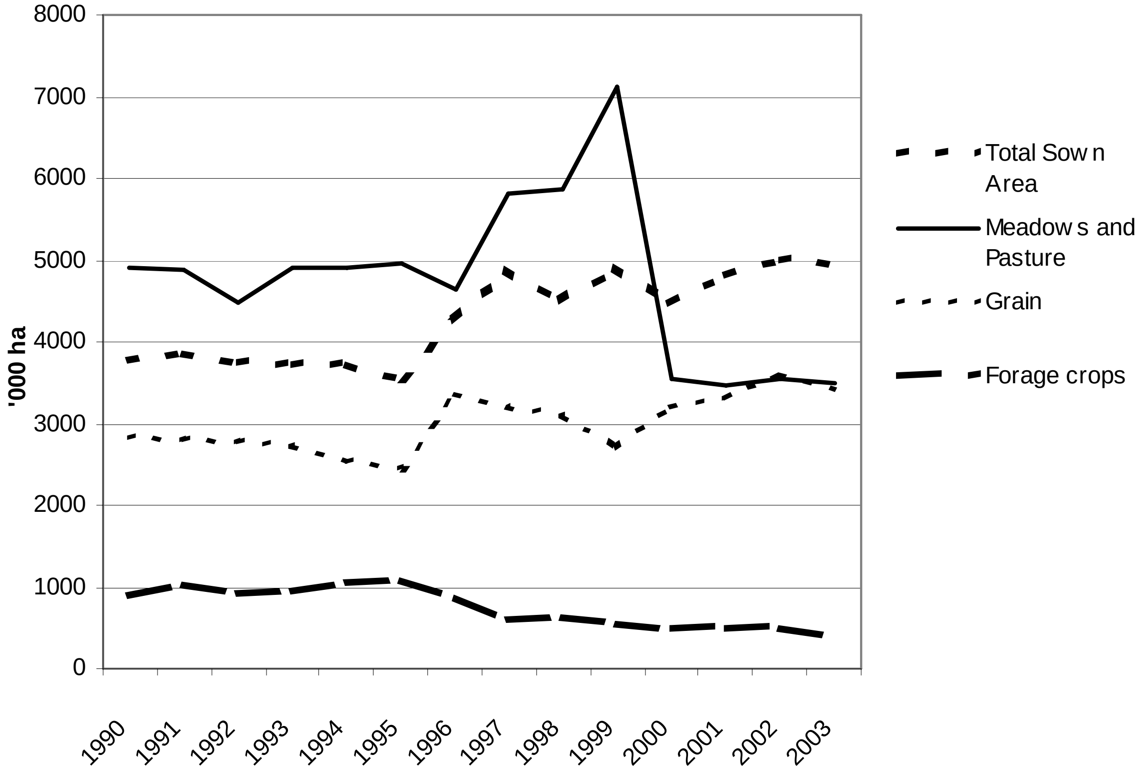


Source: Own Map.

Note: TSE=Tselinogradski Rayon, GLU=Glubokovskoe Rayon, TUR=Turkestanski Rayon.

Akmola (oblast capital *Kokshetau*) lies north of the large steppe *Sari-Arka* and is characterised by an intensive grain production mostly carried out on large farms. The oblast is characterised by large plains and a hilly region about 200 km north of the capital *Astana*. The steppe character of the region manifests itself in the land use. As Figure 3-8 reports, the largest share of land is extensively utilised as pasture land for cattle, horses and sheep. The decline in pasture area can be explained by the strong decline in livestock numbers. In 2003, the number of cattle has been reduced by 34 per cent and the number of sheep and goats by almost 40 per cent compared to 1994.

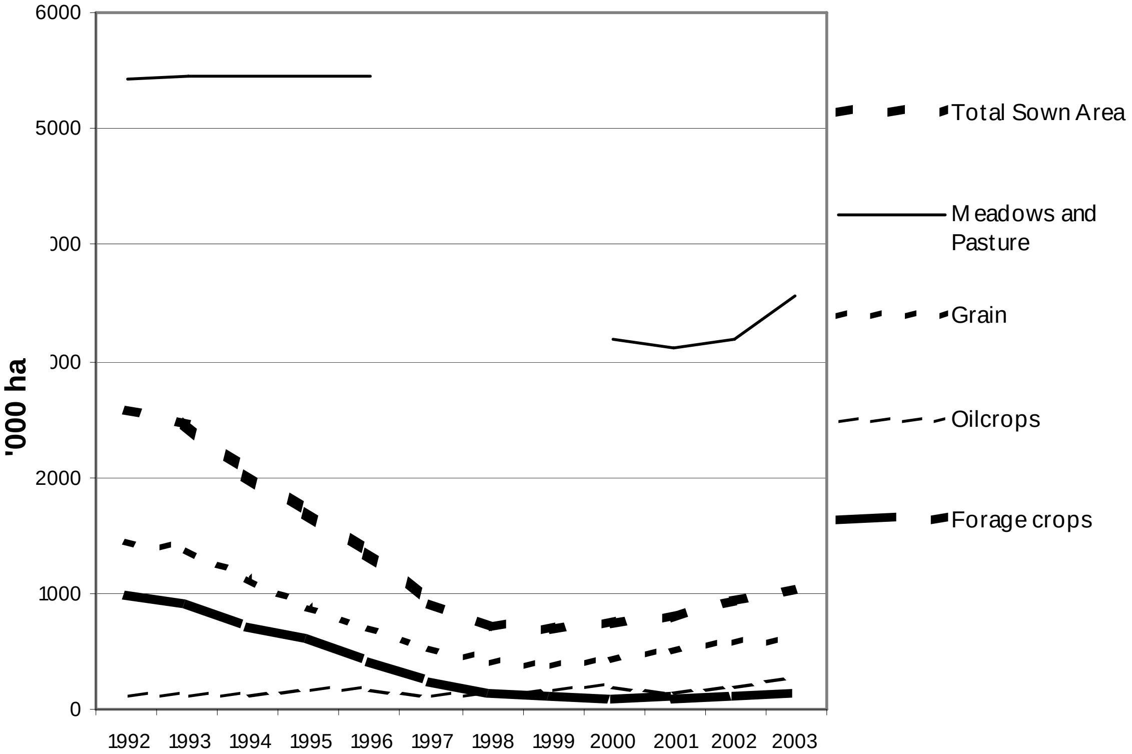
Figure 3-8: Development of agricultural areas under most important crops (Akmolinskaya Oblast, 1990-2003)



Source: Own figure based on survey data.

East Kazakhstan is situated in the farthest east of the country, bordering on Russia and China. With the beginning of the transformation period, the oblast was formed from East Kazakhstan oblast and Semipalatinskaya oblast. The two parts of the new oblast are different in geological structure and consequently in land use. Whereas the eastern part is strongly influenced by the Altai mountain climate with high precipitation and good soils, the region around Semipalatinsk is plain steppe. As in Akmola, the number of livestock was reduced drastically, consequently the meadows and pasture area decreased (s. Figure 3-9). As everywhere in the country, the total sown area decreased until 1998 and is recovering since then. Oil-yielding crops play a central role in the future development of the regional crop production. Beside sunflowers, rapeseed is gaining importance in the regional crop portfolio.

Figure 3-9: Development of agricultural areas under most important crops (East Kazakhstan, 1992-2003)



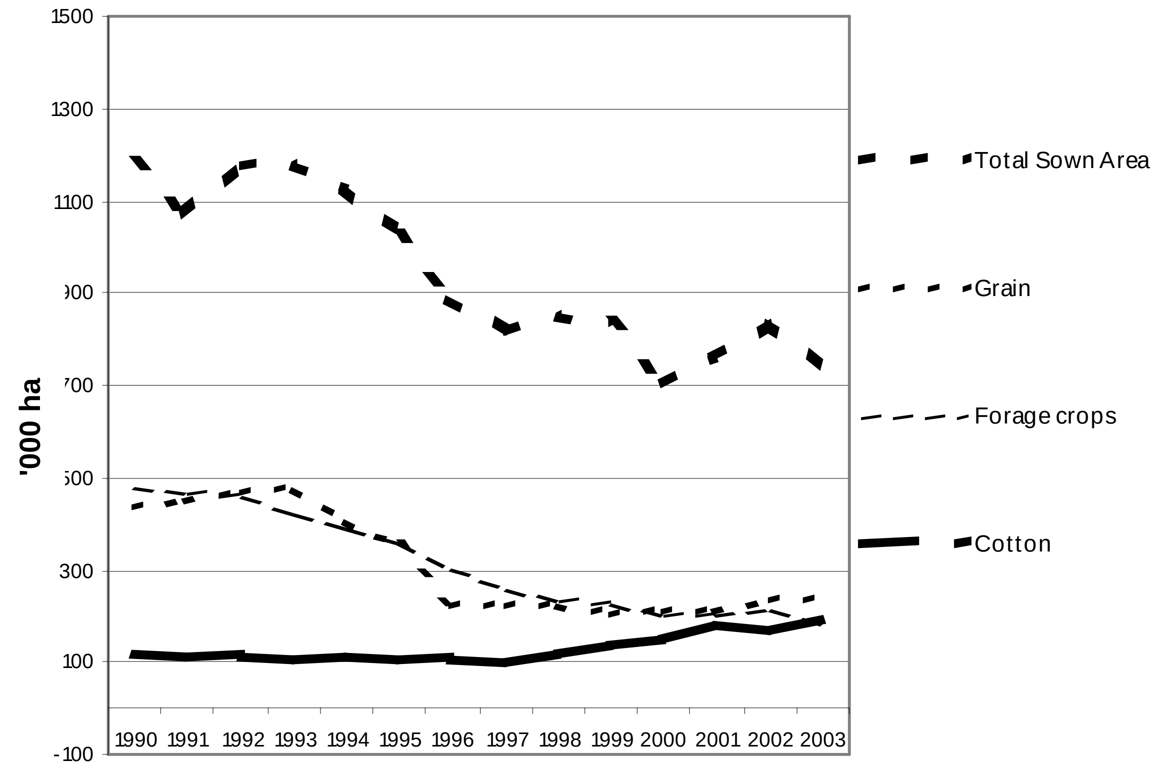
Source: Own figure based on survey data.

South Kazakhstan Oblast geographically takes up the central part in the south of the country. Its extension from north to south is around 550 km, from east to west 40 km. The oblast is characterised by plains and mountains. The altitude varies mainly between 150m and 300m in the plains whereas the mountains reach altitudes up to 4500m.

Three main zones can be identified: First, a sandy desert with partly afforested lowlands; second, an afforested zone with irrigation plants; and third, a mixed step-mountain zone. The annual sum of temperatures above 10°C varies between 3000 and 4600 with a much higher variation in the mountainous region. Annual precipitation amounts to 300-900 mm in the mountainous region, whereas the sum in the desert zone varies between 130 and 200 mm. Also, the vegetation periods are subject to large changes across the oblast. Whereas in a part of the mountainous zone the vegetation period is maximum 215 days long, it lasts in a part of the desert zone only to maximum 165 days (MINISTRY OF AGRICULTURE, 1967). The soils are characterized by sandy to clayey Serosyoms (Xerosols) that developed from loess soils. They are weak in humus (1-2%), calciferous up to the soil, weakly weathered, loose and easily prone to erosion. Normally, the agricultural utility of these soils is small, but their advantageous physical properties make them productive under irrigation (KAUSCH et al., 2000).

In South Kazakhstan, irrigated crops like cotton, fruits, and vegetables gained importance during the last years, whereas the share of grain and forage crops decreased drastically since the beginning of transformation (Figure 3-10). Only in recent years, the total sown area has been stabilising.

Figure 3-10: Development of agricultural areas under most important crops (South Kazakhstan, 1990-2003)



Source: Own figure based on survey data.

Note: For reasons of visibility, pastures and meadows were not included in the graph. The average pastures and meadows area between 1990 and 2003 was about 9.3 mil. ha.

All of the selected oblasts play an important role in the national agricultural production. Although Akmolinskaya oblast contributes only 2.89[27] per cent to the GDP, its contribution to the agricultural GDP is significant with a share of 11.3 per cent. East Kazakhstan is fairly industrialized and contributes 7.36 per cent to the GDP. Its contribution to agricultural GDP is around 9.66 per cent with more than half of it coming from livestock production. South Kazakhstan is a densely populated oblast, contributing 6.19 per cent to the GDP. South Kazakhstan's agriculture makes up 12.43 per cent of the national agricultural GDP, though the

[27] The numbers in this paragraph are means for the period 2002-2004.

area sown is relatively small compared to the other two oblasts. The reasons for this lie in the production of high value-added products.

The agricultural sector plays an important role in the regional economies. In terms of contribution to the regional GDP, it is the most important sector in Akmola, the second most important sector after industry in South Kazakhstan and the third most important one after industry and trade in East Kazakhstan.

In terms of employment, agriculture is the most important sector throughout the country. In Akmola 47.1 per cent of the population are employed in agriculture, in East Kazakhstan 35.4 per cent, and in South Kazakhstan 34.9 per cent. Crop production is the predominant production branch in the country. It contributes by 70.6 per cent to agricultural gross product in Akmola, 48.2 per cent in East Kazakhstan, and 67 per cent in South Kazakhstan. However there are differences between the organisational forms, e.g. in East Kazakhstan the share of crop production is around 44.9 per cent in agricultural enterprises and around 81.1 per cent in private farms. The number of agricultural entities and their organisational status varies strongly from oblast to oblast. Both indicators seem to depend more on such factors as potential agricultural income portfolio, crops grown, intensity of crop and livestock production, and the regional agricultural authorities. Regional statistics on the oblast level (Table3-12) reveal marked geographical patterns in farm ownership structures, with the majority of legally registered peasant farms located in the southern and eastern oblasts, while the majority of the JSCs and PLLs are situated in the grain-growing northern oblasts. This can partially be deduced to the more favourable conditions for a variety of labour-intensive crops like cotton, fruits and vegetables and pressure on land due to high population density, esp. in South Kazakhstan, and the comparative advantage of vertically integrated structures in large-scale grain production.

Table 3-11: Selected characteristics of investigated oblasts

Feature/Oblast	Akmola	East Kaz	South Kaz	Kazakhstan
Share of Ag in GDP (mean 2001-2004) (in %)	34.5	11.5	18.4	9.1
Share of crop production (mean 2001-2004*) (in %)	70.6	48.2	67.0	58.1
Share of crop production, agr. enterprises (mean 2001-2004) (in %)	92.9	44.9	89.0	86.2
Share of crop production private farms (mean 2001-2004) (in %)	99.1	81.1	99.3	91.7
Share of crop production household plots (mean 2001-2004) (in %)	27.1	22.2	35.0	38.0
Number of agr. enterprises (mean 2003-2005)	546	126	3,499	8,020
Number of private farms (mean 2003-2005)	4,486	13,165	52,515	156,399
Soil quality (bonitet)	38 (26-57)	39 (9-93)	30 (20-57)	–
Sown area (2003) (‘000 ha)	3,844	1,011	740	17,454
Population (in ‘000) (2005)	747.2	1,442.1	2,193.6	15,074.8
Percentage of rural population (2005)	52.9	40.8	59.9	42.9
Percentage of population working in agriculture, mean (2001-2004).	47.1	35.4	47.1	34.9

Source: AGENCY OF STATISTICS (2005b), KAZGIDROMET (2003, 2004).

Notes: * All kinds of enterprises including household plots; – missing value.

However, one has to distinguish between registered and operating farms (Table 3-13). Especially stunning are the numbers in South Kazakhstan: Only 5,022 of 43,323 registered peasant farms and 735 of registered 3,421 agricultural enterprises and organisations reported cultivation of land for 2003 (REGIONAL STATISTICAL OFFICE SOUTH KAZAKHSTAN OBLAST, 2003). The high number of non-active farms could partially be explained by problems with liquidity and access to capital. Family farms which have access to more stable, non-agricultural income sources decide not to invest in agricultural production as long as their own capital cannot provide them with sufficient collateral for the engagement in risky agricultural production.

Table 3-12: Development of legal forms in Kazakhstan's agriculture 1999 and 2005

	Peasant farms	Producer Cooperatives	Joint Stock Companies	Partnerships (LL)	Other
Akmola 1999	3,575	112	34	203	30
Akmola 2005	4,647	46	26	491	1
East Kazakhstan 1999	6,761	55	19	149	5
East Kazakhstan 2005	14,198	26	9	95	9
South Kazakhstan 1999	23,198	847	11	113	81
South Kazakhstan 2005	67,121	1,933	17	1,569	14

Sources: GRAY (2000); AGENCY OF STATISTICS (2005b).

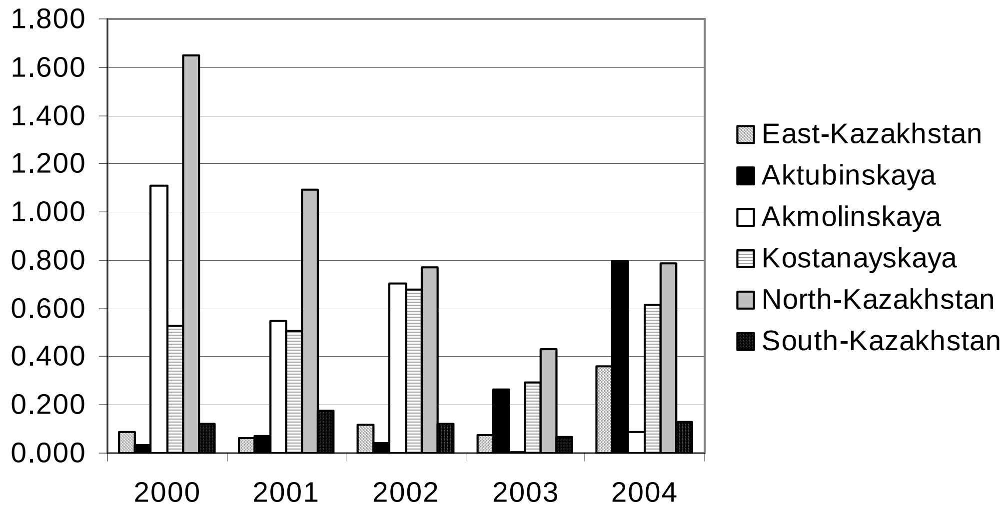
Table 3-13: Difference between registered and active farms 2003

	Peasant farms	Producer Cooperatives	Joint Stock Companies	Partnerships (LL)
Akmola 2003 (registered)	4,412	59	25	448
Akmola 2003 (active)	4,406	12	13	349
South Kazakhstan 2003 (registered)	43,323	2,088	30	1,303
South Kazakhstan 2003 (active)	5,022	465	6	264

Sources: REGIONAL STATISTICAL OFFICES (2003); AGENCY OF STATISTICS (2005b).
Note: – Missing value.

Figure 3-11 depicts the prevailing underinvestment in the agricultural sector for almost all research regions in almost all years. Specifically, it shows the relationship between the relative investments in agriculture as a share of total investments in the economy and the share of agriculture in the regional GDP. A "1" would express investments in the agricultural sector according to its importance in the regional economy. Despite the great importance for the regional economies, investments in agriculture correspond in only two years (2000 in Akmolinskaya Oblast and 2001 in North Kazakhstan Oblast) to the economic sector weight. This relationship might be put into perspective by the high probability that many investments in smaller enterprises (East and South Kazakhstan) have not been accounted.

Figure 3-11: Relationship between relative investments in agriculture and share of agriculture in regional GDP



Source: Own figure based on survey data.

According to Table 3-14 crop production has been marked by increasing specialisation. The share of wheat in total area sown has steadily increased during the last years. On the national level, the share of wheat area in total area sown increased from 41 per cent in 1995 to 66.1 per cent in 2002. The same development can be perceived for East Kazakhstan and Akmola, where the share was around 77 per cent in 2002. These numbers express the high portfolio risk of the farmers in the respective regions. The figures for South Kazakhstan show a somewhat different picture. The wheat share is relatively stable around 25 per cent.

Table 3-14: Share of wheat area in total sown area

	1995	1998	1999	2000	2001	2002
Akmolinskaya	0.628	0.714	0.713	0.742	0.748	0.771
Aktyubinskaya	0.421	0.611	0.548	0.632	0.712	0.736
East Kazakhstan	0.168	0.172	0.357	0.400	0.439	0.511
Kostanaiskaya	0.662	0.646	0.700	0.759	0.775	0.757
North Kazakhstan	0.181	0.605	0.645	0.687	0.724	0.743
South Kazakhstan	–	0.271	0.239	0.229	0.240	0.255
Republic of Kazakhstan	0.410	0.573	0.591	0.624	0.646	0.661

Source: AGENCY OF STATISTICS, 2003.

Note: – Missing value.

The differences between production conditions can best be shown by comparing yield data for wheat, the by far most important crop in Kazakhstan that is grown in all regions.

Table 3-15 shows some wheat yield characteristics for all regions. The average wheat yield over all regions was 0.92 t/ha for the period from 1980-2002. The three research regions show strongly varying yield features: Crop production in Akmolinskaya Oblast strongly focuses on grain, though yield levels are relatively low (0.939 t/ha for wheat) in comparison to South Kazakhstan. This region is endowed with a large share of irrigated crop area (60%) and thereby reaches a comparatively high yield (0.128 t/ha), though soil quality is relatively low (yield power of 30 in average). East Kazakhstan possesses a medium yield potential for grain crops. The relatively high yield instability, expressed in a coefficient of variation (CV) of 0.43 might partly be attributed to the unification of the former East Kazakhstan and Semipalatinskaya Oblast, where natural conditions are more unfavourable.

Table 3-15: Mean, standard deviations, and coefficients of variation based on wheat yield data from 1980 to 2002

Oblast	Mean	STD	CV
Akmolinskaya	9.39	2.94	0.31
Aktubinskaya	6.06	3.12	0.51
Almatinskaya	13.53	4.81	0.36
Atyrauskaya	4.72	3.32	0.70
East Kazakhstan	9.79	4.22	0.43
Djambulskaya	12.02	4.29	0.36
West Kazakhstan	7.01	4.21	0.60
Karagandinskaya	6.42	2.88	0.45
Kustanaiskaya	9.98	4.03	0.40
Kysilordinskaya	9.81	3.99	0.41
Pavlodarskaya	6.33	3.20	0.51
North Kazakhstan	11.48	3.73	0.32
South Kazakhstan	12.77	4.57	0.36
Republic of Kazakhstan	9.19	2.82	0.31
Min	4.72	2.82	0.29
Max	13.53	4.81	0.73
Median	9.59	3.86	0.40

Source: Own calculations based on survey data.

Table 3-16 depicts selected results for the rayons, in which the three study farms are situated. An investigation of productivity in crop production between farms on the rayon-level depicts higher differences in the pre-transition period (1984-93) than in the restructuring period thereafter (1994-2003). Results show a significant yield decline for wheat and sunflowers in Glubokoe, a weaker one in Tselinograd for wheat and barley and a slight increase of wheat and cotton yields in Turkestan. The coefficients of variation decline between the periods for wheat and barley in Tselinograd, sunflowers in Glubokoe and cotton in Turkestan are mainly influenced by the yield declines. The productivity differences are measured as coefficients of correlation between investigated farms. For three selected regional cultures the average correlation coefficients increased compared to the preceding period. Productivity differences between farms become particularly visible for the large rain farms in Tselinograd.

Table 3-16: Productivity differences between farms before and after transition

Rayon	Crop	Mean yield 1984-1993	Mean yield 1994-2003	CV 1984-1993	CV 1994-2003	Mean CV b/w farm yields 1984-93	Mean CV b/w farm yields 1994-03
Tselinograd	Wheat	11.6	9.1	0.330	0.257	0.890	0.730
(Akmola)	Barley	13.4	10.9	0.439	0.381	0.815	0.590
Glubokoe	Wheat	20.3	13.8	0.163	0.219	0.593	0.609
(East Kaz)	Sunfl.	18.4	11.5	0.203	0.193	0.696	0.639
Turkestan	Wheat	14.3	18.2	0.365	0.382	0.822	0.952
(South Kaz)	Cotton	19.6	20.3	0.227	0.183	0.748	0.977

Source: Own calculations based on survey data.

3.5 Available and potential risk management instruments

3.5.1 On-farm risk management instruments

As discussed in chapter 2.2.1, the main on-farm risk management measures are portfolio selection and technology choice. These two instruments will be discussed in the following with regard to the conditions in Kazakhstan. The concluding paragraph will describe the current government measures to support on-farm risk management.

3.5.1.1 Technological instruments

MEINEL (2002) investigates the geo-ecological effects of the Virgin Land's Campaign in Western Siberia and derives recommendations for the future use of these areas. The thesis mainly aims at formulating best practise recommendations from an ecological viewpoint of erosion minimisation. Table 3-17 gives an overview of proposed measures, their effects and utility for the typical wheat-fallow crop rotation.

Table 3-17: Recommendations for a cropping concept for the typical steppe

Cycle	Measure	Effect	Utility
Fallow	Shallow cultivation with disc harrow	Last year's stubbles remain	Protection against erosion Low evaporation
	Herbicide use (total herbicide)	Weed control	Low transpiration
Wheat	Herbicide use in early spring	Weed control	Low weed competition
	Early seeding	Early seed emergence	Longer vegetation period Optimal usage of melt water Protection against erosion in spring
	Fixing the straw production	Increase of stubble length	Improved snow collection Optimised influx of organic material Reduced evaporation Protection against erosion

Source: Own formation based on MEINEL (2002).

However, gross margin calculations used by Meinel as examples do not allow to draw general conclusions for the long-term economic sustainability of different technologies. It is proposed to use mainly old machinery for no-till technology. This view cannot be supported by the author of this thesis, although the proposed agro-technological measures are capable of stabilising yields.

Experience with minimum tillage technology[28] from North America shows promising results in terms of costs and yields and makes it a considerable option under the prevailing natural and economic conditions for crop production in Kazakhstan. It would make sense to introduce this technology as one of the on-farm risk-management instruments in the later discussed programming model.

[28] Definition: The least amount possible of cultivation or soil disturbance done to prepare a suitable seedbed. The main purposes of minimum tillage are to reduce tillage energy consumption, to conserve moisture, and to retain plant cover to minimize erosion.

Unfortunately, there is not sufficient data available yet to model a minimum technology option. The report of a joint project of the Ministry of Agriculture, the FAO, CIMMYT, and the Farmers' Union on the use of soil-conserving technologies for a sustainable crop production in Northern Kazakhstan (MINISTRY OF AGRICULTURE, 2005) displays results on costs and yields for one year only, which is not suitable for drawing any conclusions about probability functions.

Development and dissemination of technologies is strongly dependent on market availability. The establishment of trader networks of some international farm machinery producers will provide farmers with a broader range of technological solutions. As shown by the investments plans of the international farm machinery corporation *Agco* there is a huge market potential, predominantly caused by lack of investments in new machinery during the transition phase (INTERFAX FOOD AND AGRICULTURE REPORT, 2006 c).

3.5.1.2 Diversification

The agriculture sector in planned economies was characterised by a strong specialisation and hardly any diversification of enterprises. The transformation to market economies opened opportunities to manage risk by diversification of economic activities.

CHAPLIN et al. (2005) investigated factors which support and inhibit enterprise diversification in Poland. Diversification-stimulating factors found are the level of general education and the frequency of public transport. Impediments to diversification are age and the desire to concentrate on farming activities. In the Polish case, both factors inhibit the willingness to enter other sectors. Whether this is the case for Kazakhstani farmers and what role mentality and risk aversion play is an interesting question for further research. The results of the Chaplin paper suggest that understanding the reasons for rural households not diversifying can contribute to producing more realistic and better tailored development policy. For an analysis of off-farm diversification in rural households in Slovenia and Macedonia see MÖLLERS (2006).

MISHRA et al. (2005) examine the impact of various farm, operator, and household characteristics on the level of on-farm enterprise diversification in US agriculture. They find evidence that larger farms are more specialised. According to the results, there is significant evidence that insurance and diversification is positively correlated, indicating that farmers who buy insurance operate diversified farms. This result demonstrates the farmer's ability to self-insure and supports the view that insurance and diversification are complements. For the investigated Kazakhstani farms, the results of a logit model estimation on factors influencing the demand for crop insurance suppose a somewhat different picture (see chapter 4.4.2.8).

SULEIMENOV et al. (2005) investigate agronomic and economic potentials of crop portfolio diversification in Kazakhstan. They come to the conclusion that a replacement of summer fallow in a typical fallow-wheat-wheat-barley crop rotation would be beneficial from two perspectives. First, the planting of alternative crops such as oats and pea reduce soil erosion significantly. Second, overall grain yields and profit margins increased. The authors forecast a high yield and economic potential for safflower, an oil crop with high drought resistance. This assessment was confirmed by personal communication with experts (UMBETOVNA, 2004; KRUSE, 2003, 2006). Their conclusions are based on investigations in western Kazakhstan carried out for the years 2000-2002. Further research could test the long-term economic potential of alternative crops under changing natural conditions and prices.

Estimations of yield-stabilising effects of crop diversification show clear results. The analysis of coefficients of yield variation (CV) for the main cultures in the research rayons demonstrates a significant reduction in CVs of weighted, aggregated yield[29] of all cultures compared to the CVs of individual crops for a majority of the investigated enterprises.

BABU and RHOE (2001) demonstrate that agricultural diversification will improve food security through several different avenues. First, agricultural diversification will divert land and labour resources from grain production to the production of higher value-added products, such as animal or horticultural products. Second, with rising urbanisation in Kazakhstan and its surrounding export markets and a perceived change in the demand of higher income elastic foods such as meat, fruits, and vegetables, agricultural diversification will assist in achieving equilibrium in supply and demand. Third, diversification could lead to rural industrialisation through post-harvest activities, such as storage, transportation, processing, and marketing.

3.5.2 Financial risk management measures

Financial risk management measures are the second component of a holistic risk management approach. The following sections discuss the situation of Kazakhstani farms regarding own capital endowment and access to credit. However, the focus of this chapter lies on the description and analysis of the current mandatory

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29 Aggregated CVs were estimated in three steps. First, the production share of the individual crops (measured in sown area) was weighed. Second, the yields of the individual crops were aggregated by multiplying them with the weighing factor. Third, the CV of the aggregated yield was estimated.

crop insurance system as well as future options to establish a fully market-based voluntary insurance system.

3.5.2.1 Own capital

Own capital is the limiting factor for the expansion of enterprises and the application of a certain technology. Therefore a key adjusting screw of the programming model that will be discussed later is the availability of own capital. Table 3-18 demonstrates that many agricultural enterprises are not profitable. Only in East Kazakhstan, the number of unprofitable farm enterprises decreased significantly during the years 2003 and 2004.

Table 3-18: Profitability on agricultural enterprises (2001-2004)

	Profitable				Unprofitable			
	2001	2002	2003	2004	2001	2002	2003	2004
Republic of Kazakhstan	1832	1565	2103	1954	1973	1499	833	1427
Akmolinskaya	228	213	80	228	171	185	14	208
East Kazakhstan	80	53	101	93	73	47	18	15
South Kazakhstan	420	360	530	541	531	321	265	350

Source: AGENCY OF STATISTICS, 2005b.

Profitability problems have a negative impact on solvency and own capital accumulation for self-insurance. For that reason, similar to the Russian Federation, the establishment of agro-holdings[30] plays an increasingly important role in Kazakhstan (SUNDETOV, 2004). In 2003, for example the holding "Agrozentr Astana" cropped approximately 320,000 ha of grain in Akmola oblast which corresponds to 9.4 per cent of the entire sowing area of this oblast. The enterprise manages further areas in North Kazakhstan. HOCKMANN et al. (2003) present several reasons for the establishment of agro-holdings in transition. One reason is the presence of a principal-agent problem in financing agricultural enterprises. Vertical integration in the form of an agro-holding fulfils primarily two purposes:

[30] According to UŠAČEV (2002) an agro-holding is the entirety of legal bodies, that are linked to each other via contractual or asset relationships. One participating enterprise takes on the function of the main or central company that directs the activities of the participating firms and makes strategic decisions. Particularly, the main company might be responsible for a unified investment, technology and product policy as well as for the distribution of the profit (EK, 2001, quoted in HOCKMANN et al., 2003). In addition the main company prepares the consolidated or common balance of the holding and coordinates the flow of financial resources and commodities. Finally the main company may have the right to employ and remove managers and specialists in the participating or as they are also called subsidiary company (ibid).

First, it permits access to information to reduce information asymmetries, e.g. between suppliers and processors. Second, it provides the investor with an efficient control over the utilisation of his financial means by delegating decision rights and exercising control rights. On the other hand, disadvantages may arise in the form of agency problems between financiers and managers of an agro-holding. The inability of financiers to observe the behaviour of managers creates moral hazard problems. Managers may divert resources from intended use and put less effort in running the firm than they would do if their own capital were involved.[31]

3.5.2.2 Credit

Because of the extremely short periods for sowing and harvesting campaigns, the use of reliable machinery plays a particular role in Kazakhstan's crop production. The inability to replace or repair existing machinery and inputs is a major productivity constraint. Therefore the provision of adequate credit access plays an important role in the agricultural restructuring process.

Kazakhstan's rural credit system, a carryover from the Soviet system had the reputation for favouring collective and ex-state farms (POMFRET, 1995). The operation of a rural financial system is still mostly benefiting large producers. 2001 the Agricultural Credit Corporation (ACC) was established to provide subsidised credits to farms. Since then, 30 Agricultural Credit Partnerships (ACPs) were established across the country. The amount of rural lending is expected to increase. In 2003 the agricultural sector has received about 1.3 billion US$ of credits from commercial banks. However, most are directed to large farms and to operational lending. Credit for small farms and for the renewal of obsolete equipment is far below needs. The continued activity of the European Bank for Reconstruction and Development (EBRD) in financing the grain warehouse receipt programme shows the need and appropriateness of short-term credits for financing variable costs (EBRD, 2004)

PETRICK and DITGES (2000) investigate risk management instruments of a case farm in Aktubinskaya Oblast by applying a quadratic programming model. They find that increased liquidity could improve the risk management of farms. However, the authors did not recommend government support for agriculture in the form of cheap credit. They rather recommended other measures to tackle risk in agriculture, such as developing rural transport and communication infrastructure, removing legal obstacles to collateralisation, easing foreign direct investment in the

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[31] For a discussion on the influences of farm capital structure on risk management decisions, s. HEIDELBACH (2005c).

sector and to establish a rural advisory service. Six years after these recommendations were made, different measures, such as the establishment of a marketing infrastructure, the introduction of a market information system, and an input cost subsidisation programme were introduced. The rural advisory service will be put into operation within the framework of a currently operating World Bank project. The objectives are the distribution of knowledge on sustainable cultivation practices and improving farm management.

In a comparison of production costs for a high-input scenario typical of the Soviet era and a low-input scenario representative of current condition, LONGMIRE and MOLDASHEV (1999) estimated that a reduction of the real interest rate by 10 per cent from improvements in the credit system would result in production costs savings equivalent to a yield improvement of 10 kg/ha.

SUBBOTIN (2005) analyses access to credit for corporate farms in Russia using logit regression. His results indicate that more profitable farms have better access to credit. Contrary to the pattern in market economies, asset endowments (land and capital stock) have a very weak effect on the ability to borrow, reflecting the low collaterisability of farm assets in Russia. According to information provided by a representative of Zesnabank, one of the largest financiers of agricultural production in Kazakhstan, collateral is the most important factor in the decision for or against providing credit (TARADANOV, 2005). SWINNEN (2005) states that large corporate farms might have an advantage in receiving credit because their initial wealth is larger and/or because their transaction costs in credit markets are lower.

3.5.2.3 Crop insurance

Crop insurance has a long history in the former USSR in general and in Kazakhstan, in particular. Agricultural insurance exists already since tsarist times. In 1918, all insurance companies, with an exception of the mutual ones were transferred into state ownership under the roof of the state insurance company Gosstrakh. In the framework of the intensification of the planned economy, Gosstrakh was disintegrated in 1930. Three years later a re-establishment of the state insurance company began, which ended in the 1940 law "On compulsory insurance". 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 republics.

After 1968 the soviet crop insurance system was reformed. An all-risk insurance was introduced with coverage level of up to 70 per cent of the average yield of the last five years. (OSTRIKOVA, 2003). After the dissolution of the Soviet Union in 1991, the state insurance system was cancelled. Five years later, a new mandatory crop insurance system was introduced under the supervision of the state insurance company "Kazagropolis". According to information provided by a former inspector of the state insurance system, "Kazagropolis" went bankrupt, because many farmers could not pay their premiums (UAISOVICH, 2003). On the other hand, many farmers stated, that the state insurance company did not pay indemnities in case of a crop loss. In 2001, "Kazagropolis" was closed down, but some of the negative image of the former state insurance system remained. The bad reputation might be an obstacle to the new crop insurance system, which is based on private insurance industry participation.

Under the national agro-food programme of the Republic of Kazakhstan, the law "On Mandatory Crop Insurance" was adopted on March 10, 2004. It came into effect on April 1, 2004, and all by-laws were adopted for its implementation. However, due to absence of insurance companies holding license for crop insurance activities, implementation of the law in 2004 was impossible. Practical implementation started in 2005 with the beginning of the sowing campaign.

The main objective of this law is to ensure protection of property interests of crop producers from consequences of adverse natural phenomena, leading to partial or complete loss of harvest, through insurance payments. Since the law was adopted, the dissemination process provoked mostly depreciative reactions on the side of the farmers and farmers' organisations. Contrary to the argumentation of Tazhmakin (cited in PROKHOROV, 2005), chairman of a Kazakhstani insurance company, not only poor farmers object crop insurance. According to experiences gained during my extensive visits to the country, there is a broad distrust in the current crop insurance system. International experience shows, that large farmers and the insurance industry often profit most from crop insurance programmes.

The crop insurance covers losses caused by following adverse natural phenomena (excerpt from a 2005 insurance contract).:

– *Air drought* – Absence of effective precipitation (above 5 mm per day) in vegetation period during at least 30 successive days with maximum temperature above 25 C° (in southern regions above 30 C°). In some days, not longer than 25 per cent of the period duration (7 days), maximum temperatures may be below the specified limits.
– *Soil drought* – In vegetation period, reserve of productive moisture in the soil layer 0-20 cm is 10 mm maximum during at least 30 days in a row, or during at least 20 days, if before drought reserve of productive moisture in the soil layer 0-100 cm was below 50 mm.
– *Frosts* – Decrease of air temperature (soil surface) below 0C° in period of active vegetation of crops, leading to their significant damage.

- *Winter killing* – Damage to grain crops, caused by low temperatures in absence of snow cover or its insufficient capacity during severe frost.
- *Lack of heat* – Lack of active and effective air temperatures, required for physiological development of plants (development of certain phases of development of various crops).
- *Excess soil moisture* – In vegetation period, soil 10-12 cm deep is visually characterized as sticky and fluid during at least 20 days in a row. In some days, not longer than 4-5 days, soil may transfer to soft plastic consistency.
- *Hail* – Particularly dangerous, when size of hailstones is 20 mm and more (average size of 10 largest hailstones); smaller hailstones may be considered, too, if they caused big damage.
- *Shower* – Rainfall 20 mm and more during less than one hour; rainfall during shower is counted.
- *Storm* (dust, sand) – Average speed is at least 15 m/sec and visibility is 500 m at most.
- *Hurricane* (strong wind, squall) – Wind with average speed or gusts 15 m/sec and more. Maximum speed of wind that damaged plants is counted.
- *Flood* – Flooding of crop land during spring floods, rain floods, ice jams.
- *Mudflow* – Water flows, caused by floods in mountain rivers, with very high content of mineral particles and fragments of rocks

The insurance company indemnifies the farmer based on standard costs per hectare, which were formulated by the Ministry of Agriculture (MoA). The farmer can choose between two standard costs types (scientifically justified technology, simplified technology, and three types of costs including labour, fuel, and seeds). 50 per cent of the payments to insurance organizations are subsidized by the government *Fund for Financial Support of Agriculture*. Licenses *without time limit* for insurance activities in the field of mandatory crop insurance have been issued to four insurance companies (JSC Grain Insurance Company, JSC TransOil Insurance Company, JSC Victoria Insurance Company, and JSC Eurasia Insurance Company). Active work on conclusion of contracts of mandatory crop insurance in 2005 has been carried out by the first two companies only. However two insurance companies turned out to be insufficient to provide complete coverage of mandatory crop insurance as Table 3-19 through Table 3-21 show.

Table 3-19: Crop insurance market characteristics 2005

Oblast	No. of contracts	Total insured area (ha)	Insured area/ contract	Total sown area (2004)	Insured area as share of sown area (2004)
Akmolinskaya	961	1,870,060	1,946	3,606,000	0.519
Aktubinskaya	632	243,963	386	726,300	0.336
Almatinskaya	1,210	45,941	38	490,000	0.094
East Kazakhstan	2,016	572,056	284	595,900	0.960
Djambulskaya	541	46,909	87	377,300	0.124
West Kazakhstan	521	223,930	430	666,900	0.336
Karagandinskaya	486	203,549	419	845,400	0.241
Kysylordinskaya	81	20,721	256	79,600	0.260
Kostanaiskaya	3,339	2,808,782	841	3,053,700	0.920
Pavlodarskaya	777	473,735	610	578,000	0.820
North Kazakhstan	2,319	1,714,245	739	3,031,000	0.566
South Kazakhstan	189	2,107	11	226,400	0.009
Total	**13,072**	**8,225,998**	**629**	**14,278,000**	**0.576**

Source: Own formation based on information provided by JSC "Grain Insurance Company", 27.07.2005 and JSC "Trans Oil", 20.07.2005.

The total insured area was 8,225,998 ha, which is 57.6 per cent of the entire crop area subject to mandatory insurance (14,278,000 ha), including

– Cereals – Insured area was 7,982,513 ha, which is 57,5 per cent of entire crop area under cereals (13,886,000);
– Oil crops – Insured area was 237,753 ha, which is 38.9 per cent of entire crop area under oil crops (610,900);
– Sugar beet – Insured area was 1969 ha, which is 10.4 per cent of entire crop area under sugar beet (19,000);
– Cotton – Insured area was 1818 ha, which is 0.9 per cent of entire crop area under cotton (200,700).

There is a higher penetration of crop insurance in regions with a higher share of large-scale enterprises and better infrastructure, like Akmola, Kostanai, East and North Kazakhstan. Smaller private farms have restricted access to insurance, though they would need it more than large farms, since their self-insuring opportunities are limited. This development was predictable according to the statements of the chairman of "Grain Insurance Company" as of September 2003, whose main interest lies in insuring large-scale farms in Northern Kazakhstan (TASHMAKIN, 2003). Private insurance companies clearly act as profit-maximisers and try to keep transaction costs low.

Table 3-20: Insured area according to crop and farm type, 2005

	Insured area (ha)					
	Grain		Oil crops		Cotton	
Oblast	**AE***	**PF****	**AE**	**PF**	**AE**	**PF**
Akmolinskaya	1,632,114	237,946	–	–	–	–
Aktubinskaya	131,588	112,375	–	–	–	–
Almatinskaya	15,911	11,238	10,030	5,027	–	–
East Kazakhstan	256,605	176,800	67,965	70,686	–	–
Djambulskaya	23,745	16,720	4,944	1,771	–	–
West Kazakhstan	58,447	165,483	–	–	–	–
Karagandinskaya	108,433	95,116	–	–	–	–
Kysylordinskaya	19,578	1,083	60	–	–	–
Kostanaiskaya	1,849,858	958,924	–	–	–	–
Pavlodarskaya	172,914	225,795	15,904	59,122	–	–
North Kazakhstan	1,577,748	134,453	2,044	–	–	–
South Kazakhstan	89	–	200	–	1,800	18
Total	**5,847,030**	**2,135,483**	**101,147**	**136,606**	**1,800**	**18**

Source: Own formation based on information provided by JSC "Grain Insurance Company", 27.07.2005 and JSC "Trans Oil", 20.07.2005.

Note: * AE=Agricultural enterprise, PF=Private farm.

In 2005, in course of practical application of the law norms, defects were discovered. Accordingly, the MoA created a working group for development of proposals on improvement of the law on mandatory crop insurance. In a meeting of the MoA working group in October 2005, three main problems of the actual system became evident:

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

- *Communication*: Loss of information about insureds' characteristics (production, technology...) caused by missing collaboration between agricultural administration, statistical offices and insurance companies. Different, sometimes shady practices for transfer of premiums and indemnities.
- *Insufficient provision of information* to farmers and regional agricultural administration: Lead to confusion and resentments among farmers in different regions, i.e. productive farmers in Northern Kazakhstan do not want to subsidize highly risk-prone farms in Western Kazakhstan.

Other weak points of the insurance programme not mentioned in the meeting are:

- *Adverse selection and moral hazard* may arise, as farmers could select the highest cover (scientifically justified technology), although they have used simplified technologies, hoping to increase the probability of insurance payout.[32]
- The law does not make 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 and a high claim rejection rate*. The loss adjustment is performed by a commission, which determines the yield loss. The first year processing rate was very low due to implementation difficulties. As of December 2005, only 60 per cent of the farmers' claims were processed, although the law includes a maximum processing and indemnification period of 30 days after the loss occurred. If a total loss will be reported, this period reduces to even 10 days. Interestingly, 95.8 per cent of the claims were rejected. Most of the rejected claims, are currently under litigation. These disputes show that the loss adjustment process needs to be revised in the very short run, as this will affect the reputation of the whole crop insurance scheme and even the reputation of the insurance industry.
- Another evident problem on the way to a functioning commercial crop insurance system is the *lack of interest of potent insurance companies*. Liquidity problems of insurers can be caused by systemic risk and credit-rationing. Credit-rationing could be overcome by diversifying the insurer's portfolio with insurance types which losses are not correlated to crop insurance. In Kazakhstan, the insurance market is not fully developed yet. There is a range of small insurers with unsatisfactory securities, such as "Grain Insurance Company", which was especially founded for the purpose of providing insurance to the agricultural sector. The company

[32] The monetary effects of this behaviour will be investigated in chapter 0.

faces an extremely high risk when considering the portfolio of clients. "Grain Insurance Company" and "Trans Oil" belong to the smallest among the 37 insurance companies registered in Kazakhstan (as of 1 July 2005). Together they possess less than two per cent of the entire own capital of the whole national insurance industry. One might question the adequacy of small companies to act as a crop insurer on a national basis.

Table 3-21: Trends in crop insurance market development

Oblast	No. of contracts 2005	No. of contracts 2006	Change 2006/2005	Total insured area (ha) 2005	Total insured area (ha) 2006	Change 2006/2005
Akmolinskaya	961	1,837	1.91	1,870,060	3,520,477	1.88
Aktubinskaya	632	638	1.01	243,963	245,789	1.01
Almatinskaya	1,210	1,997	1.65	45,941	21,149	0.46
East Kazakhstan	2,016	5,191	2.57	572,056	370,794	0.65
Djambulskaya	541	724	1.34	46,909	56,975	1.21
West Kazakhstan	521	700	1.34	223,930	330,435	1.48
Karagandinskaya	486	952	1.96	203,549	372,604	1.83
Kysylordinskaya	81	102	1.26	20,721	26,979	1.30
Kostanaiskaya	3,339	3,404	1.02	2,808,782	3,097,948	1.10
Pavlodarskaya	777	791	1.02	473,735	489,024	1.03
North Kazakhstan	2,319	2,303	0.99	1,714,245	1,917,382	1.12
South Kazakhstan	189	369	1.95	2,107	4,662	2.21
Total	**13,072**	**19,008**	**1.45**	**8,225,998**	**10,454,218**	**1.27**

Source: Own formation based on information provided by JSC "Grain Insurance Company", JSC "Trans Oil", and JSC "Victoria", 14.04.2006.

In spite of many implementation difficulties, the number of insurance contracts and the total insured area increased in 2006 compared to 2005 in nearly all oblasts (Table 3-21). Nevertheless, the insurance penetration is continuing to be very low in southern Kazakhstan oblasts (South Kazakhstan, Almatinskaya, Djambulskaya, Kysylordinskaya).

Keeping in mind the described implementation problems, the next chapter proceeds in discussing which implications government support of a crop insurance system has and which alternative non-trade distorting support mechanisms the government of Kazakhstan is currently using.

3.5.2.4 Government measures

Crop insurance was historically subsidised by the state. Whether this is correct from the point of the state depends on the political objectives formulated by the respective democratic government. From an economic viewpoint, direct subsidisation of crop insurance might be questionable in many cases. No less questionable, though, is another behaviour exemplified in the demands of Russia's Agricultural Minister to support Russian farmers who were affected by winter killing in 2006 despite the existence of a crop insurance system (Agra-Europe, 2006c). Ex-post disaster relief contributes to the weakening of an insurance system by taking away ex ante insurance incentives. Public support of disaster relief and crop insurance at the same time annuls the idea of ex ante risk management through crop insurance. HARDAKER et al. (2004, p. 301) ask "Why should farmers purchase crop insurance against major calamities if they know that farm lobbies can usually apply the necessary political pressure to obtain direct assistance for them in times of need at no financial cost?" While lobby pressure might be predictably high after occurrence of natural disasters, giving in to this pressure on the part of the politicians leads to undermining the crop insurance system.

Until recently the Government of Kazakhstan used to maintain relatively little involvement in influencing crop production. Investment in research and extension was minimal. Likewise, infrastructural investment, such as development of roads, terminal facilities, marketing system, and agribusiness promotion, remained insignificant (MENG et al., 2000). Starting in 2003, several actions were undertaken by the government to develop rural areas and particularly the agricultural sector. For example Kazakhstan's Food Contract Corporation launched a grain terminal in Ventspils, Latvia, with a capacity of 1.5 million tonnes of grain. Furthermore, the long-time planned grain terminal at the port of Aktau on the Caspian Sea, with a handling capacity of up to 500,000 tonnes a year was put into operation. The corporation established representations in Britain, China, Iran and Uzbekistan (INTERFAX FOOD AND AGRICULTURE REPORT, 2005 a). A further government action is the recent launching of a project on improving the competitiveness of agricultural commodities.

4 Empirical analysis of risk management instruments

This chapter presents the most important empirical findings of the dissertation. Specifically, the following sections highlight the research conditions, the selection of research regions, the questionnaire contents, and the most important survey findings. Thereafter, the methodology for assessing the efficiency of different risk management instruments and the results from model estimations will be presented.

4.1 Research design and objectives

Different approaches have been used to work on the research topic. Besides the investigation of the current crop insurance system by the means of comparative literature analysis and the study of secondary data, the collection and analysis of unique own data was an integral part of the research concept.

The research questions were approached by exploratory expert interviews and two workshops with scientists, representatives of insurance companies, state institutions and agricultural interest groups. However, conducting structured personal interviews on the farm-level and collecting secondary statistical data on cropping areas, yields, prices and regional weather data were the most important elements of data collection.

The rationale for the empirical study, particularly the farm survey, is to obtain information about production risks that Kazakhstani farmers face, their attitude towards risk, and the risk management instruments they apply. Furthermore, factors influencing the demand for insurance products will be investigated. This information provides the basis for further analysis of potential risk management instruments for farmers in transition countries in general and under the prevailing production conditions in Kazakhstan in particular. No appropriate data was available before. In Kazakhstan and other CIS countries survey data collection in many cases is not affordable for socio-economic research institutes.

The rationale for the aforementioned interviews was to gain insight in experts' perceptions of functioning crop insurance in Kazakhstan. The interviews were conducted with 13 experts from insurance companies, chairmen of farmers' unions and agricultural trading companies and scientists from the disciplines Meteorology, Agronomy, and Agricultural Economics. They provided the basis for further refinements of the farm survey questionnaire. Furthermore, the interviews detected critical issues that had to be addressed on the workshop.

The workshops were designed to bring together different groups of experts with different interest with regard to crop insurance in order to stimulate discussion about crop insurance in Kazakhstani agriculture. The objective of the first workshop was to inform the participants about the research objectives and basic principles of crop insurance, and on this basis to gain information for further empirical investigations, particularly with respect to the selection of survey regions. Through moderation and visualization techniques that facilitated discussions, workshop participants could make statements regarding the most important regional and supra-regional risks, preferred insurance products and their design features.

The dissemination of results among stakeholders was accomplished by a second workshop organised by the project team and scientific publications in the country of research. The workshop, which took place in October 2005, in the Ministry of Agriculture in Astana, provided a forum for discussing results. Workshop participants included political decision-makers, representatives of the World Bank, the Kazakhstani Farmers' Union, regional administrators, insurance companies, researchers, farmers and journalists.

Table A-1 provides information on the different survey components: It describes their objectives and informs about the respondents to the different parts of surveys, the number of observations, the character of the extracted data and the time span when the data was collected. The components constitute a crucial part of the research and contribute to the aforementioned research objectives by providing the data base.

4.2 Research conditions and data quality

This chapter comprises two parts. First, it provides some observations about conditions for field research, which emerge from the fieldwork periods in 2003 and 2004 and the dissemination of results among stakeholders in 2005. Second, it critically discusses the data quality in a transition country, such as Kazakhstan.

4.2.1 Field work[33]

Four points are worth making about the conditions for conducting field research of this kind. First, experience from the year 2003 showed that carrying out a random selection procedure for rayons and farms does not produce satisfying results. Rayons that were administratively re-organised and farms that changed legal form, ownership status, and crop area several times during the past years, might be selected. Structural interruptions such as these might lead to spurious findings. As a result, more importance should have been attached to additional recommendations of the often very helpful oblast and rayon administrative staff. As the 2004 experience has shown, the fieldwork tasks in the rayons can be organized more efficiently when taking seriously the recommendations of the administration.

Second, staff and data resources in the departments of statistics and agriculture vary significantly across rayons, and thereby the degree of necessary support for researchers also fluctuates. For our purposes, we needed long time series of yields and sown areas for the most important agricultural crops on a farm-level basis. But as a result of different organizational and structural reforms and changes, this data is scattered among different institutions, i.e., oblast and rayon statistical and agricultural departments and archives. We are able to safely say that each rayon has its own rules. Thus, data collection resembles detailed detective work. Equally, the access of foreigners to the non-secret agricultural data is regulated and managed in different manners across oblasts and rayons. In the Northern Kazakhstan city of Kostanai, it was more difficult to collect data than in other regions, according to the head of the Regional Department of Statistics the result of ‘bad experiences made with foreigners’, i.e. misuse of confidential data.

A further lesson learned is that the quality of accounting data varies greatly across farms. While smaller private farms might not have any records at all for the past years, larger, well-performing farms sometimes have an army of accountants. However, only the main accountant has an overview of the data, but usually is not obliged to pass on information to a third party without the agreement of the head of the respective enterprise. That makes it necessary to obtain an appointment with both persons. The last point shows the importance of hierarchy in Kazakhstani institutions.

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33 This chapter is based on HEIDELBACH (2005a).

The outstanding role of the head is inherent to the system and is an obstacle to both the functioning of the institutions itself and the efficiency of their clients.

Finally, the efficiency of fieldwork is likewise limited by regional telecommunication availability and rural infrastructure. The exchange of data via electronic systems is often possible between state institutions, but limited between institutions and other entities – in our case researchers. The state of the Kazakhstani telecommunication network is illustrated by UN statistics. Kazakhstan placed 134 out of 187 countries regarding internet accesses per population, 106 out of 204 countries regarding the number of main phone lines per population and 126 out of 191 countries regarding mobile phone subscriptions per population (UNITED NATIONS, 2003a). In a UN paper assessing the overall diffusion of information and communication technology Kazakhstan is ranked 166 out of 180 countries (UNITED NATIONS, 2003b). In addition, taking into account the bad state of many roads and the vast territory of rayons, both a clear-cut plan and intense organization of the field work by experienced researchers will contribute to a successful and efficient data survey.

A conclusion from this chapter could be formulated as follows: Field research is always a complex process involving many contextual factors, discontinuities, negotiations, and compromises. Comprehending cultural and historical peculiarities of the research area, learning how local institutions function, and being willing to adapt personally to new circumstances that affect planning and negation strategies are key qualifications for conducting successful data surveys, especially in transition and developing countries.

4.2.2 A critical discussion of the data quality

COBLE and BARNETT (1999) describe the problem of inappropriate data for risk analysis. Aggregated data might lead to spurious results. Table 4-1 illustrates this point. The table reports the ratio of weighted average of farm yield standard deviations to the rayon yield standard deviations for the rayon where the example farms are located. Rayon yield standard deviation underestimates the average farm yield and severely biases analysis of yield risk.

JUST and POPE (2003) also criticise the use of aggregate data in risk analysis. They argue that it often distorts risk and renders empirical applications little more than illustrative exercises. These critics motivated the use of specific study farms for analysis within the framework of the risk programming model.

Table 4-1: Underestimation of deviations in farm yield, when aggregating the data

Location (rayon)	Mean standard deviation of farm yield (wheat, 1994-2003)	Mean standard deviation of farm yield/standard deviation of rayon yield (wheat, 1994-2003)
Tselinograd (Akmola)	2.91	1.25
Glubokoe (East Kazakhstan)	4.44	1.47
Turkestan (South Kazakhstan)	4.52	1.03

Source: Own estimations based on survey data.

TOMEK and PETERSON (2001) discuss the problem of doing useful analyses by a lack of easy access to data on some of the relevant portfolio choices. They mention that when one introduces yield futures and insurance products to a portfolio model, research becomes more costly, as an understanding of the probability functions of farm-level yields is crucial.

As described in chapter 3.2.3, the former state and collective farms were downsized and transformed into cooperatives, limited liability partnerships, joint stock companies and private family farms in the early transition period. This had a significant effect on production technologies and practices. To follow this data particularity both farm as well as aggregated yield time series (rayon, oblast, and national level) were tested for structural change in the respective period by employing a Chow-test (CHOW, 1960). In the presence of a structural break, two sub-periods, before and after the structural break, are regarded for yield de-trending (s. BOKUSHEVA et al., 2006)

Since it was not possible to select a common procedure[34] for the whole data set, yield time series were de-trend according to a procedure described in BOKUSHEVA et al. (2006).

The main distinctions between different procedures employed are those regarding the functional forms used and application of F-test to the trend parameters estimates. Additionally, all procedures were used with and without taking into

[34] In several cases, the data provide evidence for structural change, but trend parameters estimates are not significantly different from zero. Thus, it is not fully appropriate to de-trend yields employing these estimates. On the other hand, as long as the hypothesis of structural break is not rejected, we have to count for a bias, if we do not apply de-trending to those time series.

account annual weather effects. Introduction of a weather parameter into de-trending procedures can be justified by the fact that in the period from 1995 to 1998 wheat yields sank consecutively as a result of extremely adverse weather conditions. Thus, considering annual weather effects should allow a more correct assessment of time trends. However, since weather parameters cannot be introduced on the aggregated levels, particularly on the national and regional levels, both, standard de-trending procedures and de-trending with taking into account weather effects were used.

Another factor with regard to data quality is *trust* in the collected data. In Kazakhstan and other CIS countries, the discrepancies between actual and reported crop (grain) production may be less important than in the livestock sector, as grain continues to be produced mainly on large collective or corporative farms, for which there is an established system of data collection. However, the reliability of data coming from the large farms is being undermined by the deficiencies in the grain production and marketing chain.

Strong motivation continues to exist at all levels of the grain chain to under or over report. Despite the variety of conditions in grain production and marketing among the CIS countries, the reasons for under-reporting grain output are similar and reflect mainly farmers' need for cash, aversion to (re-)paying tax and debts, and disappearance of grain at various levels in the marketing system – local elevator, rayon, oblast and higher levels of government – in countries where grain trade is still under partial control. In addition, lacking cash, farmers commonly pay for inputs and services in grain, before the grain enters the official marketing channels at the elevator.

At the same time however, and despite the formal privatization of the farms, the tendency of underreporting production/exports in order to maximize earnings continues to be counterbalanced to an unknown extent by over-reporting data for the area sown and/or production. This happens because regional officials are under considerable pressure to achieve hierarchically imposed area and/or production targets or risk losing a position of power. As reported by the FAO (1997), in some countries, such as Kazakhstan in 1997, under-reporting of yields continues to be offset (though to an unknown extent) by over-reporting of area sown. The uncertainty regarding the size of the areas sown to grains adds to the difficulty of estimating yields, thus making it almost impossible to accurately estimate the final harvest.

4.3 Data description

4.3.1 Sampling

For our study purposes, i.e., a study of a large geographically dispersed population (farms), it was convenient to use a multi-stage sample design. This is a type of design where in the first stage a sample of larger units is selected (the oblasts in our case), then in the second stage, from each of the selected first stage units a sample of smaller units (rayons in our case) is chosen. The last step included a selection of farm enterprises and individual farms in the rayons. For these purposes, a Simple Random Sample (SRS) procedure was employed (POATE and DAPLYN, 1993). A multi-stage design is particularly appropriate where a large-scale survey is to be conducted, and where for logistical and organizational reasons it is convenient for the sample to be grouped together in a more limited number of geographical areas, rather than being spread thinly and dispersed across the country (POATE and DAPLYN, 1993).

The selection of representative oblasts was conducted using statistical data and expert statements from the first project workshop and by taking into account various criteria as noted below. Methodological principles used for the selection of oblasts and farms were based on the combination of typological and structural grouping methods (BOEV, 1995). Official information from the Agency for Statistics of the Republic of Kazakhstan served as a data base for the selection process.

Specifically, the selection of research regions was based on the following indicators: 1) gross output of the crop production sector in monetary terms; 2) share of the crop production sector's gross output of total agricultural output in each oblast; and 3) share of rural population in each oblast of total rural population of the country. The first indicator shows the place of the oblast in the country’s crop growing sector. This is the key indicator. The second indicator allows the assessment of the crop growing sector's importance in agriculture as a whole by oblast. This criterion also indicates agricultural specialisation (crop production or livestock industry) of an oblast. The third indicator provides an opportunity for ranging the oblasts based on the number of people whose material well-being is directly connected to the state of agriculture. In other words, the indicator highlights the regions of population concentration whose welfare depends mostly on agriculture. The integration of the three indicators mentioned above has been made in the following way: For each indicator, oblasts have been ranged. Then, each indicator (criterion) is assigned a weight. An oblast's rank in each criterion was to be multiplied by its weight. Then the total number of points was calculated for each oblast.[35] Taking into account the factor of representativeness of different geographical regions with different geo-morphological and agro-climatic conditions, as well as the production of strategic crops such as wheat, cotton and oil crops, Akmola, North Kazakhstan, South Kazakhstan and East Kazakhstan, respectively, were chosen as possible regions for the farm survey.

The region selection procedure was presented at the first workshop with key actors in September 2003. The discussion of the results of the selection results with workshop participants came to the conclusion to introduce two additional regions into the initially formed sample: Kostanai in the North and Aktobe in the West in order to take into account the specific production conditions in these regions.

In the second stage, between two and four rayons per oblast were selected according to the criteria 'natural yield potential'[36] and 'relative importance of crop production'[37]. Data from the regional statistical agencies served as a base for the selection process. Moreover, the selection process was supported by the directors of the regional departments of agriculture by providing valuable information on the local research conditions.

4.3.2 Survey data

Besides the structured interviews with a sample of farmers, data on yields and crop areas was collected for about 200 farms in 17 rayons for up to 40 years.

Additionally, meteorological data on temperature, precipitation, humidity and soil moisture is available for several rayons. The data is used to assess the statistical correlation between meteorological coefficients and yield and the development of functioning index-based insurance schemes.

The multi-stage sample design was employed to create nationwide representativeness, however the stratified randomness of the agricultural producers' sample is weakened by the achieved number of observations. The major reason for this were the inevitable budget and time constraints. Nevertheless, the data provides a satisfactory basis for generating valid risk management related hypotheses and their tests.

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35 Thanks go to Talgat Kussayinov for the design of the selection methodology.

36 This criterion takes into account historical yields, soil quality and agro-climatic conditions.

37 I.e. physical output of the strategically most important crops relative to other rayons in the same oblast.

4.3.3 The farm survey questionnaire

The farm survey questionnaire (see appendix B) is structured in five sections. The first section asks about standard personal characteristics from the respondent such as age and education. The questions concerned with the personality of the respondent fulfil two purposes: Firstly, they belong to the so-called warming-up phase; after the introduction of the enumerator, the respondent gets the opportunity to tell something about himself. Secondly, these questions serve to obtain an assessment of the educational background of the studied population. The questions in section two try to steer the respondent towards specific aspects of crop insurance schemes such as preferences associated with insured crops, contract duration, level of deductibles, and so on. Part three asks about local natural conditions of crop production and the characteristics of the most frequently experienced natural hazards. Section four evaluates respondents' attitudes towards production risk and tries to assess their risk management behaviour. The main objective of this part is to formulate an impression about the willingness to take risk, risk management responses and the consequences of risk the farmers are most concerned about. It is important to give the respondent the full spectrum of answering possibilities on a five-point Likert-scale, i.e. not to restrict him to the three possibilities "strongly agree", "neutral" and "strongly disagree".

Part five of the questionnaire summarises the evaluation of the survey given by the enumerators. This part is designed to provide the enumerator with the possibility of supplying a short personal assessment of the respondent.

4.4 Analysis of survey data

4.4.1 Results of the workshops with stakeholders and expert interviews

In the opinion of the workshop participants, drought and early frosts represent the greatest production risks for all regions included in the study. Other risks such as pests, plant diseases and hail play a more subordinate role in causing fluctuations in yields. The majority of those participants questioned, however, are calling for a comprehensive or multi-peril crop insurance. Similarly, many favour an income-related insurance over a yield-related one.

The expert interviews brought similar results. They took place with the same target group that attended the workshop. A principal topic of discussion was the development of insurance products. Instruments that guarantee flexibility seem to be of great importance. Examples of this are the possibility to choose the coverage level, a mechanism that allows weather conditions to be included in the development of the product, as well as a regional differentiation. The potential and suitability of products based on weather parameters were hotly debated by the experts, and the issues were not resolved by the end. Separate ongoing studies show that such products offer realistic and efficient alternatives to conventional insurance schemes.

Also in dispute is the question whether compulsory insurance in Kazakhstan offers advantages over a voluntary variant with different choice options. Those in favour of a compulsory insurance have more faith in the traditional system, in which the state is a central authority that also regulates the insurance market and guarantees the agricultural sector a basic risk protection. There is also no clear agreement on the question of whether insurance contracts should be long term or only cover the period from sowing to harvest. Less contentious is the attitude towards deductibles. The representatives from the insurance companies, in particular, value the positive effect of this instrument in reducing moral hazard. The average excess rate that the experts suggest should be aimed for, and which businesses should be able to afford, is about 30 per cent deductibles.

Another issue that was keenly debated both during the workshop and in the discussions with experts is that of the monitoring mechanism. Essentially there are different variants of production control and damage checks. Beside remote sensing systems that necessitate a high level of technological expense, the insurance companies can send in experts. However, only a system of independent experts who are paid for by the state seems to be acceptable to all sides.

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 Kazakhstani 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 problems of asymmetric information, they could serve as a facilitator for market entrance of private insurers. However, area-yield crop insurance, as well as weather-based-index insurance, do 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.

4.4.2 Farm survey results

4.4.2.1 Key characteristics of respondents and farms

Interviews were conducted with 73 farmers and managers of agricultural enterprises, 32 of which are limited companies (43.8 per cent), 26 individual enterprises (35.6 per cent), 14 producer co-operatives (19.2 per cent), and 1 state enterprise (1.4 per cent). The average agricultural area of all interviewed enterprises is around 9687 ha, ranging between 4674 ha in South Kazakhstan and 25,583 ha in Kostanai. Wheat production is economically the most important branch in Kazakhstani agriculture. Consequently, the study enterprises comprise a large proportion of wheat producers (71.6 per cent), a smaller proportion of cotton farmers (17.6 per cent) and a small share (10.8 per cent) of mixed farmers who produce sunflowers vegetables and fruits, for instance, in addition to grain crops and cotton.

The respondents were, on average, 51 years old, ranging between 33 and 70 years, with only seven respondents younger than 40. The educational background of the respondents is quite diverse: More than 69.9 per cent graduated from university, 11 per cent visited a vocational college and 12.3 per cent a secondary school. Just 2.8 per cent attended only elementary or vocational school, while 1.4 per cent could not read and write at all. Regarding agricultural educational background, the majority of respondents studied agriculture: While 30 per cent have practical experience solely, 1.4 per cent attended short theoretical courses in the past. Another 2.7 per cent visited a vocational school, 8.2 per cent an agricultural secondary school, and 57.5 per cent an agricultural university. 53.4 per cent of the respondents took additional training courses after schooling and higher education respectively, 5.1 per cent of which in food processing, 25.6 per cent in management and 48.7 per cent in other fields.

The natural production conditions in the survey regions, and thereby the average yield levels and yield fluctuations, vary widely across farms, e.g. the average yield power[38] of all sample farms is 39 (of 100), ranging between 12 and 66 (means: Akmola 42, North Kazakhstan 46, Kostanai 44, Aktobe 26, East Kazakhstan 47, and South Kazakhstan 28). For the selection of the research rayons the regional committees of land resources provided data on the average yield power values for the total agricultural area in each oblast (s. Table 4-2). The regional differences in natural conditions are reflected in different average

[38] The yield power of a soil is a function of soil type, actual state of the soil and local agro-climatic conditions such as temperature and precipitation. The maximum yield power is 100.

grain yields and fluctuations of the grain yields over time. Correlations between aggregated grain yields and yield power values are not reasonable, since the reference areas for both values are not identical and different grain crops have different production elasticity with regard to yield power.

Table 4-2 shows grain yields for all Kazakh oblasts from 1970-2001. The average grain yields reflect approximately the yield power values of six research regions. Only South Kazakhstan's relatively high value cannot be explained by yield power. In this region, as well as in Kyzyl-Orda[39], irrigation of crops is an additional stimulating factor for yield values.

Table 4-2: Regional grain yield characteristics 1970-2001 (unit: 100kg/ha)*

Region	Mean	Min	Max	Stand. dev.	Yield power**
*Akmola****	9.3	3.6	17.0	3.4	39
Aktobe	6.5	1.1	10.9	2.7	13
Almaty	12.1	4.8	21.6	4.1	–
Atyrau	3.5	0	9.6	2.8	–
East Kaz	12.4	5.6	17.7	3.3	39
Zhambyl	11.4	3.3	22.8	4.5	–
West Kaz	7.5	1.6	16.4	4.3	–
Karagandy	6.8	2.9	15.0	3.1	–
Kostanai	10.2	2.7	14.9	3.8	38
Kzyl-Orda	33.7	14.0	43.7	7.0	–
Pavlodar	6.0	2.6	12.2	2.5	–
North Kaz	12.8	6.7	18.7	3.6	43
South Kaz	13.8	4.3	21.3	4.3	35

Source: Survey data.

Notes: * Data from regional departments of statistics.
** The value for South Kazakhstan is the average yield power of the irrigated land.
***Research regions are marked in italics.

4.4.2.2 Attitude towards crop insurance products

Past experience with insurance respective to crop insurance has an important impact on current attitudes towards crop insurance. 31.5 per cent of interviewed farmers reported having experience with crop insurance in the past, mostly under the centrally-planned economic system of the Soviet Union. 64.4 per cent of the total group of respondents would like to insure crops in the near future. 80 per cent of farmers in the three Northern oblasts (Akmola, North Kazakhstan

[39] Here, aside from wheat and barley, rice plays a major role in grain production (approximately 71 per cent of total grain production area). Rice yields in this oblast are three to four times higher than yields of other grain crops.

and Kostanai), 77.8 per cent in East Kazakhstan, 60 per cent in Aktobe, and only 39.1 per cent in South Kazakhstan would, generally, like to insure their crops. These results reflect the production situation of the enterprises under investigation. In South Kazakhstan, farms are smaller, more diversified, and have at least a part of their land under irrigation. The respondents who did not want to insure had several reasons for their attitude: 47.1 per cent do not believe that insurance can pay off its costs, 17.6 per cent had bad experiences with insurance in the past, 5.9 per cent made insufficient liquidity of their enterprises responsible for their decision. 29.4 per cent named other reasons, such as distrust in private insurance companies and sufficient on-farm risk management. Despite the facts that the crop insurance system during the 1990s did not work properly and many farms remained uninsured, as well as the negative experiences Kazakhstani citizens had with the introduction of compulsory health insurance, 37 per cent of the respondents believe that crop insurance in Kazakhstan should be compulsory. The most frequent explanation for that answer was that all farms are exposed to risk.

Assumptions about a correlation[40] between age and the preference for or against compulsory crop insurance were not proven by the data: The average age of an opponent of compulsory insurance was only one year less than that of an advocate of it. Likewise, the test for a relationship between one's risk attitude and willingness to procure long-term contracts[41] did not produce significant results. Respondents that would be willing to sign contracts spanning three to five years often named stability as a reason. The will for stability in this question is not connected to the risk attitude value that was captured by questions 4.1.3 to 4.1.5 (s. appendix).

The introduction of deductibles to insurance contracts plays an important role in counteracting moral hazard problems. For that reason, we tried to test for the willingness to procure such contracts. The majority of respondents had a positive attitude to deductibles (66.2 per cent). The individually sustainable rate of deductibles varied between 5 per cent and 50 per cent of the insurance sum (mean: 24.9, standard deviation: 9.6). 77.1 per cent perceive 20 to 30 per cent of the insurance sum as a sustainable deductible rate (question 2.6.1). All interviewed representatives of insurance companies perceived deductibles as a reasonable element of insurance contracts and assessed the sustainable rate of deductibles for farmers at about 30 per cent.

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[40] The correlations between metric variables were estimated based on t-tests. Kendall's Tau-tests were used to estimate correlations between ordinal variables.

[41] A vast literature on the principal-agent problem is treating long-term contracts as moral hazard reducing (e-g- LAMBERT, 1983). S. a. chapter 2.3.1.1.

The enterprise specialisation, as well as the importance of cash crops to enterprise performance, is reflected in the answers to the question which crops should be insured: Wheat (55 per cent), barley (18.8 per cent) and cotton (17.5 per cent) make up a large proportion of all crops that could potentially be insured. Regarding the number of perils that have to be insured, 15.4 per cent of the respondents would prefer all-risk insurance, 70.8 per cent would like to be insured against a group of most important risks, and for 13.8 per cent an insurance against just one predominant peril would be appropriate.

What kind of risks have to be insured is assumed to be dependent on the considered crop, i.e. the extent individual crops are exposed to natural hazards and price risks. Results in Table 4-3 show for all considered crops a clear tendency to vote for income insurance (47.9 per cent) and crop-yield insurance (43.8 per cent) rather than an insurance of price risk. A possible explanation approach could be the interaction of risk of natural hazard and price risk. Both types of risk are reflected in income risk. Farmers assess price risk to be adequately covered by income insurance.

Table 4-3: Crop-specific insurance types*

Insurance against / Crop	Price risk (induced by price fluctuations)	Risk of natural hazards (crop failure)	Income risk
Wheat (N=42)	.071	.381	.547
Barley (N=17)	–	.529	.471
Cotton (N=16)	.063	.375	.563

Note: * The numbers reflect the share of respondents preferring given type of crop insurance.

Table 4-4 depicts average wheat yields and price indices (average price from after harvest to harvest of the following year) for all investigated regions in Kazakhstan. The data shows no uniform tendency across all regions. Especially prices in Aktobe are in the period 2001-2003 higher than in 2000. In most of the other regions wheat prices in 2001 and 2002 are lower than in 2000. Only in 2003 prices in all regions are relatively higher than in 2000. The tentative calculation of correlation coefficients showed that farmers could not rely on the 'natural hedge' effect, i.e. there is no negative correlation between yields and prices. Distorted grain markets might be the most important obstacle to natural hedging. However, a lack of consistent price time series without structural breaks eliminates the estimation of efficient correlation coefficients. Therefore, alternative methods to evaluate price risk have been applied and will be discussed below.

Table 4-4: Wheat yields and relative prices 2000-2003

		2000	2001	2002	2003*
Kazakhstan total	Average yield (in 100 kg)	9	11.8	10.9	11.3
	Price index Sept.-August**	100	97.0	83.9	129.1
Akmola* **	Average yield (in 100 kg)	7.6	10.8	8.7	9.9
	Price index Sept.-August	100	90.6	79.0	133.9
Aktobe	Average yield (in 100 kg)	7.5	7.7	5.6	9.0
	Price index Sept.-August	100	116.8	106.5	158.1
Kostanai	Average yield (in 100 kg)	10.6	11.8	11.8	12.2
	Price index Sept.-August	100	103.4	92.5	126.3
South Kazakhstan	Average yield (in 100 kg)	12.7	15.2	22.7	22.3
	Price index Sept.-August	100	103.6	77.4	100.8
North Kazakhstan	Average yield (in 100 kg)	8.8	13.9	10.8	10.8
	Price index Sept.-August	100	92.4	82.7	131.3
East Kazakhstan	Average yield (in 100 kg)	13.9	15.3	16.7	12.1
	Price index Sept.-August	100	100.3	75.8	132.3

Notes: * For 2000-2002: Yield before processing, for 2003 only data for yields after processing was available. We therefore assumed a factor of 0.9 for the yield after processing. This assumption is supported by ISKAKOV and SUNDETOV (1978) and SUNDETOV (1982).
** The prices from 2001 to 2003 are expressed relative to the price in 2000.
*** Major wheat growing regions are in bold.

4.4.2.3 Price risk

For effective risk management, understanding the mean price level is not sufficient, since it is the extreme prices occurring with low probability that can bankrupt firms. If economists could accurately estimate commodity price behaviour and thereby produce reliable price forecasts, then price risk management techniques could better support income stabilisation instruments. Extensive efforts obtaining reliable forecasts of commodity prices have been proven difficult. This has led TOMEK and PETERSON (2001) to conclude that much of the price variability can be classified as risk.

Starting from that background, we conducted a little forecasting experiment. The experiment's objective is to test the confidence level of price prognoses.

In July 2005 grain price data for six regions and five consecutive years was collected from the statistical office in Astana. Wheat future price distributions were estimated on the basis of regional historic monthly prices for the period after harvest in November 2000 until April 2005. Prices recorded before that period are to a large extent distorted by state interventions and were not taken into account for the forecasts. Moving average and exponential forecasting models were tested and evaluated using the mean absolute deviations (MAD) as a criterion (EPPEN et al.1998; GAYNOR and KIRKPATRICK, 1994).

Table 4-5 depicts estimation results for an exponential smoothing model which has the best predictive power. The October 2005 prices vary across regions between 12683 KZT in North Kazakhstan and 16612 KZT in Aktobe. The mean absolute deviations between forecasted and real values as well as the standard deviations might be in an acceptable range for many farmers in Kazakhstan, who in reality possess much less price information.

Table 4-5: Estimated and observed prices for the 2005 harvest

	Akmola	Aktobe	East KZ	Kostanai	North KZ	South KZ
Estimated price (KZT)	13313	16612	15042	13292	12683	16425
Mean absolute deviation	33.04	75.39	56.74	21.54	24.13	76.28
Standard deviation	751.8	627.95	730.11	549.96	573.68	821.18
Observed price (KZT)	12440	15797	12907	12964	12120	16082
Deviation (est. P/real P)	1.070	1.052	1.165	1.025	1.046	1.021

Source: Own estimations.

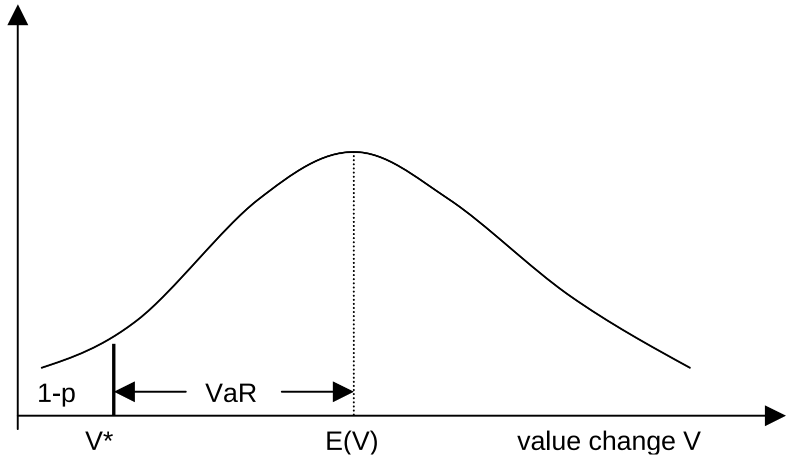
Note: Forecasting period 6 months.

In July 2006, new price data was collected in order to compare the estimated prices with the real ones and to determine the deviations. High deviations would support the Tomek and Peterson hypothesis for Kazakhstan's wheat market. The deviations lie between 2.1 and 16.5 per cent. In all cases, the model overestimates the observed October prices. This result underpins Tomek and Peterson's assessment that price forecast is an ambitious project.

Supplementary to the price forecast analysis, a Value at Risk (VaR) analysis is a useful instrument to assess price risk. JORION (2001) defines VaR as the worst loss over a target horizon with a given level of confidence. More formally, VaR describes the quantile of the projected distribution of gains and losses over a predefined time period. If *c* is the selected confidence level, VaR corresponds to the *1-c* lower tail level. For example, with a 95 per cent confidence level, VaR should be such that it exceeds 5 per cent of the total number of observations.

Figure 4-1 highlights VaR for an example distribution. All values to the left of the solid line contribute to the share of specified loss probability. The targeted VaR might vary from case to case depending on the decision-makers' objective function.

Figure 4-1: Graphical illustration of Value at Risk (VaR)



Source: Own figure based on ODENING and MUSSHOFF (2001).

ODENING and MUßHOFF (2001) describe and empirically apply different methods of VaR analysis, among which are the variance-covariance method, the Monte-Carlo simulation and the historical simulation. For our wheat price analysis, we use historical simulation. This method does not require any assumptions about the distribution – it is non-parametric. No random generation of values has to be carried out, since values are directly estimated from historical data. The analysis was carried out using statistical wheat price data for the three research regions Akmola, East Kazakhstan, and South Kazakhstan. The data comprises a price time series from November 2000 until April 2005. Three different holding periods were assumed (1 month, 6 and 12 months), i.e. a farmer has the opportunity to sell the wheat 1, 6, or 12 months after harvest. The production costs are assumed to be constant over time and no costs for storage are assumed. The analysis solely aims at discovering the pure price of marketing wheat.

The tables below show that VaR is significantly increasing with holding period and confidence level. This development is evident for all investigated markets. In the case of Akmola, the maximum VaR (holding period 12 months, p=0.98) amounts to 64.4 per cent of the average price for the analysed period. For East Kazakhstan, the ratio is 72.7 per cent and for South Kazakhstan 54.3 per cent. The differences between the regions can also be found when analysing coefficients of variation (CV) for the same period. The CV for Akmola amounts to 0.227, for East Kazakhstan 0.247, and for South Kazakhstan 0.168.

Table 4-6: VaR of wheat production revenue for different confidence intervalls and holding periods (in KZT/ton) – Region Akmola

δt (months)	VaR (p=0.98)	VaR (p=0.95)	VaR (p=0.90)
1	2082	587	390
6	6487	6460	4459
12	7424	7369	7289

Source: Own calculations.

Table 4-7: VaR of wheat production revenue for different confidence intervals and holding periods (in KZT/ton) – Region East Kazakhstan

δt (months)	VaR (p=0.98)	VaR (p=0.95)	VaR (p=0.90)
1	2355	1110	1045
6	7516	7490	5305
12	8712	8524	8402

Source: Own calculations

Table 4-8: VaR of wheat production revenue for different confidence intervals and holding periods (in KZT/ton) – South Kazakhstan

δt (months)	VaR (p=0.98)	VaR (p=0.95)	VaR (p=0.90)
1	810	810	686
6	5781	4488	2487
12	6683	4949	4444

Source: Own calculations.

When evaluating price risk on the farm level, portfolio price risk, market power of the enterprise and quality aspects have to be taken into account. According to own data collections, prices between enterprises vary significantly and differences between official statistical data and on-farm data are large. This is exemplified by price data from East Kazakhstan. We compared own survey data and official wheat prices for the years 2000 to 2003 and found that the price difference varied between 11.1 and 35.2 per cent over the research period. This can be attributed to weaknesses in the market information system.

Table 4-9: Comparison of on-farm and official wheat prices in East Kazakhstan, 2000-2003 (in KZT/ton)

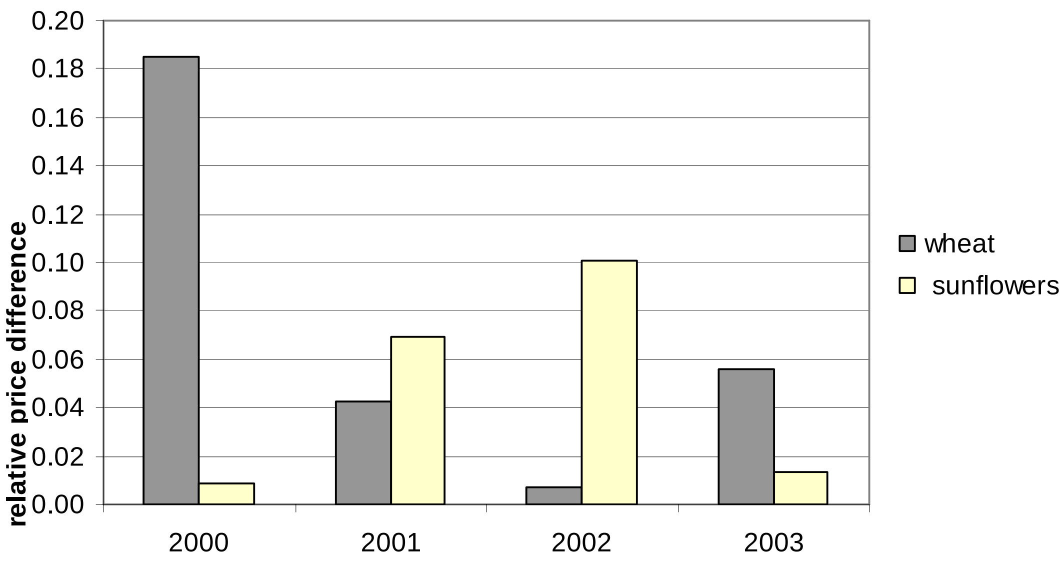
Year	On-farm prices*	Mean oblast prices	Price difference	Relative price difference
2000	10974	9874	1100	0.111
2001	10406	12622	-2216	-0.176
2002	7011	9472	-2461	-0.260
2003	15063	11141	3922	0.352

Source: Own calculations.

Note: *= Mean of collected prices.

The price differences between selected enterprises (11 in East Kazakhstan) and the mean of the entire sample are depicted in relative terms in Figure 4-2. The values can be understood as a measure of homogeneity or integration between farms in one region. The strong fluctuations over the years do not form a consistent picture or give any hint on the reasons for the price differences between farms. One can conclude the market for wheat and sunflower in East Kazakhstan is not sufficiently integrated. The law of one price does not hold.

Figure 4-2: Relative price differences between individual farm prices and mean for the whole farm sample



Source: Own estimations based on survey data.

Grain market power is highly concentrated, as illustrated in the following example: Prodovolstvennaya Kontraktnaya Korporatsiya (Food Contract Corporation (FCC), or Prodkorporatsiya), an agricultural trading Joint Stock Company and Kazakhstan's main grain procurer for the state reserves, bought 2.368 million tonnes of grain from the 2003 harvest for the state reserves in 2003. The country exported almost 5.816 million tonnes in 2003, a large share of which was exported by large grain trading companies. Kazakhstan harvested 14.8 million tonnes of grain in 2003 (INTERFAX, 2004 b). That means that more than half of the grain harvest is concentrated in the hands of a relative few with strong bargaining power. Crop production requires upfront financing such that expenses on variable inputs are due in period 0, whereas returns occur in a period that is different from 0 – the period lies between several months and several years (permanent cultures) after the settlement date of production costs. In Kazakhstan, the procurement of grain and other crops for the state reserves is done by a two-tier system that includes spring-summer advances for fieldwork (70 per cent) and direct fall purchases (30 per cent) (USDA, 2004), i.e. farms with low liquidity are highly dependent on grain buyers' payments.

Market structures might change over time. According to a statement of Daniel Akhmetov, former prime Minister of Kazakhstan, the country plans together with Russia and Ukraine a common grain market. The three countries have an annual export potential of 15-18 million tons of grain (Agra-Europe, 2005). Table 4-10 shows that export increased during the last years. New markets were found, but due to high transportation costs the future marketing potential for lower quality grain is limited. Therefore, the Ministry of Agriculture plans to reduce wheat area significantly in exchange to other cultures, like rapeseed, soybeans, barley, hard wheat, and rye (AGENCY AGROFAKT, 2005). This could on the one hand, have a positive effect on producer prices but on the other hand, increase political pressure on farmers to diversify crop portfolio. In the long-run, assuming a further progress of reforms, Kazakhstani farmers will have to find marketing niches and refine their plant products.

Table 4-10: Production and use of grain for the period 1990-2003 (in '000 tons)

	1990	1995	1999	2000	2001	2002	2003
Resources							
Stock, beginning of the year	7062	11260	3104	8731	7249	11856	14073
Total production (after processing)	28488	9506	14264	11565	15897	15960	14777
Import	355	13	15	17	24	55	37
Total resources	35905	20778	17383	20313	23170	27871	28887
Use (of which)							
As fodder	6063	1755	933	2679	3044	2986	3019
As seed	3684	2528	1486	1349	1393	1934	2340
Processing for sales	8619	6114	1968	2617	2668	3470	3767
Loss	1258	253	129	127	409	485	503
Export	2923	3818	3818	5684	3311	4357	5835
Private consumption	37	45	219	248	221	251	256
Stock, end of the year	13122	6166	8731	7249	11856	14073	11895

Source: AGENCY OF STATISTICS, 2005a.

BROSIG and YAHSHILIKOV (2005) investigate the interregional integration of wheat markets for three main market spots in Kazakhstan. One of them is being located in Petropavlosk (North Kazakhstan) at the border to Russia, another located in Karaganda in the centre of the country and the third, Kokshetau, located between these two. The authors of the study find a heterogeneous picture of integration: Price fluctuations are closely related between the two northern locations (Petropavlosk and Kokshetau). They conclude there to be a multitude of market participants on both supply and demand side and the finding of cointegration is likely to reflect a competitive integrated market. Cointegration was also found between price time series of Kokshetau and Karaganda, though arbitrage trade seems to be confronted with particularly high transaction costs. For the third pair of locations no cointegration was found.

However, the data used does not provide a full overview of different markets in the selected locations, because only one data source was used. Differences between traders, which might be huge according to own investigations by the author of this thesis, are not reflected.

We can conclude that price risk is an important source of risk for Kazakhstan's farmers, but its role is both, diminishing with increasing market integration and strongly influenced by politics. Therefore, and for the better seperabilty of price and production risk effects, the analysis of risk management products focuses on production risk solely.

4.4.2.4 Regional weather conditions and natural hazards

As described in chapter 3.3, agriculture in Kazakhstan is strongly affected by the sharp continental climate with very hot summers and extreme winter frosts as well as large fluctuations in seasonal temperatures, in summer even in daily temperatures. Spring frosts are an obstacle to early sowing and early frosts in autumn restrict yields. A strong deficit in soil humidity in spring connected with atmospheric drought and dry storms (sukhovei) have a negative influence on crop production (SPAAR and SCHUHMANN, 2000).

The survey respondents considered drought as the most important risk for their businesses, followed by hail, varmints invasion, and spring frosts. The geographical extension of the hazards is varying (s. appendix: Table in question 3.2). While drought affects always widespread areas, hail is a fairly local event. Pest invasion and spring frost are varying with respect to extension.

Like the extension, also the frequency is varying across perils. Pests are the hazards, that farmers who named them as one of the most important group of hazards experience most frequently, i.e. in six of ten years. Drought and spring frost affect crop production every third year, hail appears every fourth year in average.

The aforementioned natural hazards can locally induce crop losses up to 100 per cent of the expected yield, in average the losses vary between 39 per cent as an effect of hail and 58 per cent caused by drought.

Only 54 per cent of the respondents apply on-farm risk management measures currently. Mostly agro-technical methods, like accumulating snow on crop areas from surrounding areas are applied against drought. In order to fight the negative effects of pests, insecticides are applied. For example fruit producers, who experience spring frost use fumes and water films to protect their plants. In the cases of all four perils only a minority of the respondents see additional risk management instruments on farm.

For a large majority of the respondents on-farm risk management measures are preferred to crop insurance. Nevertheless, there is a demand for the residual risk that cannot be efficiently managed on farm.

4.4.2.5 Farmers' risk attitudes

In part four of the questionnaire producers were asked to use a Likert-scale from 1 to 5 to rank the importance of various sources of income variability which create risk. Respondents were also asked to assess the importance of various management responses to variability, as well as their concern about risk consequences. Furthermore, producers had to assess themselves in their role as decision-maker in risky situations (questions 4.1 and 4.5).

For policy purposes, we often need more than just a qualitative analysis. We would like to know, how important is risk in agriculture and in particular how large is the response to a change in risk and in which direction will it take place. To answer the second question, in particular, to know how farmers would respond to the kinds of changes in risk induced by income stabilisation programmes, we need to be able to infer that the individual's behaviour towards this new risk situation will be similar to his behaviour towards earlier risky situations which he has faced (NEWBERRY and STIGLITZ, 1981). For that purpose, five statements were included in the questionnaire in order to gain insight into producers' risk attitudes (question 4.1). Questions 4.1.3 to 4.1.5 were used to construct a risk aversion[42] index (*RATT*) [43], since they reflected farmers' attitudes to production risk best. Values of the *RATT* index give an impression about how individual farmers assess their risk aversion relative to other farmers. Low *RATT* scores a high risk aversion. The mean coefficient for the total sample is 2.52, expressing that respondents are rather agreeing with risk-aversion statements. Table 4-11 depicts the results of the risk aversion analysis differentiated by region. Risk aversion is slightly lower in East and South Kazakhstan, where the diversification of enterprises is more advanced, but t-test statistics show no significant differences between respondents of different regions.

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[42] Definition of risk aversion: 'Individuals who accept a lower average return to reduce the variability of returns are said to be risk-averse' (HARWOOD et al., 1999).

[43] *RATT*=risk attitude. The coefficient was produced by calculating the arithmetical means of ordinal numbers which were provided as answers to each question. In a second step the overall mean was calculated.

Table 4-11: Risk aversion indices by regions

Region	Mean	St. Dev.	Min	Max
Northern Kaz (Akmola, Kostanai, North Kaz)	2.44	1.33	1	5
Aktobe	2.53	1.04	1	3.67
East Kaz	2.70	1.09	1	4
South Kaz	2.57	1.57	1	5
Kazakhstan total	2.57	1.35	1	5

Source: Farm survey results.

The constructed index is not related to the coefficient of relative risk aversion[44] introduced by ARROW (1965) and PRATT (1964), which might be validated to some extent by constructing a representative risky prospect, computing its certainty equivalent and then asking the decision-maker whether the implied indifference between the risky and the sure prospect seems reasonable (ANDERSON and HARDAKER, 2002). During the first interviews Arrow-Pratt risk-aversion tests were conducted. However, the test needs intense explanation and is thereby time consuming. Only few respondents were motivated to participate in the test. The research team decided to cancel the tests in favour of the simplified, but empirically more practical measure (as described above) that shows relevant tendencies of risk aversion.

In addition to the questions that aim to measure risk attitude by an index, the respondents were asked to assess their willingness to take risks relative to other farmers (question 4.6). Results show that farmers assess their behaviour as more risk-loving relative to others (mean: 3.44) – across different management areas only slight variations can be observed (see appendix). However, besides the level of risk aversion and the supplied form of insurance, other factors that influence the extent to which schemes will appeal to farmers are the availability of other risk management strategies, the variability of yields and prices, the price/yield correlations, the ad hoc support provided by governments in case of disasters, and farmers' perception of risks (MEUWISSEN et al., 1999).

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44 $R_r = \frac{U''}{U'} W$, where *U''* and *U'* indicate, respectively, the second and first derivative of the von Neumann-Morgenstern utility function and *W* indicated the level of wealth.

4.4.2.6 Perception of risk sources, consequences, and management responses

Different sources of risk were analysed according to their importance in decision-making. The most important source of risk among respondents are crop price fluctuations as it is reflected in its high ranking in question 4.3 (see Table 4-12). 94.1 per cent considered price fluctuations as an important to very important source of risk (mean: 4.58 on a five point Likert-scale). Two other particularly important sources of risk and uncertainty are changes in costs of variable inputs (4.58) and in cost of capital items (4.01). The output as well as the input price volatility might be related to transition forces, particularly the undergone change in the institutional framework. Terms of trade have been altered due to high contracting costs in the agricultural sector following the deterioration of input and output channels. The fact that crop price variability is the most important risk source for decision-making, but respondents would prefer income or yield insurance might be explained by the assessment of risk management instruments. The respondents might consider price insurance not as the most efficient risk management instrument to mitigate the negative effects of crop price variability.

Table 4-12: Evaluation of risk sources according to their importance in decision-making*

Risk sources	Mean	Stand. deviation
Crop price variability	4.58	0.85
Changes in cost of inputs	4.49	0.85
Changes in costs of capital items	4.01	1.22
Changes in credit availability	3.79	1.42
Changes in government commodity programmes	3.76	1.25
Changes in technology	3.64	1.33
Changes in land rents	3.56	1.56
Crop yield variability	3.54	1.35
Changes in interest rates	3.41	1.49

Note: * 5 point Likert-scale: 1 – Not important, 5 – Very important.

Crop yield variability is an important source of risk in Kazakhstani crop production. Although, its importance regarding decision-making of the interviewed farmers is low compared to other considered risk sources. This might, on the one hand, be attributed to the limited opportunities to further minimize yield variability. On the other hand, yields in the production years before the survey were not affected by severe droughts, with the consequence that farmers perception of yield variability as an important risk source for their decision-making diminishes. Business risk has different economic consequences for agents. Farmers are assumed to evaluate risk consequences based on the actual performance of their enterprise as well as their personal experiences with respect to risk of their businesses. The respondents were most concerned about low income (mean: 3.91; standard deviation: 1.16), followed by insolvency (3.21; 1.26) and equity losses (3.14; 1.76). The reduced possibilities of receiving a credit and the loss of equities were even of lesser importance for the study population. In this context, it is interesting to look at the results of question 2.15: The respondents defined a crop loss of 26.5 per cent, on average, as catastrophic for their enterprise. This relatively low value can be explained by the strong specialisation of farms and the relatively low yields. 26.5 per cent of an average wheat yield of 1.2 tons is slightly more than 0.3 tons per hectare, a value that is almost negligible for Western European farmers.

Question 4.4 evaluates the importance of risk management responses. The responses can be structured in three categories: Diversification of farming enterprises, geographic dispersion of production, being a low cost producer and having back-up management/labour can be summarised as production responses (mean: 2.96 on a five point Likert-scale). Government farm programme participation and forward contracting can be categorized as marketing responses to risk and were evaluated as slightly more important (3.04). The group of risk responses that received the highest scores, on average, were financial responses, i.e. crop insurance, life insurance, off-farm investments and employment, maintaining financial reserves and leverage management (3.40). Considering the full list of responses, the three most important ones were maintaining financial/credit reserves, being a low-cost producer and off-farm employment. Interpreting especially the results on risk management, one has to keep in mind that farm restructuring in the 1990s may have led to an extensive loss of knowledge due to changes in management structures and migration of specialists into other sectors of the economy or abroad. However, on-farm risk management is a matter of experience.

4.4.2.7 Risk management instruments and technology adoption

In question 4.2 of the questionnaire (see appendix B), farmers were asked to indicate the largest percentage of their current expected yield they would be willing to give up for an absolutely stable yield every year, assuming a hypothetical new method of growing. The question aimed at providing an idea of the premium price producers would be willing to pay for a crop insurance product that stabilises revenue. Results were analysed for wheat and cotton farmers and show a lower value for the former. Taking into consideration the relatively lower wheat yields and prices, the average willingness to pay per hectare is less for wheat ($10.49) than for cotton ($79.42) (see Table 4-13). However, the exact amount of money farmers are willing to pay for specific forms of income insurance can only be tested by pilot programmes (MEUWISSEN et al. 1999).

Table 4-13: Average wheat and cotton producers' willingness to pay for yield stability

Crop	Largest percentage of current expected yield (mean)	Average yield, 100kg/ha (1998-2003) (national level)	Average price, $/100kg (1998-2003) (national level)	Average gross revenue, $/ha (national level)	Average willingness to pay for yield stability, $/ha
Wheat	15.00[1]	10.02[2]	6.98[3]	69.96	10.49
Cotton	18.14[1]	20.17[2]	21.70[1]	437.84	79.42

Sources: [1] Own survey data.
[2] FAO data.
[3] Data from TACIS Marketing Project.

4.4.2.8 Factors influencing the demand for crop insurance[45]

When designing and pricing insurance products an estimation of potential demand might be useful. There has been considerable work been done on crop insurance demand and participation decisions. Three major studies have estimated models of crop insurance purchase decisions using county level data (SMITH and BAQUET, 1996; SMITH and GOODWIN, 1996; and COBLE et al., 1996). VAN ASSELDONK et al. (2002) as well as MISHRA and GOODWIN (2006) investigate factors influencing the demand for crop insurance products using farm-level and household data. This approach seems promising from a methodological viewpoint. Conclusively, this study also uses farm-level data and employs a binominal logit model to identify the main factors that determine demand for crop insurance. Binominal logit models belong to the group of discrete choice models. They are able to assess the importance of each independent variable with respect to the single outcomes of the dependent variable. The binominal logit model promises the greatest success regarding the data attributes. It was tested for multicollinearity. Backward selection has been applied. All variables that showed multicollinearity were removed from the model.

The results in Table 4-14 include the description of all variables, the values of the logit coefficient estimates, the t-statistics plus some general statistics to verify the overall model. The findings are largely consistent with anticipated relationships and indicate that potential buyers of crop insurance are characterized by a specialisation in grain production and a high degree of concern about income losses as a consequence of risk. Grain production specialisation increases income variability and thereby the need for income stabilizing instruments. Diversified

[45] Based on HEIDELBACH, 2005b.

farms, e.g. in South Kazakhstan, have a lower demand for crop insurance. Potential buyers of crop insurance services can be found in the group of respondents that is concerned about income loss as a consequence of risk.

Adoption of insurance (and technology) is to some extent grounded in human capital theory. The research of WELCH (1970), KHALDI (1975), NELSON (1985) and WOZNIAK (1989) uses education as a measure of human capital to reflect the ability to adopt innovation (either technology or insurance). The education level proved significant for the purchasing decision in Smith and Baquet's study. This confirms earlier studies by JUST and CALVIN (1990) and EDELMAN et al. (1990) who found that participation in Multiple Peril Crop Insurance is positively correlated with education level. These results cannot be confirmed by the result found in our study. Here, personal characteristics of the study population such as age and education do not play a significant role for the participation decision. This might on the one hand be explained by the insufficient experience with crop insurance. On the other hand, educated farmers may see a range of other instruments to increase and stabilise income in their newly founded enterprises.

Furthermore, neither concerns about insolvency as an outcome of risky business, nor farm size and past experiences with crop insurance are of any significance for the decision to participate. The relationship between the use of risk management instruments and risk aversion, respectively, on the demand for crop insurance are discussed in further detail in the following.

SHERRICK et al. (2004) hypothesise that insurance users are expected to be more experienced and better educated, indicating a greater responsiveness of insurance use to modern, more sophisticated approaches to risk management. This assumption was not verified by model results. The use of on-farm risk management instruments by operators (*RM*) was considered to be a relevant factor for the decision for or against the purchase of crop insurance. Farmers who apply risk management instruments are assumed to have weaker reasons to purchase crop insurance as additional risk management. This relationship is confirmed by the negative tendency of the coefficient, although it is not significant. An interpretation in favour of non-significance is contrary to the discussed thought: Farmers who apply risk-management measures know about their efficiency and effectiveness in reducing risks and assess them as non-sufficient. They would like to purchase crop insurance in order to back up the remaining residual risk. Another possible interpretation could be that farmers who are already applying on-farm risk management instruments in the absence of insurance could be more efficient farmers, who also see the possible risk efficiency and long-term character of a functioning insurance scheme.

The literature on risk research contains no uniform assessment about the importance of production risk in analysing farmer's economic behaviour. For instance, HUETH and HENNESSY (2002) argue that presence of risk does not explain the tendency to contract, although it is an important consideration in designing optimal contracts once decisions to contract are made. FRASER (1992) assumes that producers who were more risk averse with respect to their losses would be more likely to participate in insurance programmes. The used risk aversion variable (*RATT*) was of significance and shows the expected tendency.

Table 4-14: Summary of logit model results

Variable	Description	Logit Model	
		Estimate	**T-Ratio**
CONSTANT		-3.47*	-2.19
AGE	Age of the respondent (0 = younger than 50, 1 = 50 or older)	0.47	0.69
EDUgen	General educational background (0 = no studies and primary education, 1 = higher education)	0.24	0.30
EDUag	Level of agricultural education (0 = no agricultural education, 1 = agricultural education)	0.54	0.74
EXP	Experience with crop insurance (CI) (0,1)	0.50	0.69
RM	Use of on-farm risk management (0,1)	-0.55	-0.66
SPEC	Specialisation: 0 = no grain, 1 = grain	1.85*	2.36
AREA	Agricultural area (in ha)	-0.00001	-0.60
RATT	Risk attitude (with respect to income losses)	0.65*	2.09
		Log-likelihood:	-33.00
		Pseudo R-squared	0.222
		Chi-squared:	18.82
		Significance level:	0.016

Source: Own table.

Note: * Statistical Significance at the 5% level.

4.4.3 Evaluation of the farm survey

When doing research, the evaluation of the process of doing it is an important factor to assess the value of the research. What lessons can be learned from organising data surveys? What additional insight can be gained by looking at the research process from the meta-level?

A key conclusion derived from the data survey is that field research is always a complex process involving many contextual factors, discontinuities, negotiations, and compromises. Particularly, comprehending cultural and historical peculiarities of the research area, learning how local institutions function and data is aggregated, and being able to quickly adapt to unforeseen circumstances that affect planning and negotiation strategies are key qualifications for conducting successful data surveys, especially in transition and developing countries.

To provide an assessment of the experiences with the survey instrument, it must be stated that the field work demonstrated the suitability of the questionnaire. An important precondition for this was the conducted pre-test, which helped to modify questions according to experience. The various parts with different types of questions worked well, including the relatively complex table in part three (see appendix B). Data verification procedures showed that most of the collected answers were plausible and useful. In most questions, the quality of data exceeded the expectations of the research team – non-responses remained within acceptable ranges (see appendix).

The exception was the accounting information, which was not always provided at a satisfactory level as described above. Many farms in Kazakhstan were restructured several times in recent years, and even if they do have an accountant today, they might not have any data for previous years. Even with the support of the local administration, farms with a satisfactory accounting organisation were not always selected.

The evaluation of the farm survey allows a number of tentative conclusions. First, more than half of the respondents had some or even much interest in responding. Second, the majority of respondents was qualified to answer the questions posed. The overall evaluation by the interviewers was positive.

4.5 Empirical analysis of different risk management instruments

The results generated by descriptive statistics provided an overview about crop production in Kazakhstan with regard to natural production conditions and the attitude of farmers towards risk and insurance. Further analyses will focus on the development of appropriate risk management instruments for farms specialised in crop production in the investigated regions. Particularly, this chapter investigates the risk efficiency of selected risk management instruments, such as technology, insurance and credit. First, the study farms selected for analysis will be described. Second, the risk programming model will be specified, before model results will be presented. In a further step, the results of an alternative methodology, namely the second-degree stochastic dominance analysis will be included in the discussion.

A last section quantifies possible moral hazard effects, when crop insurance is introduced

4.5.1 Characterisation of study farms and their risk management

Three study farms were selected for a more detailed analysis of production programmes and risk management instruments. This section characterises study farms and their environment in detail. Table 4-15 gives a short overview of farm characteristics, such as legal form, size, income sources, and crop yield characteristics.

Table 4-15: Characterisation of study farms

Oblast	Akmola	East Kazakhstan	South Kazakhstan
Legal form	Ltd.	Ltd.	Individual farm
Year of foundation	1998	1996	2001
Size (crop area in ha)	34,272	3,100	2,446
Irrigated area	–	–	2,066
Number of employees (mean 2000-2003)	100	63	185
Own capital (mean 2000-2003) in thous. KZT	349,397	28,795	4,000
Income from			
Crop production	85	100	100
Livestock production	12		
Processing	3		
Specialisation	Wheat, Barley	Wheat, Sunflowers	Cotton, Wheat
Average yield power	35	62	20
Average wheat yield (1999-2003)	13.9	19.6	20.63
Coefficient of variation (1999-2003)	0.117	0.203	0.152
Future investment intentions	Processing, air operations	–	Cotton and grain processing

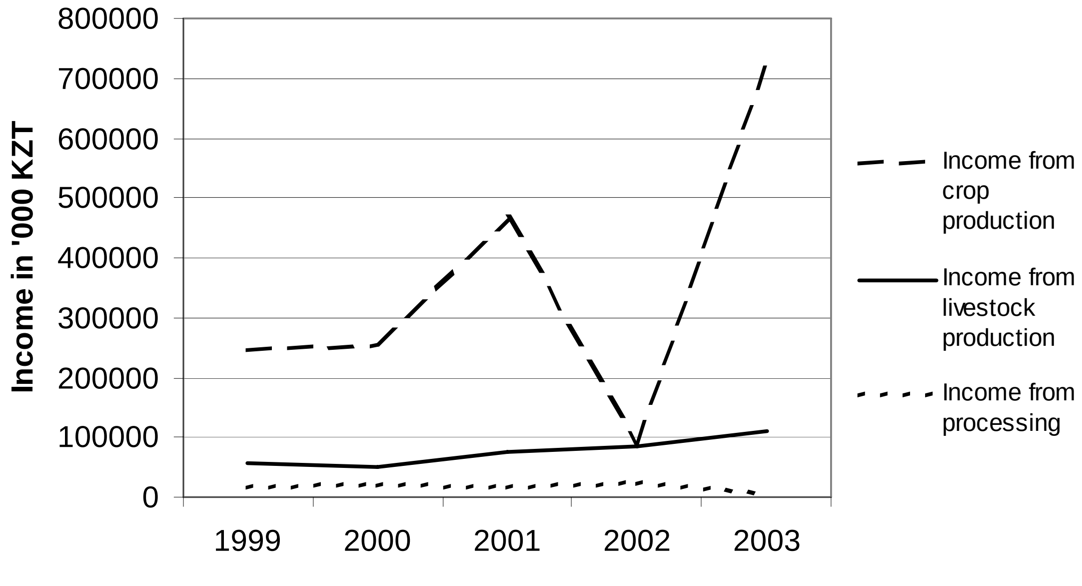
Source: Survey data.

Study farm Akmolinskaya oblast:

As one of the study farm serves a large crop farm (34,000 hectares of sown area) in the grain belt of Northern Kazakhstan. In the years 1999-2003 about 74 per cent of the farm income is generated by crop production, 21 per cent by livestock production and 5 per cent by processing. A relatively high yield level, a strong weight of crop production in overall economic performance, and the 'organisational history' of the enterprise, make the model farm an interesting research object. After a recent restructuring of the enterprise, the new organisational form is a limited liability company. 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 takes most of the important decisions.

Figure 4-3 shows the contributions of the different economic activities to the overall income of the enterprise. Income from crop production is strongly fluctuating over the years, whereas the income generated by livestock production and processing is constantly increasing. The fluctuation in crop production income can be partly attributed to the generous storing capacities of the study farm, which allow sales in high-price periods. The development towards augmenting livestock activities resembles the overall trend of growing importance of livestock production and processing in Kazakhstan.

Figure 4-3: Development of income sources over time for the case farm in Akmola



Source: Survey data.

For this enterprise, not only crop, but also livestock production activities were included in the programming model discussed at a later stage. The following excursion explains the reasons for the integration of livestock activities in the programming model and briefly describes how the assumptions about total farm income affecting features and future prospects of livestock activities were derived.

Excursion: The role of livestock production in Kazakhstan's agriculture in general and its contribution to income stabilisation of the selected farm enterprise in Akmolinskaya oblast in particular

The steppe characteristics of most of the region are best suited for nomadic pastoralism, which has been pursued by an ever-shifting pattern of peoples in the history of the territory of today's Kazakhstan. Collectivisation in the 1930s met with massive resistance and major losses and confiscation of livestock. Livestock numbers in Kazakhstan fell drastically during collectivisation: From 7 million cattle to 1.6 million and from 22 million sheep to 1.7 million. Figure A-4 shows the share of crop production in total agricultural production from the times of the Virgin Lands Campaign until 2004. With the successive development of the collectivised livestock sector in the sixties, the share of crop production in total agricultural production fell to values below 40 per cent. With the breakdown of the Soviet Union, the livestock sector has been suffering from a strong crisis until recent years.

After a sharp decline during the 90ies, livestock production regains importance in Kazakhstan and might support income stabilization. The World Bank stresses the importance of reviving the livestock sector in Kazakhstan and recommends making use of comparative advantages through capitalization of the vast, but under-exploited rangeland resources mainly for extensive cattle and sheep-raising in the South and in the North (WORLD BANK, 2004).

After a decrease in the early transition phase, consumption of animal products is expected to rise further with increasing average incomes in Kazakhstan. Table 4-16 shows this trend for total meat consumption: While population increased by 1.4 per cent in the period 2000-2004, the private meat consumption did by 23.6 per cent.

Table 4-16: Development of population and meat consumption over time

Year	Population in thousands	Meat consumption (in thousand tonnes)	Meat consumption per capita (kg/year)
2000	14866	660	44
2001	14851	681	46
2002	14867	707	48
2003	14951	749	50
2004	15075	816	54

Source: AGENCY OF STATISTICS, 2005.

Livestock production might represent a future income-stabilizing activity for the study farm in Akmolinskaya oblast and was therefore included in the portfolio. Therefore some assumptions about the relationship between livestock and crop production have to be made. A particular point of interest is the hedging opportunity between crop and livestock production. For this reason, the focus of the following paragraphs lies on the interdependencies in price and output developments of both types of products.

Table 4-17 depicts the average production costs for 100 kg of grain, pork and beef for various years. The great difference between 1995 and 1998 can mainly be attributed to inflation. However, the relatively low grain yields in the drought year 1998 contribute to high grain production costs per production unit. Analysis of grain production costs, which is used as an input to livestock production and beef and pork production costs demonstrates a positive correlation of both parameters.

Table 4-17: Average production costs 100 kg of marketable produce – Agricultural enterprises Akmola

	1995	1998	1999	2000	2001	2002	2003
Grain	398	790	445	605	616	722	806
Beef	3,485	9,246	9,057	9,110	11,125	11,925	9,841
Pork	8,267	20,863	18,704	17,927	14,924	13,671	13,423
Correlation grain/beef	0.651						
Correlation grain/pork	0.337						

Source: AGENCY OF STATISTICS, 2004a.

Table 4-18 and Table 4-19 give an impression on the total production and use of grain. After a low point in 1999 – probably conditional on the poor harvest the year before – the share of fodder in use of total production is relatively stable around 20 per cent.

Table 4-18: Grain used as fodder as a share of total production 1999-2004

Year	Share
1999	0.070
2000	0.245
2001	0.201
2002	0.198
2003	0.204
2004	0.257

Source: AGENCY OF STATISTICS, 2005a.

Table 4-19: Production and use of grain for the period 1990-2004

'000 tons	1990	1995	1999	2000	2001	2002	2003	2004
Resources								
Stock, beginning of the year	7062	11260	3104	8731	7249	11856	14073	11895
Total production after processing	28488	9506	14264	11565	15897	15960	14777	12374
Import	355	13	15	17	24	55	37	16
Total resources	35905	20778	17383	20313	23170	27871	28887	24285
Use								
of which								
as fodder	6063	1755	933	2679	3044	2986	3019	3178
as seed	3684	2528	1486	1349	1393	1934	2340	2450
Production for food	8656	6159	2187	2865	2689	3720	4032	3669
Loss	1258	253	129	127	409	485	503	792
Export	2923	3818	3818	5684	3311	4357	5835	2933
Stock, end of the year	13122	6166	8731	7249	11856	14073	11895	10841

Source: AGENCY OF STATISTICS, 2005a.

As we learned from the tables above, fodder has – after export and processing – a significant share in total use of grain products. Fodder demand might influence the price of grain to a certain degree, but it has to be differentiated between grain varieties mainly used as fodder resources, such as barley and oats and wheat, of which prices depend to a assumingly higher degree on world market prices which are fairly stable over time (see Table 4-19). The high values for grain export in 2000 and 2003 can partially be attributed to grain shortages in other CIS countries, which still represent the most important export destinations. Based on the assumption that production and prices are interdependent, an analysis of the extent of this interdependency might make sense. The following table demonstrates negative correlation between production and prices of oats and slightly positive correlation between production and price of wheat and barley. Thus, fodder crops provide a potential for natural hedge. The natural hedge effect seems to be even higher for livestock products, such as beef and horsemeat.

The investigation of the price relationship between crop and livestock products provides support to the hypothesis that prices of inputs (grain) influence the output prices (meat).

A shortage in the supply of main fodder inputs might lead to higher prices for livestock outputs as the negative correlation between barley/oats and beef/ horsemeat show.

Table 4-20: Testing for hedge effects between crop and animal products

Correlation between	
Production and price of barley	0.106
Production and price of oats	-0.171
Production and price of wheat	0.069
Production and price of beef	-0.865
Production and price of horsemeat	-0.726
Price of beef and price of barley	0.399
Price of beef and price of oats	0.582
Price of beef and price of wheat	0.303
Price of horsemeat and price of barley	0.303
Price of horsemeat and price of oats	0.467
Price of horsemeat and price of wheat	0.628
Price of beef and production of barley	-0.363
Price of beef and production of oats	-0.687
Price of beef and production of wheat	0.487
Price of horsemeat and production of barley	-0.440
Price of horsemeat and production of oats	-0.721
Price of horsemeat and production of wheat	0.431

Source: Own calculations based on FAOSTAT, data 1996-2002; prices were deflated.

On the basis of the above data analysis, we can state following results and hypotheses about the relationship between income from livestock and crop production. Fodder costs contribute to a large part to total production costs in livestock production. Thus, the supply of livestock products seems to be strongly determined by production costs. As we learned from the data above, an increase in input prices as well as a shortage in production of the input resources lead to an increase in output prices[46]. This relationship has to be integrated in the programming model. The following procedure is proposed: For different states of nature[47], different levels of livestock production costs will be formulated. In states with high grain (barley) yields, prices for grain (barley) as fodder as well as meat prices will be low. For the future strategy of the enterprise, production and processing of livestock products will play an increasingly important role.

End of the Excursion.

46 Demand was assumed to be stable over the years. However demand for more income elastic products, such as meat is expected to increase, since incomes in Kazakhstan are steadily increasing.

47 Ideally, a comprehensive set of states of nature is a mutually exclusive and exhaustive set of possible descriptions of the states of the world (CHAMBERS and QUIGGIN, 2000). For our purposes, the states of nature are defined by weather conditions. Within the framework of the programming model, probabilities are attributed to all states.

Study farm East Kazakhstan oblast:

The study farm in East Kazakhstan is situated in the rayon *Glubokoe*, about 70 km from the oblast centre *Ust-Kamenogorsk (Oeskemen)*. The Limited Liability Company was founded in 1996. It has 63 full-time employees and comprises 3100 ha, sown to a large extent with wheat and sunflowers. It has a high average yield power resulting in a yield comparable to the irrigated wheat yields in South Kazakhstan. The good soil conditions can be attributed to the location of the enterprise at the foothills of the Altai mountains. The farm has relatively good access to infrastructure important for marketing such as road access and short distances to the processing industry.

Study farm South Kazakhstan oblast:

The farm in *Turkestanski* rayon (South Kazakhstan) is the only private farm in the sample. It was founded in 2001, comprises a sown area of about 2,466 ha, 84 per cent of which is irrigated. The main crops grown are winter wheat and cotton. Soil quality is low, but irrigation is the decisive factor for relatively high, stable yields. Plots in South Kazakhstan are smaller, the degree of mechanisation lower and labour cheaper than in northern Kazakhstan. Therefore the number of employees is relatively high compared to much larger farms in the North.

4.5.2 Model specification and behavioural assumptions

Expected utility provides a convenient way to represent risk preferences: Its basic idea is that decision-makers maximise expected utility. When income increases, 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 certain monetary value 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 of expected utility theory in an objective function and constraints as follows[48]:

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

where
CE =certainty equivalent, r = absolute risk aversion coefficient, and

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

subject to

Ax ≤ b, Cx-Iz =uf, and x ≥ = 0,

where A is a matrix of technical coefficients for all 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, I is an n by n identity matrix, z is the annual net income in each state, u is a vector of ones, and f is fixed or overhead costs. The utility function U(z) is positive $(U'(z) \succ 0)$*, but decreasing* $(U''(z) \prec 0)$*. These functions are characterised by decreasing absolute* $r_a(z) = -U''(z)/U'(z) = r/z$ *and constant relative risk aversion* $r_r(z) = zr_a(z) = r$.

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 de-trended observations from the time period 1980-2002, treated as states with assessed probabilities.

4.5.2.1 Risk aversion

Different methods to estimate risk aversion were applied. Based on a direct utility elicitation method (ANDERSON et al., 1977), one of the three case decision-makers were classified as risk-neutral. According to alternative qualitative risk aversion tests, one decision maker was considered to be risk-loving and one as risk-averse. After testing several approaches to determine risk aversion coefficients empirically, we came to share the opinion of HUDSON et al. (2005) that consistent measurement of risk attitudes is difficult to achieve. For the described base model, all three case decision-makers (decision-maker) were classified as slightly risk averse. The implications of a change in risk aversion will be tested in different scenarios.

The relevant absolute risk aversion range for the model was derived from the plausible range of relative risk aversion, r_r, defined as the marginal utility of wealth. ARROW (1965) has shown that $r_a = r_r/w$ where w is wealth. LITTLE and MIRRLEESS (1974, cited in PATTEN et al., 1988) and HARDAKER et al. (2004)

[48] An extensive algebraic representation of the model can be found in the annex (A1).

suggest that r_r will be a number close to 2, therefore a range of 0.5 to 4 was used for the test on the risk aversion elasticity of the model. The wealth of the study farmers has been approximated by employing own capital of the farm enterprise in the last recorded year as a proxy variable. Table 4-21 illustrates the described assumptions for the case farm in East Kazakhstan. The last column shows the different CE levels for identical income and wealth levels under varied risk aversion coefficients.

Table 4-21: Assumed wealth, risk aversion levels and certainty equivalents – East Kazakhstan study farm

Risk aversion	Rr (Wealth)	Ra (Wealth)	Income ('000 KZT)	CE ('000 KZT)
Hardly risk averse at all	0.5	1.68953E-05	29,932	28,770
Somewhat risk averse (normal)	1	3.37906E-05	29,594	27,680
Rather risk averse	2	6.75813E-05	29,594	25,610
Very risk averse	3	0.000101372	29,594	23,710
Extremely risk averse	4	0.000135163	29,594	21,970

Source: Own estimations.

Notes: Rr= Relative risk aversion, Ra=Absolute risk aversion, CE=Certainty equvalent.

4.5.2.2 Scenarios

To test the effects of different risk management instruments on production programme, income and certainty equivalent, different scenarios were estimated. The scenarios are described in Table 4-22. In all scenarios marked with "1", all available technologies (I-intensive, II-medium intensive, III-extensive) are available. In the type "2"-scenarios, the most favourable technology, which was selected by the model in the type"1"-scenarios, was excluded to show the effects of inappropriate technology use. This type of analysis was amplified by type"3"-scenarios, including only the most unfavourable scenarios. In all described scenarios, all selected insurance products were introduced as activities. Scenario "R" serves as a reference scenario, in which only on-farm risk management is possible by the use of appropriate technology. Insurance is not available to the decision-maker. The scenarios were further modified by in-and excluding credit access and different insurance products. Additionally, sub-scenarios were estimated, including a variation of access to own capital and interest rates for borrowed capital.

Table 4-22: Description of model scenarios

Scenario	Description
R	Reference scenario: All technologies are available, no access to insurance and futures, no access to credit
RC	Reference scenario: All technologies are available, no access to insurance and futures, but access to credit
1	All technologies are available, no credit access
1C	All technologies are available, credit access
2	The two less favourable technologies are available, no credit access
2C	The two less favourable technologies are available, credit access
3	Only the least favourable technology is available, no credit access
3C	Only the least favourable technology is available, credit access

Source: Own formation.

4.5.2.3 Integrating expert knowledge

According to VOSE (1996), risk analysis models without exception involve some element of subjective estimation. For a number of reasons it might be impossible to determine the distribution of all relevant variables:

– The data has never been collected in the past.

– Past data is no longer relevant (new technology, changes in political or commercial environment).

– The data is expensive to obtain.

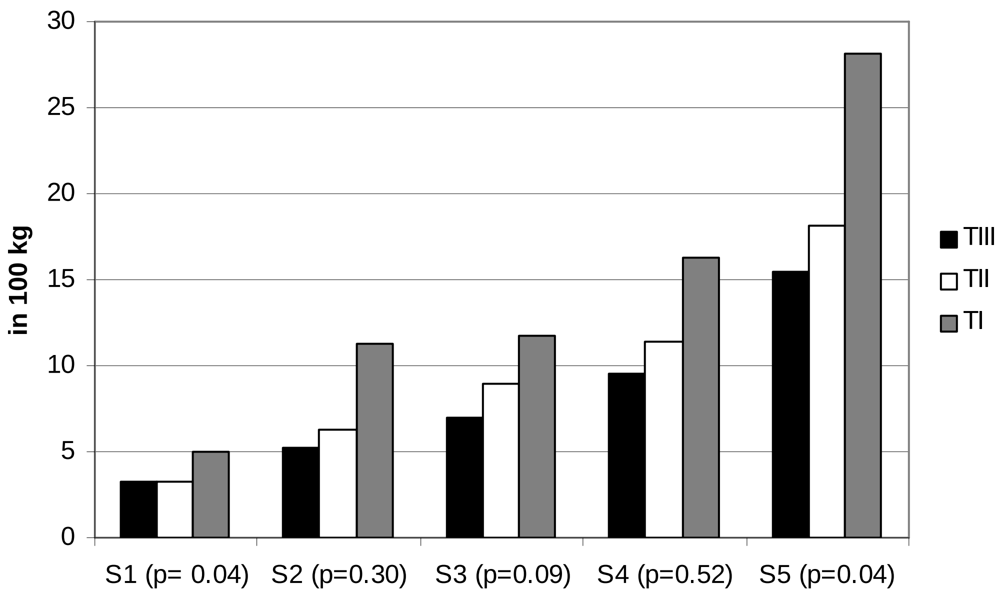
In our case the first and second reason required consultations with experts. Although there exists a number of short time series on crop yields from experimental stations, the publications available are from the 60s, 70s, and 80s. Since then, technological, climate and soil conditions have changed significantly and the actual political and economic environment is not comparable with the pre-transition period.

The value of the potentially achievable gross margins is subject to uncertainty. This uncertainty is accounted for by deriving information about distribution functions from past realisations of the random variable. Basically, extensive enterprise-specific data sets were used. As a result of political changes and the major restructuring of agricultural enterprises, the available historical data might lead to unrealistic assumptions about distributions. In such cases, taking expert advice might be justified in order to derive reliable distributions (HARDAKER et al., 2004). In our case, we used a blend of sources, including expert judgement, farm survey results, and literature resources to derive information on costs, revenues and probabilities. Concretely, parameters like size, specialisation and own capital endowment were derived from farm survey results (Table 4-15), whereas the data on input and output of different technology solutions stem from the analysis of regional yield and weather data for the period 1980-2004, and expert judgements based on interviews with farmers, researchers and regional agricultural administration staff members. The main justification of deviation from a reliance on historical data alone is the significant change in agro-climatic and economic production conditions. Soil conditions steadily worsened due to massive erosion and a lack of fertilising over the last decades. Economic transition caused a structural break in agricultural structures in general and farm management in particular. The addition of expert advice provides the opportunity to integrate potential technologies that are not widely used, but adapted to regional conditions and thereby offer the potential to improve economic enterprise performance.

The use of experts supports the research process by opening up a source of information that is usually not available for non-experts. The cognitive abilities of experts including failure to assess probabilities for a long period of time correctly required to reduce the states of nature for which the experts had to assess yield levels. As HIRSHLEIFER and RILEY (1995) note, monitoring of states is often imperfect.

In the case of Akmolinskaya Oblast, the expert formulated five states for each of the three defined technologies (IVANNIKOV, 2005). Figure 4-4 depicts the wheat yields for the five defined states.

Figure 4-4: Mean wheat yields in five expert-defined states of nature for the case farm in Akmolinskaya Oblast for three considered technologies

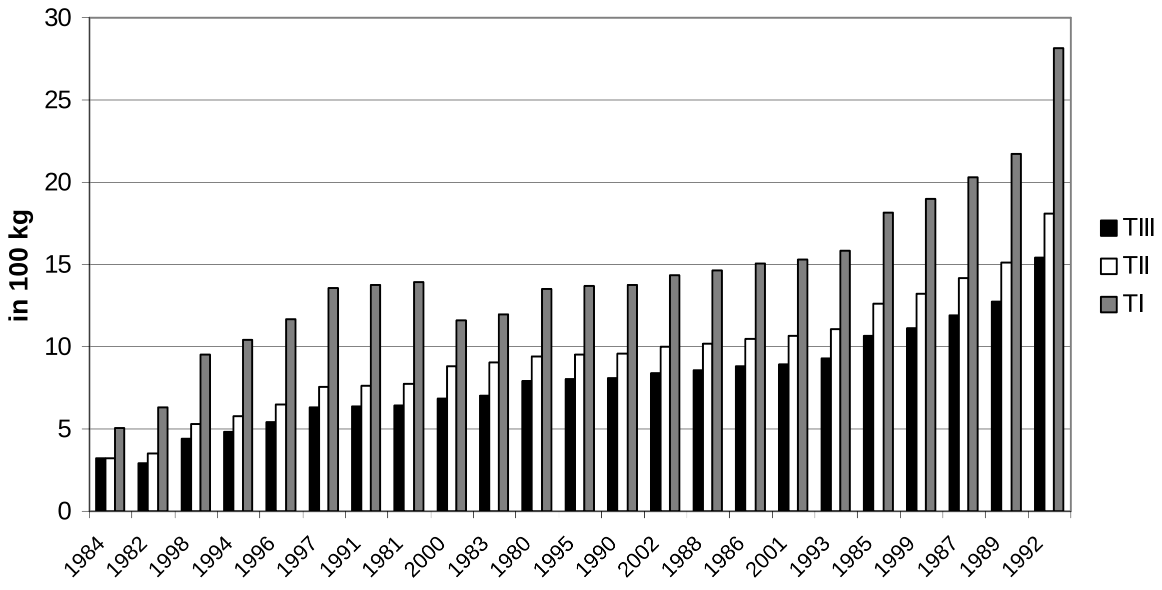


Source: Own figure.

Note: TI=Extensive technology, TII=Medium technology, TIII=Intensive technology.

This methodology implies data aggregation and thereby a loss of information. However, it is necessary to maximise the explanatory power and validity of the programming model. For that reason the number of states was extended to 23, which equals the number of years used for the design of the insurance products. This was achieved by assigning every year to a corresponding pre-formulated state and was first done for the historically applied technology and then simulated based on the expert formulation for the two hypothetical ones. The chosen approach discovers the full information provided by the empirical data as following example shows: Whereas the yield in state 2 (S2) in Figure 4-4 is lower for all technologies than in state 3, the full picture in Figure 4-5 shows that in some of the years (1996, 1997, 1991, 1981) which were aggregated to S2, technology 1 provides better results than in 2000 and 1983 that were aggregated to S3. Aggregation might lead to spurious results.

Figure 4-5: Wheat yields for the case farm in Akmolinskaya Oblast for three considered technologies



Source: Own figure.

Note: TI=Extensive technology, TII=Medium technology, TIII=Intensive technology; the states in Figure 4-4 comprise following years: S1 (1984), S2 (1982, 1998, 1994, 1996, 1997, 1991, 2000), S3 (1993, 1980), S4 (1995, 1990, 2002, 1988, 1996, 2001, 1993, 1995, 1999, 1997, 1989), and S5 (1992).

Figures A-1 through A-3 depict yield distributions of wheat and cotton in different states of nature under selected technologies for the case farm in South Kazakhstan. The distribution is ordered according to wheat states in the currently applied extensive technology (TIII). The distributions show the stabilising function of this crop mix: The two highest cotton yields over all technologies occur in wheat states with low yields (drought). This stabilisation function can be also perceived in the coefficients of variation (CV) in Table 4-23: Whereas the CVs of cotton yields fluctuate between 0.252 and 0.3 and for wheat between 0.204 and 0.278, depending on the technology used, a crop mix of both in the relation 0.26 (cotton) to 0.56 (wheat)[49], will reduce the CV significantly. The lower CV of the whole-farm sales income compared to CVs of the individual crop yields can be explained by the portfolio effect that arises when different income sources are combined. Except in one case, the variation coefficients of the sales revenue are lower than the single yield CVs, i.e. hedging with both crops is possible, even when assuming constant prices.

In the latter case the CV is measured for the sales income, which is calculated by the yields of the single crops times a fixed price.

Table 4-23: Comparative statistics for different technologies – Study farm South Kazakhstan

	Technology	Mean	SD	CV
Cotton	I	9.71	2.45	0.252
	II	7.69	2.10	0.274
	III	4.97	1.49	0.300
Wheat	I	27.53	5.62	0.204
	II	20.21	4.70	0.233
	III	10.80	3.00	0.278
Sales revenue per ha (KZT)	I	55,959	11,569	0.207
	II	42,952	9,781	0.228
	III	25,883	6,673	0.258

Source: Own estimations.

Note: TI=Extensive technology, TII=Medium technology, TIII=Intensive technology.

4.5.2.4 Integrating risk management instruments

The model captures on-farm risk management measures by introducing different production technologies. The technologies display possible solutions to influence quantity and the variability of output. To speak with HIRSHLEIFER and RILEY (1995), the technology is the umbrella of the farmer. He can decide whether or not to carry one and what kind of umbrella he will use when going outside (producing) and being confronted with the state of weather (under the simplest assumption, there are only two states (rain, no rain). The assumptions about

[49] A share of 0.16 is integrated as fallow into the crop rotation. In this case the CV is measured for the sales income, which is calculated by the yields of the single crops times a fixed price.

yields and yield distributions are based on a combination of long-term experimental data for region-specific production conditions and expert probability judgements[50] (IVANNIKOV, 2005; KENENBAEV, 2005). Input prices are based on current market prices, while output prices are taken from regional statistics from 2001-2004. The considered technologies are characterised by ploughing cultivation and fixed crop rotation systems, e.g. for the model farm in Akmolinskaya oblast the fallow is followed by two seasons planted with spring wheat and one season planted with spring barley. Tables A-4 and A-5 and Figures A-10 through A-12 present a summary of the most distinctive features of the considered technologies for selected crops. The technologies show differences regarding the quantity of fertiliser and herbicide input, the quantity of labour and fuel input (which are mainly determined by the kind and frequency of soil cultivation), and the way soil humidity generation is accomplished. All of these technology features are reflected in the volume of total variable costs, which vary significantly among technologies. The technological differences result in intensely varying yield levels in different states of nature.

Based on Fisher's separation theorem (FISHER, 1933), which was described in chapter 2.2.2, the model includes different insurance and credit activities. In contrast to the situation in countries where market-based crop insurance programmes are already established since long 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. The formulation and testing of financial risk management products was carried out by BOKUSHEVA et al. (2006).

WII products are based on three indices: A simple rainfall index, as well as two drought indices developed by PED (1975) and SELYANINOV (1958), two scientists from the former Soviet Union. BOKUSHEVA (2005) modified them by using monthly data[51]. Since soil moisture is a parameter dependent on soil cultivation intensity, which could induce moral hazard problems, the *Ped* drought index was modified by replacing soil moisture data by data on cumulative precipitation in the period from September to May. The yearly values of the three indexes x_i are computed by following equations:

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[50] The integration of expert knowledge will be extensively discussed in section 0.

[51] Since plant resistance to drought varies during growth phases, monthly data provide a basis for a more precise assessment of wheat yield dependency on weather conditions in the individual years.

Rainfall index

$$x_i^{Rain} = w_{May} R_i^{May} + w_{June} R_i^{June} + w_{July} R_i^{July} + w_{August} R_i^{August} + w_{Sept-April} R_i^{Sept-April}$$

Modified Selyaninov drought index

$$x_i^{Sel} = w_{May} R_i^{May} + w_{June} \frac{R_i^{June}}{T_i^{June}} + w_{July} \frac{R_i^{July}}{T_i^{July}} + w_{August} \frac{R_i^{August}}{T_i^{August}} + w_{Sept-April} R_i^{Sept-April},$$

Modified Ped drought index

$$x_i^{Ped} = w_{June} \frac{\Delta R_i^{June}}{\sigma_{R^{June}}} + w_{July} \frac{\Delta R_i^{July}}{\sigma_{R^{July}}} + w_{August} \frac{\Delta R_i^{August}}{\sigma_{R^{August}}} - w \frac{\Delta T_i^{June-August}}{\sigma_{T^{June-August}}} + w \frac{\Delta R_i^{Sept-May}}{\sigma_{R^{Sept-May}}},$$

where R is the cumulative precipitation and T is the average daily temperature in a specified period, i is a year 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 can be formally described following MIRANDA (1991). A measure β_i is developed which measures the sensitivity of the producer's individual yield to the systematic factors that affect the area yield. A theoretical derivation shows that area-yield insurance will be risk reducing for any producer for whom $\beta_i < 0.5$. A producer i minimizes his yield risk by selecting a coverage level

$$\phi_i^* = \frac{\beta_i}{2 \cdot \beta_c}, \text{ where}$$

β_i is a coefficient that measures the sensitivity of the producer's individual yield to the systemic factors that affect the area yield, and β_c is the critical beta

Miranda proves that area-yield insurance is risk reducing for producer i, if $\beta_i > \beta_c$, i.e. if his individual beta exceeds the critical one.

The risk reduction obtained by acquiring area-yield insurance can be written as:

$$\Delta_i = \sigma_n^2 \cdot \left[\frac{\beta_i}{\beta_c} - 1 \right], \text{ where}$$

Δ_i is the variance reduction, and

σ_n^2 is the variance of indemnity payments.

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 yields. Premium costs and indemnities were estimated based on historical yield and weather data for different strike levels.

Table 4-24 gives an overview of the insurance products that were investigated in this thesis. The calculations are based on yields de-trended and tested for structural break. Yields were de-trended in order to establish an input data base that is not affected by technology changes.

Table 4-24: Insurance types used in the risk programming model

Insurance type	Abbreviation
1.Farm yield insurance	FYI
2. Area yield future and insurance	
2.1 Future: Strike yield 100% of expected national yield 2.2 Area yield insurance (National yields)	N_Futures_100 NYI
2.3 Area yield insurance (Oblast yields)	OYI
2.4 Area yield insurance (Rayon yields)	RYI
3 Weather index based insurance	
3.1 Rainfall based index insurance	RFI
3.2 Selyaninov (modification) index insurance	Sel
3.3 Ped (modification) index insurance	Ped

Note: Strike yields vary between of 100 and 75 per cent of the expected yield. The tick size is 1 KZT. The price of the investigated insurance products depends on the investigated crop, its expected yield (location), and the strike level.

The estimations are restricted to the areas with main cultures. Special crops like potatoes, fruits and vegetables are not considered for the programming model for three reasons: First, their share of total area is relatively small. Second, they are only partially marketed and serve, to a large extent, as the basic food supply of farm labourers. Third, it is not possible to derive statistically firm distribution functions from yearly changing special cultures.

For the case farm in East Kazakhstan, insurance products similar to those in Akmolinskaya oblast were selected. Weather insurance products were specified on the basis of data from the weather station in Ust-Kamenogorsk (Oeskemen). In a first step, it was tested for correlation of weather data with crop yields: There is a positive correlation between wheat yields on the rayon and the enterprise-level and a slightly negative correlation between sunflower yields and precipitation in the vegetation period. Therefore, only for wheat weather index-based insurance was taken into account.

After a sharp decline during the 90s, livestock production regains importance in Kazakhstan. It is an income-stabilizing activity for the study farm in Akmolinskaya oblast and was therefore included in the portfolio (s. chapter 4.5.1).

4.5.3 Model results and discussion

This section comprises the most important results of the risk programming model and additional estimations. Because we are investigating farm-specific cases and look at management options and behaviour of real decision-makers, we refer to personal pronouns when speaking about the decision-maker. For simplification reasons, we use only the male form of the pronouns. First of all, different scenarios are analysed to test for effects of changes in risk aversion, own capital, and credit availability. Then, different farm types are being investigated in order to draw farm type-specific conclusions. The section is wrapped up by a summary of the results.

4.5.3.1 Income and utility effects of variation in risk aversion

The following tables investigate the influence of risk aversion on the choice of risk management instruments. Therefore the risk programming model tested scenarios with and without access to insurance under varied risk aversion coefficients. Table 4-25 depicts the results for the study farm in Akmola. With no access to insurance or futures, the decision-maker's only possibility is to hedge production risk in crop production by using another technology or to diversify the production portfolio by growing alternative crops. Since the programming model considers the two most important crops produced at the farm and technologies are given, the potential to manage risk by choosing another crop portfolio or another technology, which is better adapted to the utility function of the decision-maker, is limited. Therefore, the farmer keeps producing wheat and barley at the same level under the same technology. A scenario with access to insurance allows for a variation of crop portfolio, technology, insurance product and strike level. In this scenario, the decision-maker switches from FYI_100 to FYI_90 for wheat when risk neutrality is assumed with the effect that incomes in worse states of nature decreases, whereas it increases in more favourable states.

Table 4-25: Income and risk for different farm plans – Akmola (in '000 KZT)

Particulars	Farm Plan			
	With access to insurance		*Without access to insurance*	
	*Risk-averse**	*Risk-neutral***	*Risk-averse*	*Risk-neutral*
Gross income	469,505	469,505	469,505	469,505
Income in State 1	12,469	12,089	5,258	5,258
Income in State 2	17,631	17,351	14,379	14,379
Income in State 3	15,106	15,116	16,148	16,148
Income in State 4	21,608	21,775	23,712	23,712
Income in State 5	44,112	44,426	46,753	46,753

Source: Own estimations.

Note: * rra=2, ** rra=0.5.

In the case of East Kazakhstan (s. Table 4-26), no differences between risk-neutral and risk-averse behaviour could be measured in all scenarios. For this reason, the income distribution over all states of nature within the scenarios stays constant, when risk aversion is varied. However, there is an income difference between the scenarios with and without insurance access. As in Akmola, insurance participation redistributes income from better to worse states of nature, i.e. from states 2 and 3 to state 1. Because this farm is short of own capital and borrows capital from the bank an additional scenario with no access to both, credit and insurance was introduced. The restriction in credit access leads to a reduction in cultivation of crop area by 5.3 per cent. This reduces the expected gross income by 8.2 per cent. In contrast to the results in East Kazakhstan, the model results for the South Kazakhstan study farm show similar results to those in Akmola: The relative distribution of crop area between wheat and cotton stays constant, but the strike level for cotton insurance will be lifted from 90 per cent to 100 per cent when increasing the relative risk aversion coefficient from 0.5 (risk-neutral) to 2 (risk-averse).

Table 4-26: Income and risk for different farm plans – East Kazakhstan (in '000 KZT)

Particulars	**Farm Plan**					
	With access to insurance		*Without access to insurance, but access to credit*		*Without access to insurance and credit*	
	Risk-av.	*Risk-neutr.*	*Risk-av.*	*Risk-neutr.*	*Risk-av.*	*Risk-neutr.*
Gross income	29,932	29,932	29,932	29,932	27,474	27,474
Income in State 1	1,388	1,388	1,166	1,166	1,071	1,071
Income in State 2	1,025	1,025	1,308	1,308	1,201	1,201
Income in State 3	1,570	1,570	1,871	1,871	1,717	1,717

Source: Own estimations.

As a result, the average income under bad weather conditions (state 1) will be lifted from 744,000 KZT to 785,000 KZT. This income shift can be re-enacted in Figure 4-6, where in most of the years that form state 1 (years 1-13), the income is higher under higher risk aversion. The relatively high income in years 8 and 11 can be explained by the method of state formulation. Like in the two other regions, wheat yields were used as an indicator of natural conditions, according to which the states of nature were formulated. However, whole-farm income might be reasonably high in years with low wheat yields, because income from cotton production levels out and replaces lacking income from wheat production.

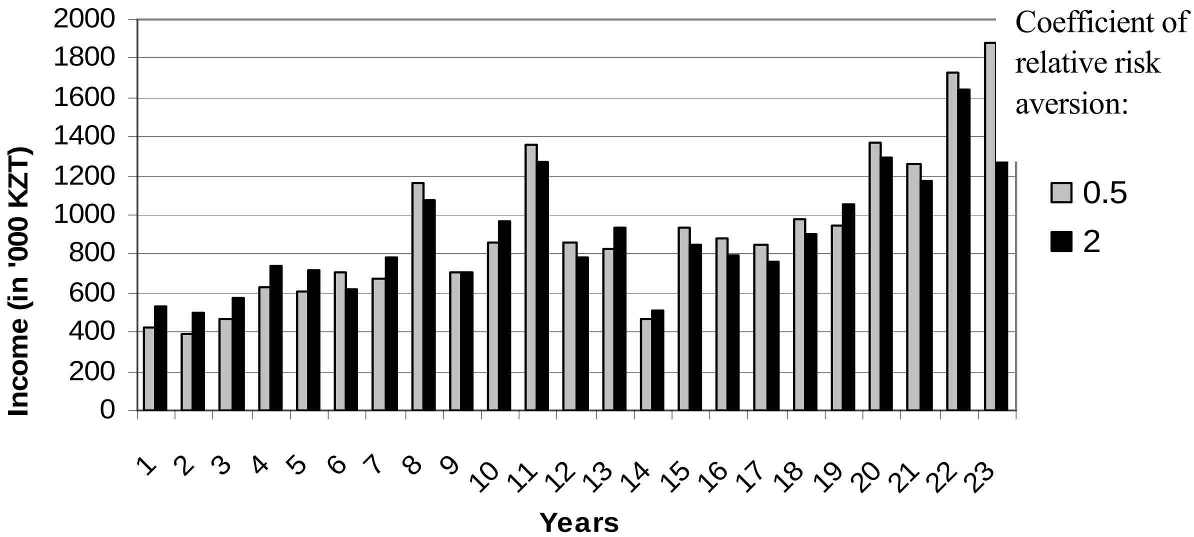
Risk-aversion variation in the scenario "without access to insurance" does not have any effect on activity choice and income distribution.

Table 4-27: Income and risk for different farm plans – South Kazakhstan (in '000 KZT)

Particulars	Farm Plan			
	With access to insurance		*Without access to insurance*	
	Risk-averse	*Risk-neutral*	*Risk-averse*	*Risk-neutral*
Gross income	20,969	20,969	20,969	20,969
Income in State 1	785	744	519	519
Income in State 2	880	918	1,206	1,206
Income in State 3	1,537	1,622	1,934	1,934

Source: Own estimations.

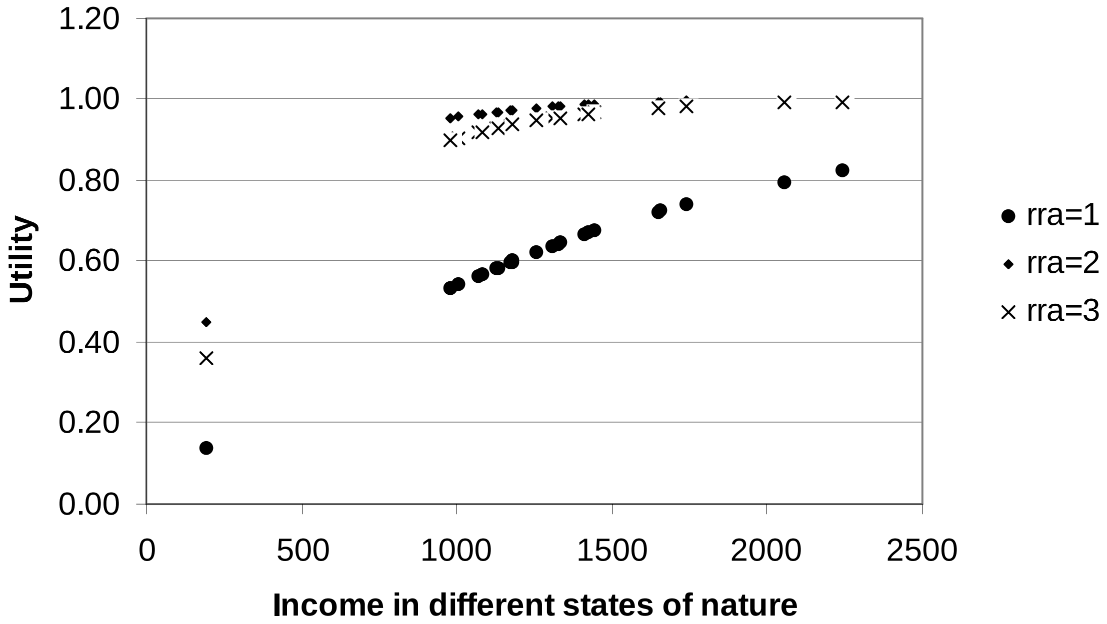
Figure 4-6: Income distribution in different states of nature for two levels of risk aversion (rra=0.5, rra=2), study farm South Kazakhstan, only farm-yield insurance (scenario 1C)



Source: Own estimations.

The relative inelasticity of utility when risk aversion is varied can be shown by the almost parallel utility curves in Figure 4-7. The negative exponential utility function gives slightly more weight to low incomes compared to high ones.

Figure 4-7: Utility elasticity of income when risk aversion is varied – Example case farm in East Kazakhstan



4.5.3.2 Effects on input use

The results in Table 4-28 reflect the situation of the study enterprises. Both, the South Kazakhstan and the Akmola farm are equipped with abundant own capital. Logically, credit with an expected interest rate of 15 per cent, although inflation is moderate, is not attractive for these farms. The East Kazakhstan enterprise uses 92 per cent of the maximally obtainable amount of credit.

The study farm in South Kazakhstan is as so far as labour intensity is concerned typical for the region. In South Kazakhstan, natural conditions and low labour costs support the production of labour-intensive crops, such as cotton, fruits, and vegetables. Even wheat production is about twice as labour intensive as in northern Kazakhstan, due to smaller plots, a lower degree of mechanisation, and irrigation.

The variation in risk aversion, however, does not have an impact on capital and labour use, since production portfolios are identical under both risk aversion assumptions.

Table 4-28: Total labour and credit use for different farm plans

Region	Particulars	Farm plan	
		Utility-efficient	
		Risk-averse	*Risk-neutral*
Akmola	Total labour use (hours)	130,868	130,868
	Labour use per ha	3.71	3.71
	Borrowing (‘000 KZT)	–	–
East Kazakhstan	Total labour use (hours)	12,347	12,347
	Labour use per ha	3.86	3.86
	Borrowing (‘000 KZT)	2,711	2,711
South Kazakhstan	Total labour use (hours)	61,851	61,851
	Labour use per ha	28.90	28.90
	Borrowing (‘000 KZT)	–	–

Source: Own estimations.

4.5.3.3 Detailed analysis of study farms

Akmola

The insurance products contained in the portfolio can stabilise income and thereby increase decision-maker’s utility significantly. Compared to the reference scenario R, where only production technology can be chosen, scenarios with application of different insurance products show higher utility values. Table 4-29 depicts that even a fair-premium insurance based on national yields reveals a certainty equivalent that is 2 per cent higher than in scenario R. As expected, farm-based products, such as farm-yield insurance and weather-based insurance products are dominant to area-yield insurance products. A future product based on national yields is surprisingly successful in stabilising income. Compared to insurance, a future has the advantage of not generating premium costs. Thus, income in bad years might be stabilised better than with insurance. An additional explanation is, that area-yield insurance discriminates farms with better than average yields compared to other farms. These results are supported by an analysis of gross margin coefficients of variation, which can be found in the appendix (see Table A-7). The table shows the full range of insurance products and strike levels. For wheat 4 farm-yield and 4 area-yield products with different strike levels (altogether 33 combinations) were analysed. For barley the overall number is slightly higher: 34 insurance and future products were analysed.

All coefficients are in a normal range. The coefficients for wheat are lower than those for barley by 8 per cent for technology II and III and by 15 per cent for technology I. The number of area-yield products in the list of the ten most efficient insurance instruments is low. For both wheat and barley there is only one area-yield product among the first ten, except for technology I, where two of these products can be found. The same holds for the second ten instruments: Considering all technologies, for wheat at maximum two area-yield choices are represented, for barley at maximum 1. Most of the area-yield products are ranking last in the list. When comparing the variation coefficient means for the first ten with the second ten products, it becomes evident that there is no big difference, especially for the products designed for wheat. Hence, the potential to stabilise income is similar for many farm-level products. The difference between the schemes becomes larger when taking into account the coefficient of variation for the third ten, which include mostly area-yield insurance products.

The dominance of technology I in stabilising income is evident regarding the differences in variation coefficients. For most of the products the variation coefficient can be significantly reduced by application of the intensive technology.

Table 4-29: Technology and insurance product choices – Study farm Akmola

								Crop						
								Wheat		Barley a		Barley b		Fallow
No.	Certainty Equivalent ('000 KZT)	Utility-ranking*	Expected Monetary Value ('000 KZT)	Risk Premium	Scenario	Subscenario	Technology	Insurance product	Area (ha)	Insurance product	Area (ha)	Insurance product	Area (ha)	Area (ha)
1	441,306	1.000	469,505	0.064	1C	only FYI_100	I	FYI_100	17,636	FYI_100	8,818			8,818
2	439,625	0.996	469,505	0.068	1C	only WII	I	Ped_67	17,636	RFI_100	8,818			8,818
3	439,007	0.995	469,505	0.069	1C	only RFI	I	RFI_90	17,636	RFI_90	8,818			8,818
4	436,478	0.989	469,505	0.076	1C	only NYI_future	I	NYI_future	17,636	NYI_future	8,818			8,818
5	436,129	0.988	469,505	0.077	1C	only FYI	I	FYI_90	17,636	FYI_75	8,818			8,818
6	435,031	0.986	469,505	0.079	1C	only Sel	I	Sel_67	17,636	Sel_90	8,818			8,818
7	434,891	0.985	469,505	0.080	1C	only Ped	I	Ped_80	17,636	Ped_67	8,818			8,818
8	434,394	0.984	469,505	0.081	1C	only FYI_75 + lower	I	FYI_75	17,636	FYI_75	8,818			8,818
9	431,812	0.978	469,505	0.087	1C	only AYI	I	RYI_100	17,636	OYI_75	8,818			8,818
10	425,057	0.963	469,505	0.105	1C	only NYI	I	NYI_100	17,636	NYI_100	8,818			8,818
11	416,070	0.943	469,505	0.128	R	reference scenario	I	–	17,636	–	8,818			8,818
12	403,282	0.870	464,066	0.151	3C	only FYI	III			–	17,636	NYI_67	8,818	8,818
13	387,641	0.878	441,238	0.138	2C	only FYI	II			–	17,636	FYI_90	8,818	8,818

Note: * Achieved certainty equivalent as share of maximum achievable certainty equivalent. Technologies I (intensive), II (medium), and III (extensive) reflect different input intensities. The insurance products chosen are explained in Table 4-24. Scenarios follow the pattern as outlined in chapter 4.5.2.2.

The technology differences are also highlighted in Table 4-29. For an evaluation of the technologies with access to farm-yield insurance, three different sub-scenarios were compared (No. 5 to No. 12 and 13). Technology III yields 91.3 per cent of the CE and 98.8 per cent of the expected income of technology I. Applying technology II, 87.8 and 94 per cent respectively of technology I levels can be achieved. Barley is the preferable crop under more extensive technologies (II and III). The largest share of the barley area remains uninsured (17,636 ha), whereas a smaller part (8,818 ha) would have to be insured with national and farm yield insurance.

However, the differences between certainty equivalents for different technologies are not as large as in the case of the East Kazakhstan farm. This can be partly explained by the technology choice which smoothes yields better than the extensive technology chosen by the model for the production programme of the EK farm.

Table A-11 displays the insurance solutions when livestock production activities are introduced. The scenarios with crop production including access to different insurance instruments plus livestock production achieve certainty equivalents that are by 13.3 per cent higher and expected incomes that are about 12.7 per cent higher compared to pure crop production results. Income increase and stabilisation can be particularly attributed to revenue generated by cattle production. However, the current stable place is limited und might constrain the income potential of the enterprise. A *sensitivity analysis* shows the income and income distribution effects of a *ceteris paribus* increase in the total number of stable places for cattle in different states of nature. In the reference scenario "R" the total livestock production would be switched to cattle production, if the number of cattle places would be doubled. This shift increases the Expected Monetary Value (EMV) of whole-farm production by 7.3 per cent, caused particularly by an income increase in less favourable states of nature (S1-S3) as Table 4-31 shows. The same development can be perceived for all other scenarios. Solely "3C"shows hardly any income increase and redistribution between states. Scenarios R, 1C, and 2C with an increase in cattle places are furthermore characterised by a decrease in income in states 4 and 5. This can be explained by the opportunity costs of cattle production in states of nature that are favourable for crop production.

Table 4-30: Effects of cattle place extension on livestock production activities

	Scenario			
Cow places: 1000 *Cattle places: 1000* *Horse places: 400*	**R**	**1C**	**2C**	**3C**
Dairy cows	246	399	1,000	1,000
Beef cattle	1,000	1,000	1,000	1,000
Horses	400	400	0	0
Cow places: 1000 *Cattle places: 2000* *Horse places: 400*				
Dairy cows	0	0	0	1,000
Beef cattle	2,000	2,000	2,000	2,000
Horses	0	0	398	0

Source: Own estimations.

Note: R=Reference scenario, 1C=Access to intensive technology and credit; 2C=Access to medium technology and credit; 3C=Access to an extensive technology and credit.

Table 4-31: Income-stabilisation through cattle production

	R	**1C**	**2C**	**3C**
S1	0.002	0.002	0.001	-0.001
S2	0.005	0.002	0.004	0.000
S3	0.001	0.001	0.001	0.000
S4	-0.005	-0.002	-0.003	0.000
S5	-0.004	-0.003	-0.003	0.001
EMV	0.073	0.073	0.096	0.008

Source: Own estimations.

Note: Values for S1-S5 depict the increase in relative income share in the respective state, the EMV values show the relative increase in expected monetary value, when increasing the number of stable places for cattle.

East Kazakhstan

The model results suggest a switch in intensity for wheat: After de-trending with account for technology effects, the average historical wheat yield corresponds to the potential yield that can be achieved under technology 2. The farm model suggests a change to the more extensive technology 3.

Table 4-33 shows the results for different scenarios of the risk programming model and orders them according to their utility-efficiency. Technology III is dominant in all scenarios. Results for scenarios that investigate the income effects of other technologies are shown in Figure A-6. As anticipated, the scenario where crops are fully insured under farm yield insurance shows the highest utility, since FYI is perfectly adapted to farm conditions and losses are smoothed perfectly over the years. Restricting the strike level for farm-yield insurance products to 75 per cent as it is done in U.S. crop insurance to prevent moral hazard, does not significantly reduce utility. Further limitation of the insurance product choice further reduces utility generation as the subsequent certainty equivalent values show. Scenario 2 with WII only for wheat and no insurance for sunflowers[52] yields the lowest utility result of the compared scenarios with insurance products. The reference scenario R without insurance shows a significantly reduced utility.

As in the case of the Akmola farm, all investigated insurance products were analysed according to their gross margin variation coefficients. Altogether 25 products for wheat and 12 for sunflowers were analysed. For wheat 11 farm-yield products and 14 area-yield products were tested. For sunflowers farm-yield insurance with four different strike levels and national and rayon-yield insurance with different strike levels were analysed. Table A-8 shows the test results. Variation coefficients for wheat are strongly fluctuating across technologies. Whereas the variation coefficient of farm yield insurance with a strike of 100 per cent is 0.167 for technology III, it increases strongly when switching to technology II (0.275) or I (0.250). The number of area-yield instruments for wheat is as low as it is in the case of the Akmola farm. Only one among the first ten is not a farm-yield product.

This is slightly different for sunflowers. Among the first five are three area-yield insurance products. This fact can be partly explained by the overall low number of farm-yield products, because no weather-based insurance products were designed for sunflowers[53]. Remarkably about both crops are the measured high values of variation coefficients. The effects of a technology change are drastic for many insurance products. However, they are especially high in terms of variation coefficient change.

Publications on effects of credit-rationing in Kazakhstani agriculture are not available to the best of the author's knowledge. However, PETRICK's (2004) contribution *inter alia* investigates effects of credit-rationing on investment decisions of Polish farm households. His analysis led to the result that credit access

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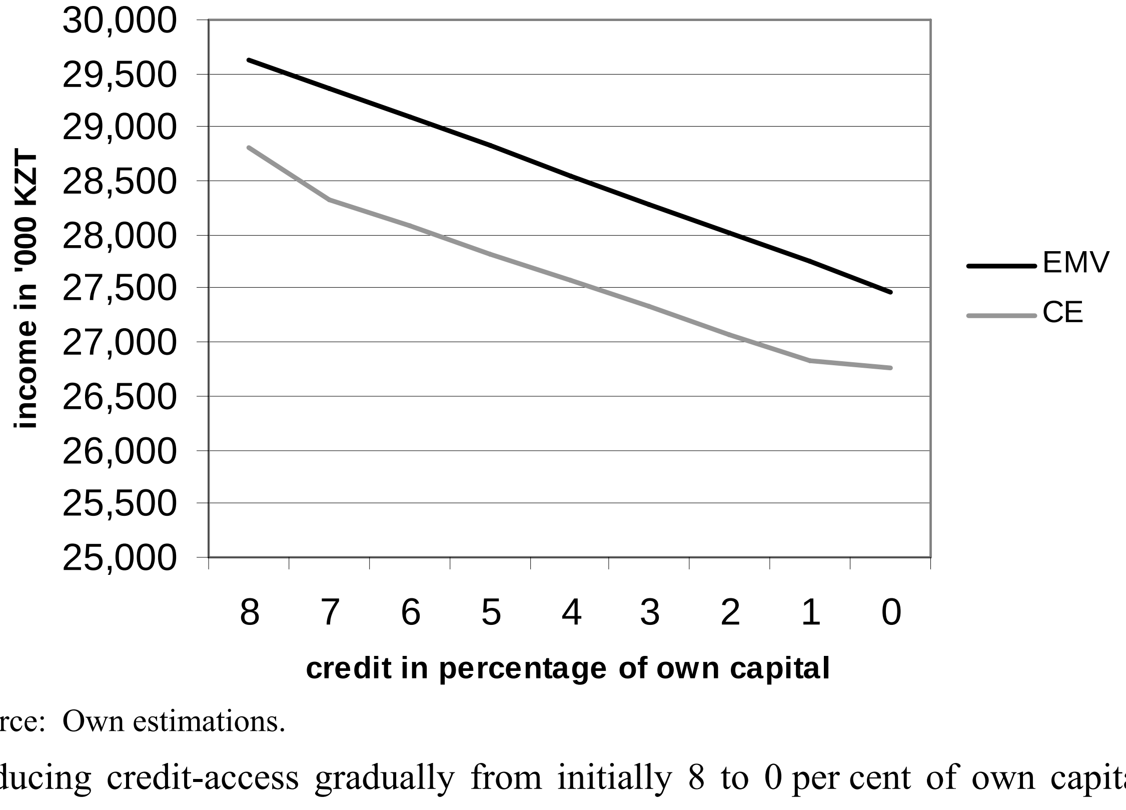
[52] This scenario depicts the case of a pilot weather index scheme for main cultures.

[53] Correlation tests between weather parameters and sunflower yields did not yield sufficient values for a decision to design weather-based products also for sunflowers.

is a significant factor of investment decisions of credit-rationed farmers. If these results can be transferred to the conditions in Kazakhstan, one can conclude that limited credit access might be an obstacle to adoption of new production technologies.

The analysis of credit- and own capital rationing within the framework of the programming model provides some insights of the effects of both restriction mln KZT between the reference scenario with and without credit access. The effects of credit and insurance are impressively shown by scenario 1 (No. 7) (Table 4-29), where access to farm yield insurance products exists, but credit is restricted. By introduction of a credit restriction, the production area available for crop production under the extensive technology shrinks by 268 hectares. Figure 4-8 depicts the effects of a change in credit availability on the expected farm income and the certainty equivalent, respectively. Both curves show an almost linear negative trend for both income measures when credit amount is reduced successively by 1 per cent.

Figure 4-8: Development of expected monetary value (EMV) and certainty equivalent (CE) dependent on credit availability

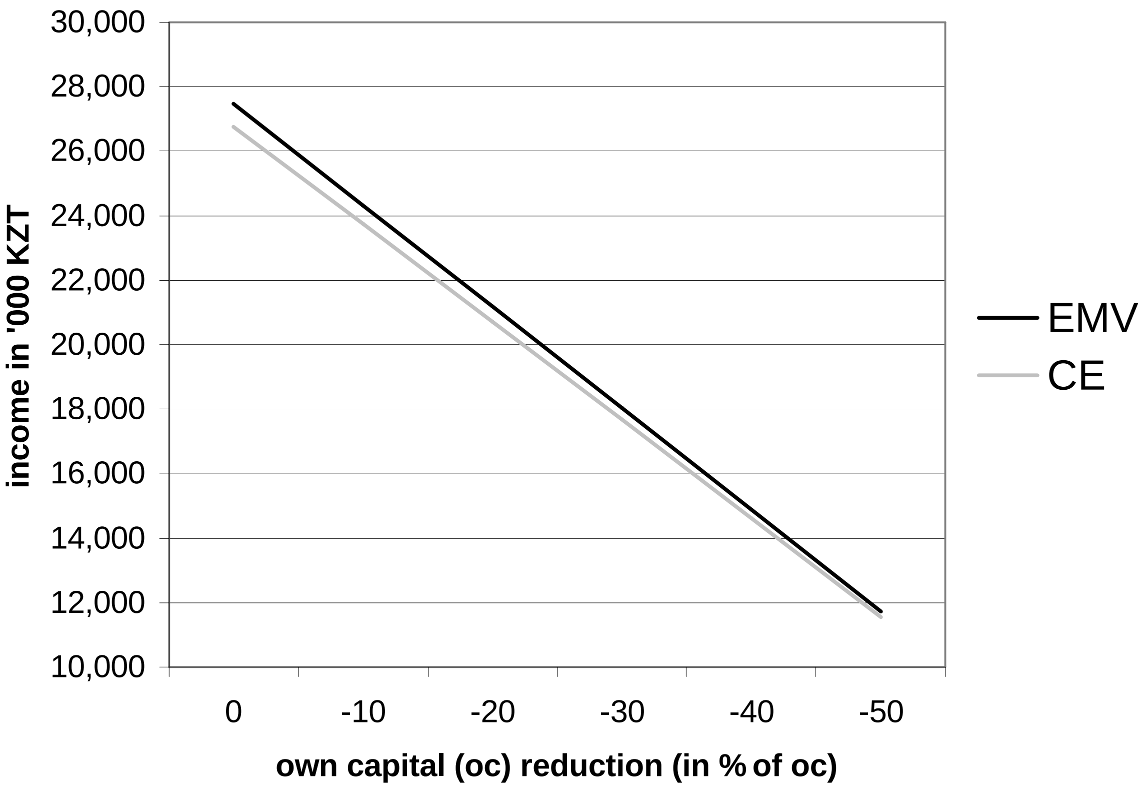


Source: Own estimations.

Reducing credit-access gradually from initially 8 to 0 per cent of own capital, reduces the expected farm income by 269,000 KZT and certainty equivalent by 255,000 KZT in average. The sown area is reduced by 29 ha per per cent of credit reduction. The turning point between 7 and 8 per cent marks the point where no additional land is rented and land rental costs become zero.

How does the situation look like, if own capital is reduced? This situation might occur, if enterprise liquidity decreases as an effect of bad harvests and own capital has to be used to stabilize liquidity, or, if the ownership structure changes. For this analysis, the own capital level was gradually reduced to 50 per cent of the original level. This reduction results in an average decrease of 29 ha of sown area for every per cent of own capital reduction (s. Figure 4-9). Likewise, the expected farm income decreases by 315,000 KZT and the certainty equivalent decreases by 304,000 KZT. While income and certainty equivalent are decreasing in an almost linear way, the production portfolio mix does not change, i.e. the shares of wheat and sunflowers stay constant.

Figure 4-9: Development of expected monetary value (EMV) and certainty equivalent (CE) dependent on capital availability



Source: Own estimations.

The convergence of both curves when own capital is reduced reflects the form of the utility curve. The lower the income level, the smaller is the absolute value of the risk premium.

Interest rates are about 15 per cent for agricultural loans. Credits might not be available for agricultural enterprises due to lack of collateral or unaffordable interest rates. Table 4-32 highlights the effects of variation in credit availability and interest rate on expected income and certainty equivalent for the case farm in East Kazakhstan. Comparing three interest rate levels under two different credit quotas (5 and 10 per cent of own capital), the table shows that real income gains and losses between interest rate levels are lower than gains and losses in certainty equivalents. Translated into reality, we can conclude that a reduction of interest rates, e.g. provoked by a governmental subsidisation might lead to subjectively experienced disproportionately high utility gains, because income gains in dry states of nature are higher compared to more humid states.

Table 4-32: Effects of variation in credit availability and interest rate on EMV and CE

Credit (in % of own capital)	r (interest rate on credit)	CE	EMV
	15	28,850	29,932
10	10	29,229	30,068
	5	29,393	30,203
	15	27,826	28,826
5	10	28,122	28,900
	5	28,221	28,974

Source: Own estimations.

The sensitivity analysis for variation in interest rates, own capital and credit access shows a result that can be perceived in transitional agriculture: Agricultural areas remain unused or underutilized, respectively due to lack of capital. This increases danger of erosion and desertification of unused or inappropriately used land.

Table 4-33: Technology and insurance product choices – Study farm East Kazakhstan

							Crops				
							Wheat		Sunflowers		Fallow
No.	Certainty Equivalent ('000 KZT)	Utility-ranking	Expected Monetary Value ('000 KZT)	Risk Premium	Scenario	Subscenario	Insurance product	Area (ha)	Insurance product	Area (ha)	Area (ha)
1	28,850	1.000	29,932	0.036	1C	only FYI	FYI_100	2,286	FYI_100	381	533
2	28,521	0.989	29,932	0.047	1C	only FYI_75 and lower	FYI_67	2,286	FYI_75	381	533
3	27,816	0.964	29,932	0.071	1C	only AYI	OYI_75	2,286	RYI_100	381	533
4	27,519	0.954	29,932	0.081	1C	only NYI	NYI_67	2,286	NYI_67	381	533
5	27,491	0.953	29,932	0.082	RC		–	2,286	–	381	533
6	27,204	0.943	29,932	0.091	1C	only WII (Wheat); no insurance (sunflowers)	RFI_100	2,286	–	381	533
7	26,766	0.928	27,474	0.026	1	only FYI	FYI_90	2,094	FYI_100	349	489
8	25,457	0.882	27,474	0.073	R		–	2,094	–	349	489

Source: Own estimations. The insurance products chosen are explained in Table 4-24. Scenarios follow the pattern as outlined in chapter 4.5.2.2.

South Kazakhstan

In South Kazakhstan, 20 insurance products were tested for wheat and 12 for cotton. Farm yield insurance was tested with five strike levels; the remaining seven were area-yield insurance products. Oblast yield insurance could not be tested because of missing data. Both crops are partly irrigated. Therefore, yields are less dependent on rainfall and an introduction of weather-based insurance is not promising.

The results of the risk programming model (Table 4-34) show no clear differences between selected insurance products, when all technologies are available. The most input intensive technology (technology I) has a comparative advantage in stabilising income and was therefore chosen by the model. The certainty equivalent in the first best scenario (rayon-yield insurance with different strike levels) amounts to 18,877,000 KZT. This value is reduced by 43.6 per cent, when only technology II is available. The third formulated technology has not been taken into account for the model estimations, because preliminary tests demonstrated a low potential in stabilizing incomes. Furthermore, the risk programming model shows that the share of cotton in the crop rotation fluctuates between 12.7 per cent in scenario 2C and 16.9 per cent in all sub-scenarios of 1C. This is explained by better income-stabilising features technology II in wheat production compared to cotton production. Raising credit was not considered in any of the solutions. As already shown for the case farm in Akmola, a combination of different insurance products or, as in this case, a combination of different strike levels, might contribute to certainty equivalent increase. For the South Kazakhstan study farm, this holds especially for cotton production.

Table A-9 shows coefficients of variation (CV) for all investigates insurance products. For the extensive technology III, values are close to and above 1 for wheat and between 1.8 and 2.4 for cotton, which expresses a highly volatile gross margin. The analysis of variation coefficients points out that the majority of products represented among the first best are farm-yield products. CV-fluctuations among technologies are large.

The above mentioned efficiency advantage of technology I becomes evident when comparing average variable costs and yields. For wheat production, variable costs for technology I are higher by 23 per cent compared to technology II and by 47 per cent compared to technology III. Simultaneously, the yield increase between technologies I and II amounts to 27 per cent and between I and III 61 per cent, respectively. The relative differences and thereby the efficiency gains from appropriate technology application are even higher when investigating cotton production. For cotton production, variable costs increase by 14 per cent when switching from technology II to I and by 35 per cent when doing so from technology III to I. Simultaneously, the yield difference between technologies I and II amounts to 21 per cent and between I and III 49 per cent, respectively. A look on the distribution of variable production costs (figures A-10 through A-12) shows the increasing share of labour costs, when production becomes more extensive. All kinds of costs are subject to uncertainty: Fertilizer and fuel are subsidised currently. If subsidies will be lifted in the course of the WTO accession, these costs might rise by up to 40 per cent and will make up a much larger share of variable costs than today. Labour costs will rise significantly in the future, if the economy will grow as fast as during the last years. The wage gap between agricultural wages and those paid in other sectors will have to be narrowed, at the latest when more and more qualified workers will leave the sector and enterprises will run short of labour. The development of water costs will be subject to the changes in water resources in the southern region of Kazakhstan, the competition of the agricultural sector with other potential users, and the institutional arrangements of water user associations.

For South Kazakhstan a price insurance, similar to CRC (Crop Revenue Coverage) or IP (Income Protection) could be introduced, because cotton prices are highly volatile and cotton farmers often take in forward contracts[54], which increase price risk. The production structure of southern region's farms is less similar to northern Kazakhstan conditions than to the ones in Mexico, where revenue insurance is being promoted by the *International Finance Corporation* (IFC).

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[54] When signing a forward contract, a farmer guarantees to supply a certain quantity of his output at a specified date. A lower than agreed quantity reduces the price.

Table 4-34: Technology (T) and insurance product choices – Study farm South Kazakhstan

								Wheat a		Wheat b		Cotton a		Cotton b		Fallow
No.	**Expected Monetary Value ('000 KZT)**	**Certainty Equivalent ('000 KZT)**	**Utility-ranking**	**Risk Premium**	**Scenario**	**Sub-scenario**	**T**	**Insurance product**	**Area (ha)**	**Insurance product**	**Area (ha)**	**Insurance product**	**Area (ha)**	**Insurance product**	**Area (ha)**	**Area (ha)**
1	19,169	18,877	1.000	0.015	1C	only RYI	I	RYI_90	1,393	–	–	RYI_100	340	RYI_80	22	385
2	19,169	18,806	0.996	0.019	1C	only AYI	I	NYI_100	772	OYI_100	621	RYI_100	200	RYI_67	162	385
3	19,169	18,793	0.996	0.02	1C	only FYI	I	FYI_75	1,393	–	–	FYI_100	85	FYI_80	277	385
4	10,818	10,655	0.564	0.015	2C	only FYI	II	FYI_100	1,393	FYI_100	91	FYI_80	271			385

Source: Own estimations. Technologies I (intensive) and II (medium) reflect different input intensities. The insurance products chosen are explained in Table 4-24. Scenarios follow the pattern as outlined in chapter 4.5.2.2.

4.5.4 Utility-efficient programming versus analysis of variance reduction by means of SSD and MV approach

Alternative methods were tested to determine the efficiency of different insurance instruments in reducing crop production risk. The investigation of variance reductions in wheat production income was carried out by means of mean-variance (MV) and second-degree stochastic dominance (SSD) analysis (s. BREUSTEDT, 2004). This chapter discusses a part of the results generated in the course of the common work with BOKUSHEVA and BREUSTEDT (s. BOKUSHEVA et al., 2006). The results have a special focus on two of the investigated regions, namely Akmola and East Kazakhstan and represent a supplement to the findings generated by utility-efficient programming. The results cannot be compared directly, since the analysis of variance reduction focuses on wheat production, while the programming model comprises a portfolio of production activities and the possibility to depict differences between production technologies. However, since wheat is an important crop in the production portfolio of both study farms, the variance reduction in wheat production has a significant impact on utility as results below show.

Table 4-35 presents variance reductions by different insurance products. It depicts the results for the rayons Tselinograd and Glubokoe. Additionally, Novoishim, a part of the rayon Tselinograd has been taken into account to test for differences in variance reductions for a smaller sample of farms, which are located directly in the surrounding of a weather station. The numbers represent the variance reductions for strike levels 100. Table A-10 depicts the variance reductions for each considered strike level in more detail. Farm yield insurance which achieves the highest variance reductions in all three regions. Rayon-yield insurance generates substantial reductions in variance for Tselinograd and its sub-region Novoishim. However, the variance reductions are significantly larger for the smaller sub-region. The same is the case for the weather-index products. The fact that all farms of the sub-region lie within a short distance from the weather station that recorded the data used for the index calculation, has the effect of higher variance reductions by weather-based products compared to the larger rayon. It becomes clear that only a dense net of weather stations can guarantee a sufficient risk reduction when introducing weather-index insurance.

A similar result evolves from the comparison of different area-yield products. Risk reductions decrease with increasing level of aggregation. This means that national-yield insurance performs worse than oblast-yield insurance, and oblast-yield insurance performs worse than rayon-yield insurance.

Results of a comparison of variance reductions in wheat production between Akmola and East Kazakhstan show the importance of crop insurance for the drier region (Akmola), which is more prone to yield fluctuations. The average variance reduction of all considered products is about half in East Kazakhstan compared to Akmola.

The differences between values estimated by SSD and MV are relatively small for Tselinograd and Novoishim, but significantly larger for Glubokoe. Thus, SSD variance reductions of index-based insurance are lower compared to MV variance reduction in regions with a low degree of systemic risk.

Table 4-35: Average variance reductions of selected insurance products according to different estimation methods

Product (Strike level: 100)	Method	Tselinograd	Novoishim	Glubokoe
NYI	SSD	0.218	0.242	0
NYI	MV	0.245	0.247	0.043
OYI	SSD	0.29	0.384	0.234
OYI	MV	0.365	0.384	0.36
RYI	SSD	0.427	0.531	0.27
RYI	MV	0.438	0.531	0.323
FYI	SSD	0.627	0.62	0.717
FYI	MV	0.627	0.62	0.717
PED	SSD	0.305	0.461	0.274
PED	MV	0.332	0.461	0.32
SEL	SSD	0.294	0.485	0.24
SEL	MV	0.306	0.485	0.336
RFI	SSD	0.262	0.461	0.23
RFI	MV	0.291	0.461	0.321

Source: Own estimations.

This causes changes in the efficiency ranking of insurance products as depicted in Table 4-36 and Table 4-37. The comparison of the three criteria utility- (certainty equivalent), SSD-, and MV-efficiency shows ambiguous results on the farm-level, because utility-efficiency can hardly be compared to the other two criteria. Only farm-yield insurance with a strike yield of 100 per cent of the expected yield (FYI_100) is unambiguously the most efficient insurance under all three criteria for both study farms. For the Akmola farm the same is true for the Ped index insurance with a strike level of 67 per cent (Ped_67), the national yield future (NYI_fut_100), and the farm yield insurance with a strike yield of 75 per cent of the expected yield (FYI_75). For other insurance products, the position in the efficiency comparison varies between 1 (OYI_75, NYI_100) and 4 (Ped_80) ranks.

Table 4-36: Comparison of UEP and SSD/MV – Study farm in Akmola

Product and strike level	UEP (CE)	UEP-Ranking	SSD (Var. reduction)	SSD-Ranking	MV (Var. reduction)	MV-Ranking
FYI_100	441,306	1	0.638	1	0.638	1
Ped_67	439,625	2	0.572	2	0.572	2
RFI_90	439,007	3	0.550	5	0.550	5
NYI_fut_100	436,478	4	0.572	4	0.572	4
FYI_90	436,129	5	0.549	6	0.549	6
Sel_67	435,031	6	0.333	9	0.333	9
Ped_80	434,891	7	0.572	3	0.572	3
FYI_75	434,394	8	0.387	8	0.387	8
RYI_100	431,812	9	0.532	7	0.532	7
OYI_75	425,672	10	0.176	11	0.201	11
NYI_100	425,057	11	0.304	10	0.304	10

Source: Own estimations.

Table 4-37 shows the risk reductions derived by means of SSD and MV analysis for different insurance products and compares them to the UEP results for the East Kazakhstan study farm.

Table 4-37: Comparison of UEP, SSD, and MV – Study farm East Kazakhstan

Product and strike level	UEP (CE)	UEP-Ranking	SSD (Var. reduction)	SSD-Ranking	MV (Var. reduction)	MV-Ranking
FYI_100	28,850	1	0.734	1	0.734	1
FYI_67	28,521	2	0	3	0	6
OYI_75	27,816	3	0	4	0.244	3
NYI_67	27,519	4	0	5	0.007	5
RFI_100	27,204	5	0	6	0.180	4
FYI_90	26,766	6	0.436	2	0.436	2

Source: Own estimations.

4.5.5 Moral hazard effects

"Perfect insurance is a good idea in principle, but if it blunts the feeling of responsibility that people have for their own actions, it might make life very costly for the insurance company, or at any rate for somebody" (RAY, 1998).

Moral hazard is a major obstacle to insurability. The following analyses have been performed to assess the potential insurance market distortions caused by moral hazard. Therefore, moral hazard was captured as a reaction to insurance expressed in technology changes. This behavioural adaptation is plausible and empirically evident as discussed in chapter 2.3.1. It is assumed that a farmer takes in single-year contracts and the insurance company does not introduce strike restrictions, deductibles or contracts with an integrated indemnity memory. The farmer has the opportunity to react to the insurance situation with a change in technology. The effect of moral hazard can be described in the following way: Assume that a farmer can demonstrate opportunistic behaviour by switching to a less intensive technology than he practiced in the past. Then, the farmer's indemnity gain due to moral hazard I^{mh} can be defined as follows:

$$I^{mh} = \begin{bmatrix} 0 & \text{if } y_t \geq y^{strike} \\ E(y^{APH}) - E(y^{ext}) & \text{if } y_t < y^{strike} \end{bmatrix} * p \, ,$$

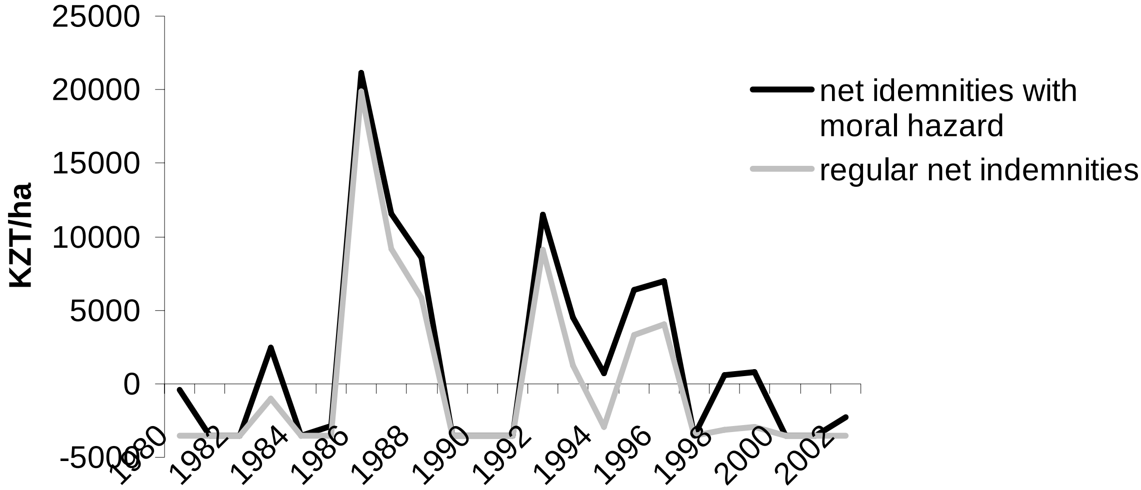
with

$$y^{strike} = E(y^{APH}) > E(y^{ext}) \, ,$$

where y^{strike} is the strike yield estimated on the basis of the farmer's actual production history and typically equals to its expected value $E(y^{APH})$; y_t is the farmer's yield under the less intensive technology in the production year t; $E(y^{ext})$ is the expected yield under this technology, respectively; and p is the price of the insured crop as stated in the insurance contract.

Figure 4-10 graphically depicts the results for sunflowers for the case farm in East Kazakhstan for the study period 1980-2002. The black curve depicts the net indemnities (indemnities-premiums) for farm yield insurance with 100 per cent strike and moral hazard, which is expressed in technology change from medium-intensive to extensive. The grey curve represents regular net indemnities. In some of the years, the farmer can achieve gains from asymmetric information. This is the case in the years where the net indemnities with moral hazard are higher than in the situation without. In an average year, the gains from shirking would amount to 1640 KZT per ha.

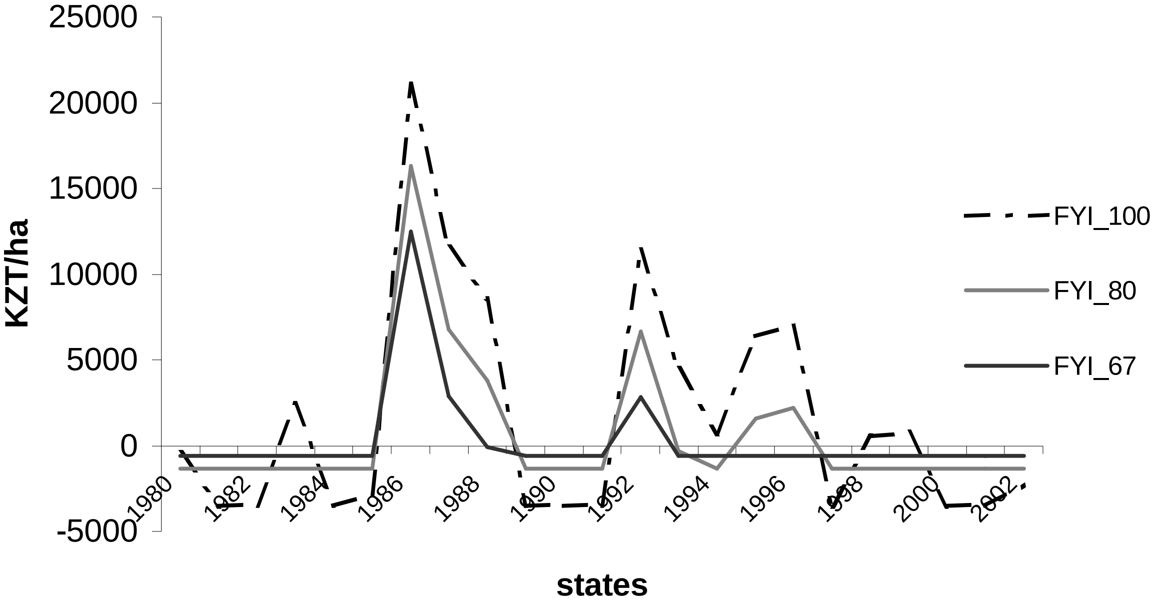
Figure 4-10: Net indemnity payments with and without moral hazard – Example switch from medium to extensive technology



Source: Own estimations.

The lower the strike, the lower are the incentives to shirk. With FYI_90, FYI_80, FYI_75, and FYI_67 the moral hazard gains are 986, 682, 508, and 287 KZT, respectively. These results that are depicted graphically in Figure 4-11 support the argument of a limitation of strike in crop insurance schemes. For clarity reasons, it does not show the curves for FYI_90, and FYI_75.

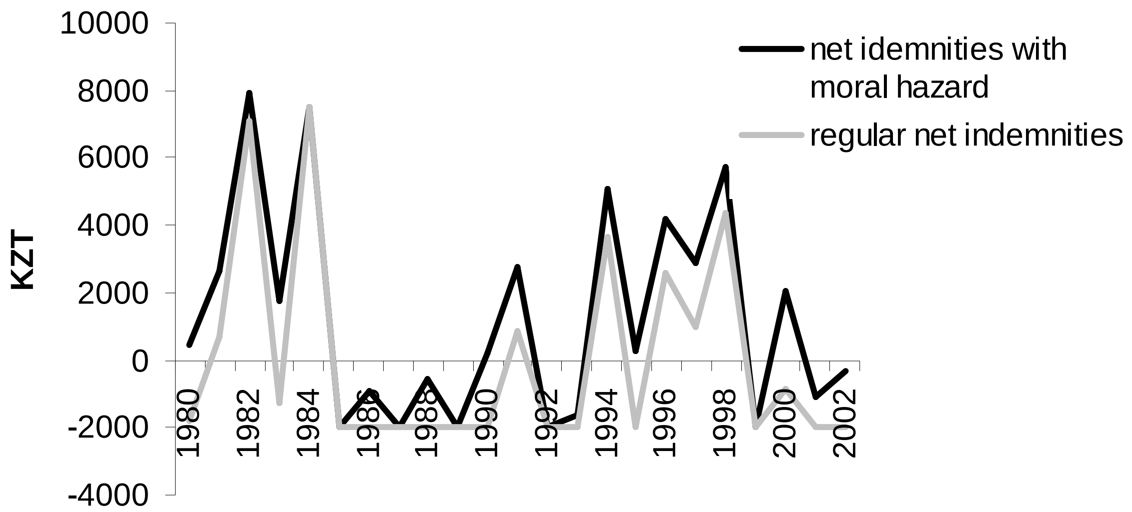
Figure 4-11: Net indemnities over time for different farm yield insurance strike levels with moral hazard (Example: Sunflowers in East Kazakhstan)



Source: Own estimations

The results are similar for the case farm in Akmola (Figure 4-12): The long-term average gain of shirking is 1261 KZT per ha for wheat and 1377 KZT per ha for barley. A detailed analysis with consideration of states of nature shows an expected result: The moral hazard gains are much larger in drier states compared to more favourable weather conditions because the medium and the extensive technology result in the same yield level in drought years, but average yields, which determine the indemnity level are comparatively higher for the medium-intensive technology. For wheat moral hazard gains are 7518 KZT in state 1, 4456 KZT in state 2, and 1909 KZT in state 3. For states 4 and 5, losses were estimated of 962 and 1983 KZT, respectively.

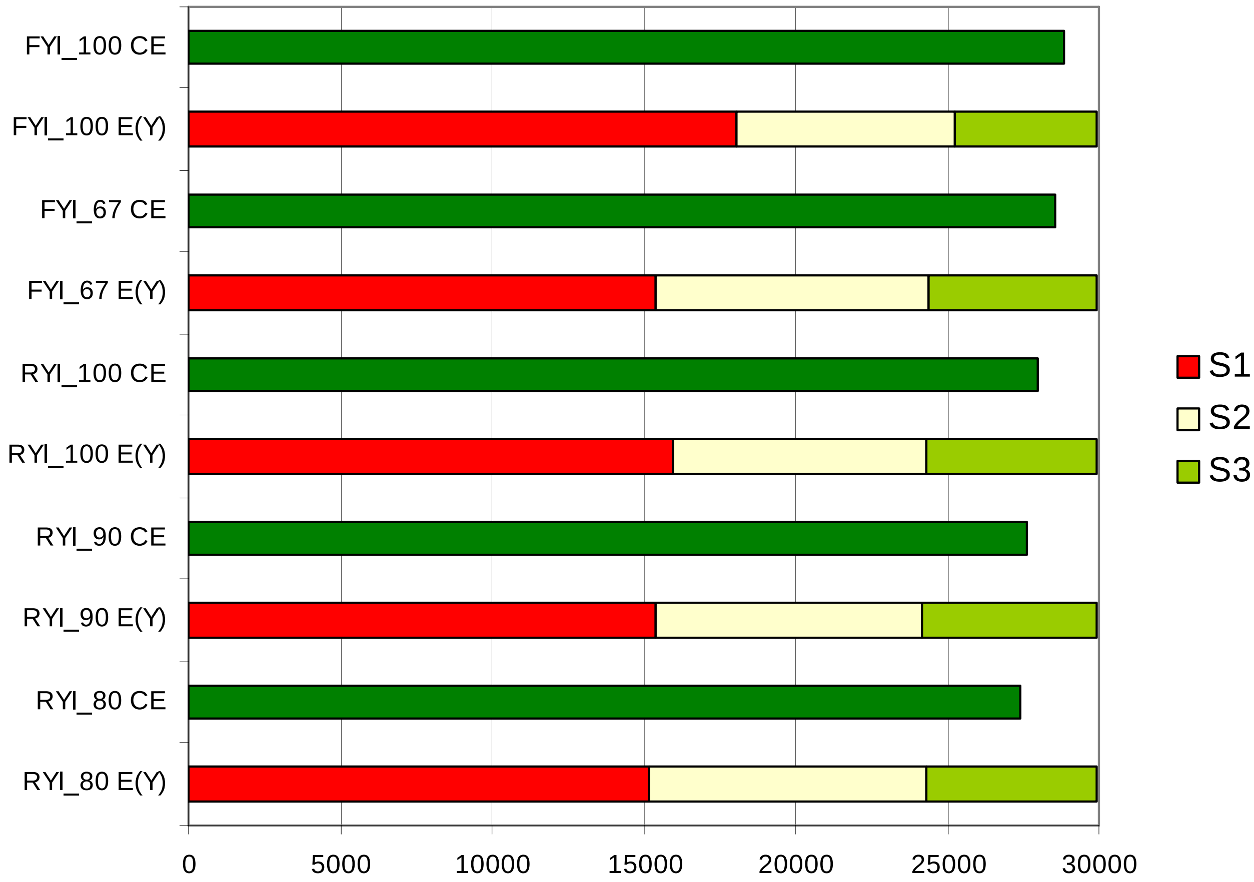
Figure 4-12: Net indemnity payments with and without moral hazard – Example switch from medium to extensive technology, wheat in Akmola



Source: Own estimations

Area-yield crop insurance has advantages in fighting moral hazard, but at a cost of providing lower variance reductions, which find their expression in lower certainty equivalents. Figure 4-13 compares two different types of insurance – farm yield insurance and area-yield insurance based on rayon-yields, both with pre-defined strike levels and both with a fair premium, which has the effect of an identical expected value. Under full coverage, the income in state 3 under favourable weather conditions is nearly equal for both types of insurance, the situation in the other two states looks different: Whereas farm-yield insurance provides a better income scheme in state 1, the same holds for rayon-yield insurance in state 2. The income distribution has an impact on the certainty equivalent. The difference in CEs across different insurance types could be interpreted as the risk premium a farmer would be willing to pay for purchasing a certain product. In our case, the difference in CE per ha between FYI_100 and RYI_100 is about 269 KZT. Conservatively interpreted, a farmer would be willing to pay 269 KZT more for farm-yield than for area-yield insurance. In practice, the positive risk reduction properties of individual farm-yield insurance products are outperformed by its relatively high administrative costs and the costs of moral hazard actions. Therefore, maximum strike is often limited to a maximum of 75 per cent, which at the same time has a drawback in limiting risk reduction. The graph gives insight in additional findings. Reductions in strike levels for farm and rayon yield insurance reduce certainty equivalents alike. Farm yield insurance with a strike level of 67 per cent outperforms rayon yield insurance with 100 per cent strike. This means that the strike yield for rayon yield insurance has to be significantly higher than farm yield strike level in order to achieve equivalent CEs.

Figure 4-13: Performance of rayon and farm yield insurance – East Kazakhstan



Source: Own estimations.

5 Summary of findings and conclusions

Kazakhstan's agricultural sector plays an important role in the country's economy. Not only does it function as an economic output producer, it also serves as a social buffer in times of transition to a market economy. The restructuring process had a strong impact on the economic performance of agricultural enterprises. As the state no longer functions as a back-up financier in times of economic downturn, farmers have to find their own sustainable instruments to manage business risks, which are significant in Kazakhstan due to the acute continental climate and the resulting revenue fluctuations. This chapter summarizes the most important findings generated throughout the research process and concludes with their implications for researchers and policy-makers.

5.1 Synthesizing lessons from the empirical findings

The results from empirical research are threefold. First, lessons from the farm survey results will be analysed. In a second step, the model findings will be discussed with regard to the practical implementation of the presented risk management instruments. Finally, the implications for current theory and future research will be presented.

5.1.1 Lessons from farm survey results

The investigation of production conditions, risk attitudes and risk management techniques was a central goal of the discussed farm survey. Analysis of the farm survey data allows to draw the following conclusions:

- A majority of farmers would like to insure their crops in the future.
- A majority would accept deductibles in insurance contracts, whose sustainable rate is about 25 per cent of the insurance sum.
- Besides natural hazards, among which the predominant role in the perception of farmers is played by drought, changes of prices for inputs and outputs are the major sources of business risk.
- The majority of interviewed farmers vote for insurance products against risks caused by natural hazards or income insurance.

- With respect to the constructed risk aversion index, the respondents can be classified as slightly risk-averse relative to other farmers.
- Risk-aversion and other factors influencing the decision-making process result in different risk-management strategies: Besides the application of risk-reducing technologies and cropping patterns, financial responses like maintaining credit reserves and off-farm employment, production responses, and reduction of costs are relevant risk-management instruments.

Conclusions, however, should be drawn carefully, since the average farmer age is relatively high and younger successors with different educational background will soon take over the management of the farm enterprises. This gives ground for assuming that knowledge dissemination on new technologies will yield fruits.

5.1.2 Lessons from model findings

As was discovered by LIEN and HARDAKER (2001) the variation of risk aversion has no great influence on the choice of risk management alternatives. Only in some cases the income distribution between different states of nature changes due to a switch between different strike levels. The relative insensitive model behaviour after changes in risk aversion coefficients can be partly attributed to the fully used hedging potential. Thus, the high number of technology and insurance activities increases the probability of the choice of those activities that retain their optimality under different risk aversion coefficients.

What can we conclude when the optimal farm plan is not changing much or at all if risk aversion is varied? PATTEN et al. (1988) perceive the relative inelasticity of the farm plan to risk aversion as a sign for the discriminative power of risk programming when risk aversion is limited to a plausible range. However, one might assume that risk aversion changes if a farmer perceives a technology as yield-stabilizing. This would affect the choice of insurance products.

Scenarios with a variation of own capital and credit access show a result that is prevalent in the real world: Agricultural areas remain unused or underutilized, because farmers are risk-averse and reduce the area cultivated if capital is lacking. This increases danger of erosion and desertification of unused and inappropriately used land.

Considering the utility-efficiency of different risk management instruments, we can conclude that the separate regional analysis was a reasonable procedure, because no general recommendations can be derived from the efficiency results. Therefore, conclusions regarding the utility-efficiency of the considered insurance instruments will be drawn regionally.

A large number of insurance products stabilises income efficiently as can be derived from the utility rankings. However, weather index insurance seems to be more appropriate (as can also be concluded from the variation coefficients) in Northern Kazakhstani grain production. This can be explained by the comparatively insufficient precipitation this region receives and the predominant role played by drought compared to other risks.

Area-yield insurance might be a reasonable alternative to weather insurance, since it provides a number of advantages in fighting moral hazard compared to farm yield insurance. Efficiency results as well as the analysis of variation coefficients show its applicability for East and South Kazakhstan conditions. However, the advantages providing better access to symmetric information should be evaluated against the potentially lower risk reduction. When introducing area-yield insurance, smaller areas (rayons) as the basis for the calculation of the underlying yield index are supposed to provide higher risk reductions than larger areas (oblasts).

According to the literature research and results derived by the farm survey, the testing of different revenue insurance is reasonable and particularly attractive for cotton farmers in South Kazakhstan, where price risk plays a predominant role.

A central conclusion can be derived for all considered study farms simultaneously. The choice of the production technology is the decisive factor in risk management (see also BOKUSHEVA anD HOCKMANN, 2006). The result can be connected to the evaluation of risk management responses of the farm survey. According to the interviewed farmers, the maintenance of capital reserves and production with low costs are two of the most important objectives in risk management. As results from the normative decision model show, these strategies are not ‘first best solutions’ for all considered farms. When crop production is insured, more intensive production technologies (with higher costs) might be more appropriate than low input technologies.

5.1.3 Implications for current theory and further research

Different crops show different reactions on a change in natural conditions. This made it difficult to formulate states of nature with consistent yield reactions on natural conditions and consistent income levels, respectively. The choice of wheat yields as an indicator for states of nature has pros and cons. On the one hand, it allows a consistent formulation of states of nature over all regions, because wheat is an important part of the crop portfolio in most crop production regions. On the other hand, the income balancing effects of other crops, such as cotton and sunflowers, are not reflected in the states of nature formulation. Furthermore, the model allows for a choice of technology according to the utility preferences of the decision-maker, which has a significant impact on the contribution of different activities to the whole-farm income. As shown by the model results in chapter 4.5.3, a change in technology might increase income in a less favourable state disproportionately compared to a more favourable state. This has the same effect as the described overcompensation of income by alternative crops. These findings provoke the question, how the method of state of nature formulation influences the model results. For future research, alternative methods could be applied to test if model validity can be further improved. One alternative method could be the use of different objective measures that form a state of nature, such as weather parameters and variables that reflect the institutional framework of agricultural production[55].

The objective of this contribution was to investigate the effects of different risk management strategies on the utility of model decision-makers. Because some of the risk management tools are new, decision-makers at this point may have difficulties evaluating the decisions modelled here. One might expect that as decision-makers become more familiar with the implications of these alternatives, they may exhibit greater readiness to utilize new combinations.

For further research, we can conclude that decision-making conditions and criteria vary across geographic regions and by farm type; thus, subsequent risk models should be adapted to the unique conditions of the research domain because standardized modelling formulations can produce spurious results. Obviously, a natural extension of this work is the investigation of other crops and regions. Future research should test the long-term economic potential of alternative crops under changing natural conditions and prices. Furthermore, different combinations of insurance with hedging products can be tested.

Existing regionally specific recommendations for crop production in Kazakhstan are mostly obsolete and a significant part of practical agricultural knowledge was lost with outmigration of experts. There is a need for sound research in the fields of agronomy and plant breeding in order to develop new technologies. On-farm research (WAGNER et al., 2005) combined with precision farming could be one relatively cost-effective way to create regionally adapted recommendations for crop production.

Furthermore, by means of panel data analysis, factors influencing diversification decisions of farmers could be investigated.

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[55] Examples for these proxy variables are market infrastructure, storage facilities, input and output prices.

5.2 Implications for policy design

This chapter discusses the most important findings of the analysis of the current crop insurance system in Kazakhstan and evaluates additional political instruments to support income stabilisation in agriculture.

5.2.1 Lessons from the analysis of the current crop insurance system

The current crop insurance system is the result of interaction of a number of factors such as farmers' demand for a sound risk management instrument, the government's wish to support the supply of crop insurance, political negotiations of different interest groups, and path-dependence with regard to former soviet agricultural insurance programmes. This mix of driving forces affected the accuracy of insurance objectives and design and caused several deficiencies of the system, such as monitoring and communication problems, insufficient provision of information to farmers and regional administration, and institutional problems (moral hazard and adverse selection, slow processing and high claim rejection rate, and lack of interest of potent insurance companies).

Mistakes have been made during the implementation of the new crop insurance scheme in Kazakhstan. Once a system with failures has been established, it takes time and money to improve it. This lesson can be learned from the long history of subsidisation in agriculture all over the world and from recent examples of crop insurance reforms in transition countries: In particular, at the end of 2005, Russia's Minister of Agriculture Alexei Gordeyev said, his ministry would radically reform Russia's subsidized crop insurance system in 2006. Four months later a ministry official informed the media that the previous procedures for providing subsidies in 2006 will be maintained (INTERFAX FOOD AND AGRICULTURE REPORT, 2006a, b).

When having the chance to build up a new system from scratch, particular effort should be put in developing a sound ratemaking procedure. In this respect, the efforts of the World Bank to establish a dense net of weather stations and to promote the introduction of weather-index insurance seem particularly promising. As the model results show, only a sufficiently dense net can reduce risk to a satisfactory level.

The hypothesis that crop insurance often supports only large-scale farmers cannot be rejected when investigating the data on crop insurance market development. One of the reasons for introducing mandatory crop insurance in Kazakhstan was to provide all farmers with access to insurance, regardless of their risk exposure or the size of their enterprises. However, insurance companies have less incentives to insure small, risk-prone farms. The future task of the government will be to find appropriate enforcement mechanisms to motivate insurance companies to provide insurance to small farms or to transform the mandatory system into a voluntary one.

A further government task involves breaking up the path dependence of crop insurance. The bad image of the entire insurance industry could be primarily overcome by setting right the legal framework, the incentives, and enforcement mechanisms. The objective would be to create an insurance system, in which insurance companies can generate profits with their clients experiencing justice and income stabilisation that provides a sound base for the development of economic activities. Therefore, the identification of preconditions for the establishment of the institution 'crop insurance' by the help of indicators could be a first step (s. HAVRYLYSHYN and VAN ROODEN, 2000).

5.2.2 Evaluation of alternative policy measures

Alternatives to crop insurance comprise the whole range of risk management instruments as discussed above. SCHLIEPER (1997) makes an interesting suggestion on the integration of crop insurance in an overall risk management framework. Based on thoughts of NOORGARD (1976), he proposes the coupling of extension service and insurance and assumes that the providers of insurance and extension services are identical. The coupling of both services would minimize asymmetric information and allow for a differentiation in premiums. A direct link between behaviour reflected in on-farm risk management and insurance tariffs would create incentives to apply risk-reducing technologies.

To strengthen the link between on-farm risk management and risk-sharing strategies, the government could promote research in agronomic methods to mitigate the effects of difficult growing conditions. Differences in agro-climatic environments such as soil type and fertility, moisture availability, distribution of weeds, and susceptibility to erosion should be better taken into consideration when developing new technology recommendations. Farmers will not adopt recommendations from the research system without the expectation that the costs of the recommendations will be balanced by their benefits. Therefore, researchers have to develop cost-effective technologies, which take into account the still strained financial situation of many agricultural enterprises. These recommendations possess the highest probability of success within the extension system.

As empirical findings from other countries, e.g. Iran (BAKHSHOODEH and SHAJARI, 2006) show, adoption of technology is strongly correlated with level of education and age. Extension classes, particularly designed for younger farmers could help to foster the speed of technology adoption.

When deciding about a future strategy for the agricultural sector, the concentration of agricultural production in favourable areas using regional comparative advantages, such as natural conditions, infrastructure and skilled labour has to be taken account. This policy is widely known as the forming of clusters (PORTER, 1990).

Additionally, policy-makers might facilitate access to credit through subsidizing interest rates. Credit reduces transactions costs and financial constraints on purchasing a new technology. Alternatives to the purchasing a new technology is renting and leasing. It allows smaller farmers to use, and less confident farmers to test, the technology (AKER et al., 2005). From that point of view, it might be reasonable for the government of Kazakhstan to continue the state-supported leasing programme for agricultural machinery.

A further project to be considered as worthwhile to be continued is the successive development of the grain marketing infrastructure. As described above, the Government of Kazakhstan invested considerable effort and financial means in grain marketing infrastructure within the country and abroad. Given the competitiveness of rainfed grain production in Northern Kazakhstan, this investment is assumed to pay off since global demand for grain is increasing.

A last point to be mentioned is the stability of the state itself. One might ask how political uncertainty affects agricultural risk management. Political uncertainty might indeed hamper the positive impact of international organisations' work on economic development, in that development projects will not be carried out and/or results of these projects will not be implemented. Furthermore, political uncertainty has a strong impact on foreign investments and the willingness of the international insurance and re-insurance industry to engage in a country. Kazakhstan's economic success is to a large extent dependent on the future political developments.

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Appendix

List of figures

List of tables

A-Appendix

Table A-1: Description of the survey components

Component	Objectives	Respondents	Number of respondents/ participants/ observations	Data character	Date
Structured expert interviews	- To define representative regions relevant for the study - To ascertain most relevant natural hazards, their character and extension - To specify conditions of insurability - To investigate possibilities to avoid principal/agent-problem	Deputies and members of the parliamentary working group on agricultural matters, representatives of insurance companies, scientists, staff of regional agricultural administrations and statistical offices.	13	Questionnaires with experts' responses	2003/09/01-2003/10/01
Workshop	- To inform political decision-makers and involved institutions about main issues regarding introduction of a crop insurance system - To discuss critical questions with respect to the results of the experts' interviews - To select the research regions	Staff of regional departments of agriculture and statistics, staff of insurance and re-insurance companies, members of committee on agrarian issues of Majilis (Kazakh parliament), researchers, representative of national farmers' union, farmers, representatives of grain trading companies	30	Voting results to the selected questions, discussion results summarised in tables and a protocol	2003/10/02
Farm survey	- To assess farmer's demand for crop insurance - To specify conditions for the farmer's participation in insurance - To define most relevant natural hazards, their character and extension	Farmers and managers of agricultural enterprises	73 (from 15 rayons in 6 oblasts)	Questionnaires with farmers' responses, accounting data on financial performance of the enterprises and production data focusing on crop production (from 1993 to 2002/2003 in the best case, but strongly varying across farms)	2003/09/15-2003/11/17 and 2004/05/10-2004/07/09

Component	Objectives	Respondents	Number of respondents/ participants/ observations	Data character	Date
Survey of secondary and meteorological data	- To evaluate weather impact on farm yields and to design weather-based insurance products	–	12 weather stations in five of the six selected oblasts	- Min/Max and average daily temperature, daily precipitation, humidity (time series ranging between beginning of the 20th century and 2003); additionally information on soil moisture (on the 18th of May – beginning of growing period) for two weather stations in Akmola oblast (1974-2003);	2003/09/15-2003/11/17 and 2004/05/10-2004/07/09
Survey of secondary data – production data and other data	- To estimate the magnitude of systemic risk and to design regionally adjusted insurance products - To gain insight into regional production conditions and the actual performance of the regional economies	–	15 rayons (time series from the 1960ies-2002/2003)	- Data on yields and crop areas on the farm level (former sovkhozes/kolkhozes and their largest successors); - Time series data on rayon average yields for the surveyed oblasts; - Additional time series on regional agricultural sectors, regional economic structures, population characteristics	2003/09/15-2003/11/17 and 2004/05/10-2004/07/09

Table A-2: Pesticide use 2004

Crops	Cultivated area (TA), kha	Treated area (TA), kha	% TA of CA	Yield, dt/ha	Crop share
Cereals	13,739	5,622	40.9%	11.9	78.8%
Cotton	200	200	100.0%	20	1.1%
Potatoes	164	50	30.5%	130	0.9%
Fruits	55	30	54.5%	36	0.3%
Corn	103	19	18.4%	41	0.6%
Soybeans	28	15	53.6%	14	0.2%
Rice	84	9	10.7%	40	0.5%
Sugar Beets	22	5	22.7%	240	0.1%
Sunflowers	447	0	0.0%	8.7	2.6%
Total	17,440	5,950	34.1%		100.0%

Source: BASF.

Table A-3: Share of agriculture (in per cent) in gross regional product

Area, city	Year					Mean
	2000	2001	2002	2003	2004	
Eastern region						
East-Kazakhstan	10.1	11.4	11.6	20.1	12.0	10.1
Western region						
Aktubinskaya	8.5	8.8	7.0	12.8	6.3	8.5
Atyrayskaya	2.1	2.5	1.9	1.3	1.2	2.1
Mangistauskaya	6.7	7.3	6.8	12.3	6.2	6.7
West-Kazakhstan	0.8	0.4	0.3	0.7	0.3	0.8
Northern region						
Akmolinskaya	28.2	36.2	33.7	59.5	32.9	28.2
Kostanayskaya	22.1	26.0	23.9	42.7	23.2	22.1
Pavlodarskaya	5.5	7.0	7.0	11.8	6.7	5.5
North-Kazakhstan	32.2	41.6	38.7	68.9	39.0	32.2
Central region						
Karagandinskaya	3.9	3.9	4.9	8.2	5.2	3.9
Southern region						
Almatinskaya	28.9	25.2	27.7	42.5	27.8	28.9
Djambulskaya	20.7	22.1	23.4	39.5	23.9	20.7
Kyzilordinsskaya	9.0	9.2	6.3	10.6	6.2	9.0
South-Kazakhstan	17.1	16.1	17.5	35.4	19.6	17.1
Astana	0.2	0.3	0.2	0.4	0.2	0.2
Almaty	0.3	0.1	0.0	0.1	0.1	0.3

Source: Own table based on OSTRIKOVA (2005).

Note: Research regions are marked in italics.

Table A-4: Characterisation of considered wheat production technologies in Akmolinskaya Oblast

Characteristics	**Technology I**	**Technology II**	**Technology III**
Total variable costs (KZT/ha)*	15,623	10,083	7,114
N input (kg/ha)	200	–	–
P input (kg/ha)	150	100	–
Costs of plant protection (KZT/ha)	1,440	480	–
Labour input (man-hours/ha)	4.95	4.37	3.50
Fuel input (kg/ha)	119	107	88
Snow collection	Yes (by mustard cultivation in fall)	Yes (2* mechanic. snow piling)	No
Expected. wheat yield (t/ha), (strong drought, p**=.04)	0.63	0.4	0.4
Expected wheat yield (t/ha), (average drought, p=.3)	1.08	0.6	0.5
Expected wheat yield (t/ha), (weak drought, p=.09)	1.19	0.9	0.7
Expected wheat yield (t/ha), (favourable weather conditions, p=.52)	1.45	1.01	0.85
Expected wheat yield (t/ha), (very fav. weather conditions, p=.04)	2.1	1.35	1.15

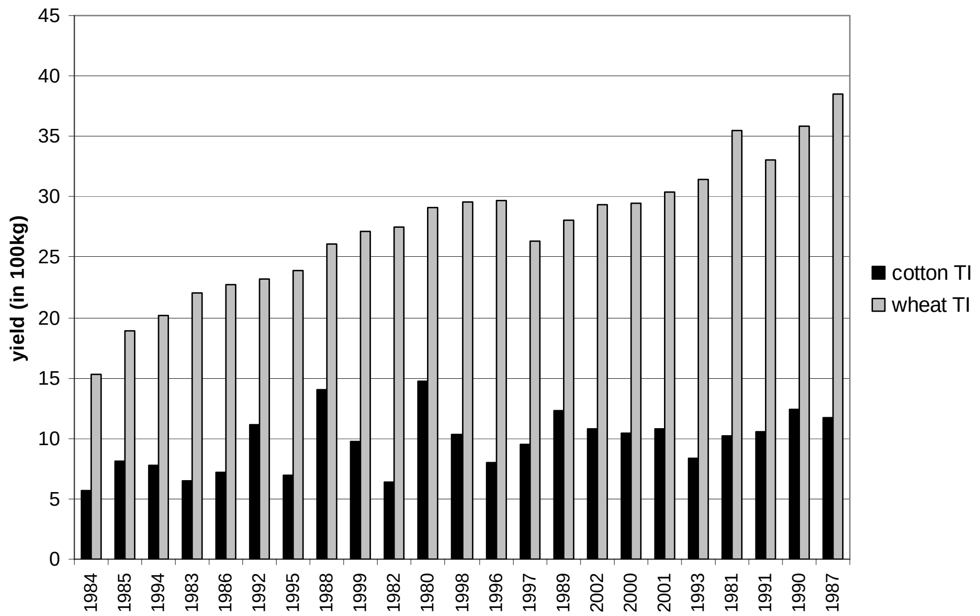
Notes: * Future variable costs might increase in Kazakhstan: Leading politicians plan to pay less subsidies for inputs, instead increase credit volume and reduce taxes for investments in processing and high-value added products (AGRA-EUROPE, 2005);
** p=probability.

Table A-5: Description of production technologies for wheat and sunflowers in East Kazakhstan

Crop	Wheat						Sunflowers					
Technology	I		II		III		I		II		III	
	Var. costs per ha	fuel input	Var. costs per ha	fuel input	Var. costs per ha	fuel input	Var. costs per ha	fuel input	Var. costs per ha	fuel input	Var. costs per ha	fuel input
Operation	KZT	kg/ha	KZT	kg/ha	KZT	kg/ha	KZT	kg/ha	KZT	kg/ha	KZT	kg/ha
Skim ploughing	1,000	20	1,000	20	1,000	20	1,000	20	1,000	20	1,000	20
Ploughing	2,000	25	2,000	25	2,000	25	2,000	25	2,000	25	2,000	25
Harrowing	500	15	500	15	500	15	500	15	500	15	500	15
Seedbed prep.	1,000	20	0	0	0	0	1,000	20	0	0	0	0
Levelling	800	20	0	0	0	0	800	20	0	0	0	0
Seedbed prep.	1,000	20	1,000	20	0	0	1,000	20	1,000	20	0	0
Harrowing	500	15	500	15	500	15	500	15	500	15	500	15
Seedbed prep.	0	0	0	0	0	0	1,000	20	1,000	20	0	0
Sowing	1,000	20	1,000	20	1,000	20	1,000	20	1,000	20	1,000	20
Fertilising	1,000	15	500	15	0	0	1,000	15	500	15	0	0
Application of herbicides	1,000	15	500	15	0	0	1,000	15	500	15	0	0
Harvest	1,500	20	1,500	20	1,500	20	1,500	20	1,500	20	1,500	20
Total		205		165		115		225		185		115
Total costs	11300	6150	8500	4950	6500	3450	12300	6750	9500	5550	6500	3450

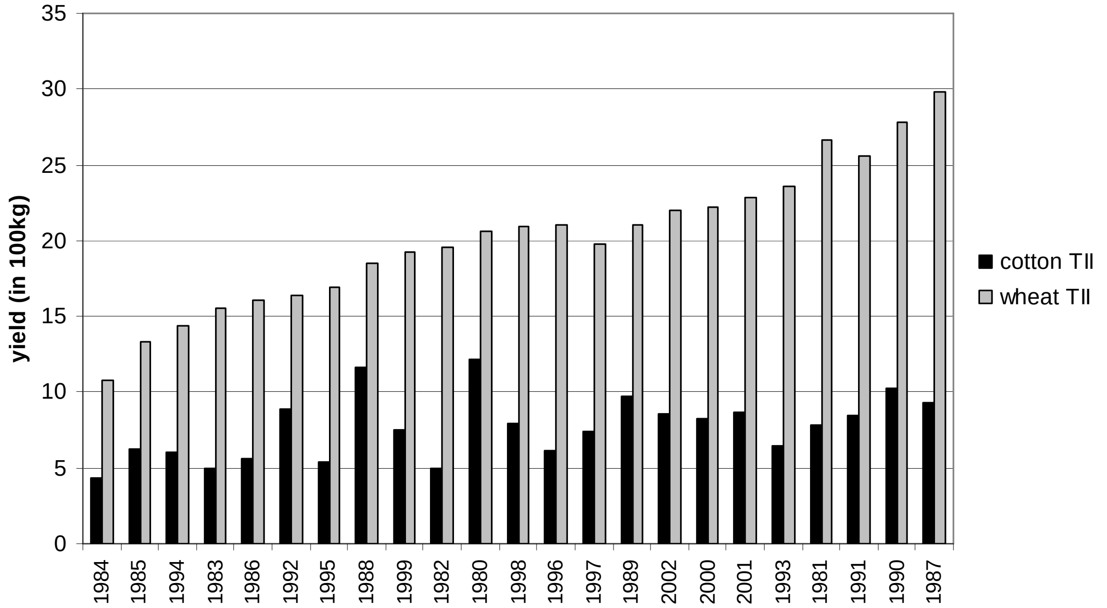
Note: Variable costs include machinery costs (25%), salary for the agronomist (25%), and salary for the tractor driver (50%)

Figure A-1: Cotton and wheat yield effects in different states of nature in Turkestan, South Kazakhstan applying an intensive



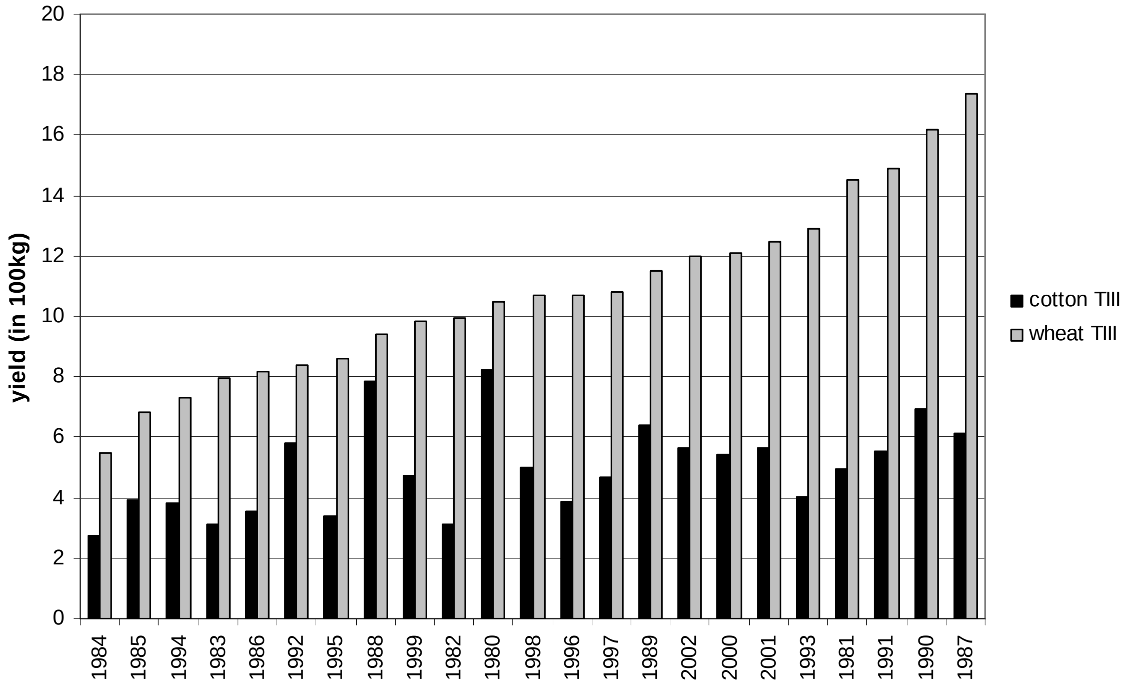
Source: Own figure.

Figure A-2: Cotton and wheat yield effects in different states of nature in Turkestan, South Kazakhstan applying a medium-intensive technology



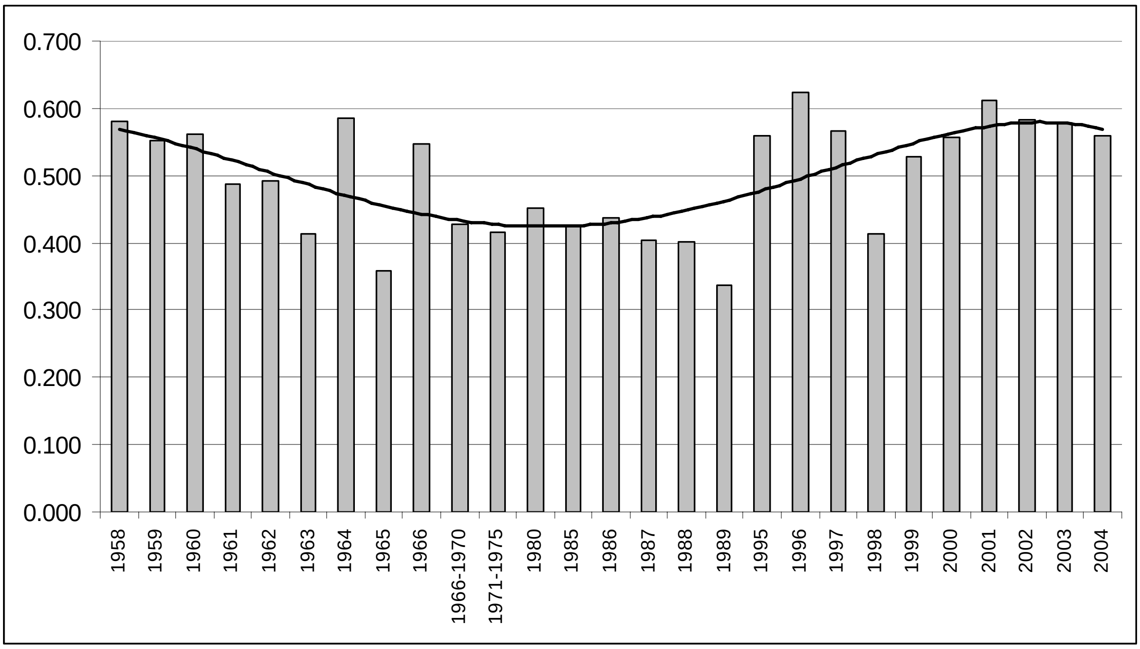
Source: Own figure.

Figure A-3: Cotton and wheat yield effects in different states of nature in Turkestan, South Kazakhstan applying an extensive technology



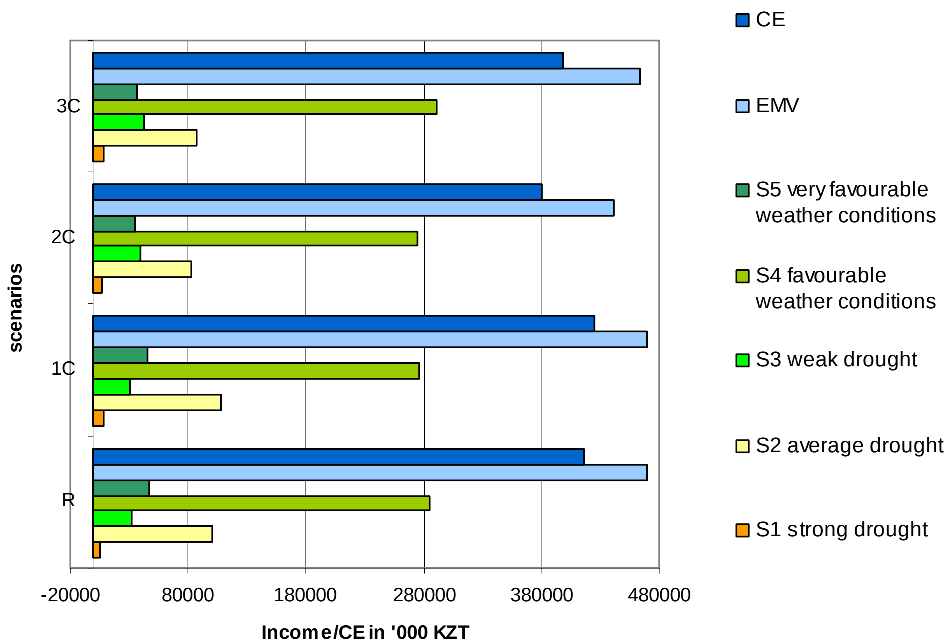
Source: Own figure.

Figure A-4: Share of crop production in total agricultural production over



Source: STATISTICAL YEARBOOK KAZAKHSTAN, various years.

Figure A-5: Income by states of nature, expected monetary value (EMV) and certainty equivalent (CE) for different scenarios – Study farm Akmola



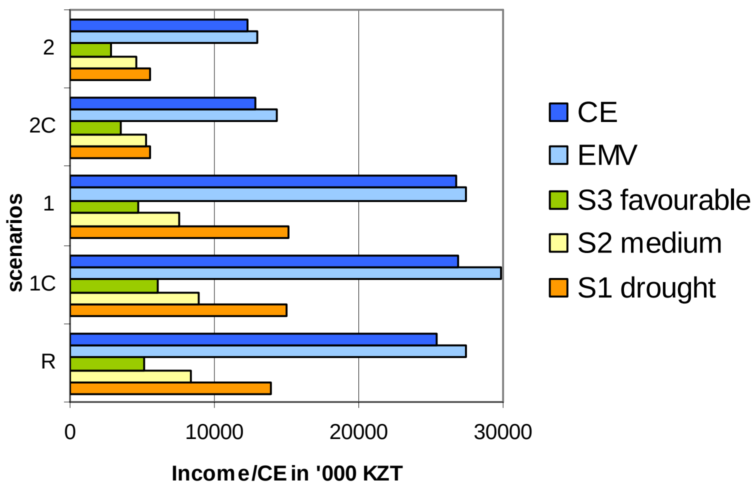
Source: Own figure.

Table A-6: Catalogue of drought years in the former Soviet Union (1950-1975)

			Region					
Number of drought affected regions	**Percentage of drought affected regions**	**Year**	**Ukraine**	**Volga Region**	**Central Tsher-nosem area**	**North Kau-kasus**	**Western Sibiria and Altai**	**North and Central Kaz.**
4	0.667	1950	X	X	X	X		
5	0.833	1951		X	X	X	X	X
2	0.333	1952	X				X	
3	0.500	1953	X				X	X
2	0.333	1954	X	X				
4	0.667	1955		X		X	X	X
1	0.167	1956		X				
4	0.667	1957	X	X		X		X
1	0.167	1958					X	
5	0.833	1959	X		X	X	X	X
0	0.000	1960						
1	0.167	1961	X					
1	0.167	1962					X	
6	1.000	1963	X	X	X	X	X	X
1	0.167	1964		X				
2	0.333	1965					X	X
0	0.000	1966						
5	0.833	1967		X	X	X	X	X
6	1.000	1968	X	X	X	X	X	X
0	0.000	1969						
0	0.000	1970						
1	0.167	1971						X
3	0.500	1972	X	X	X			
2	0.333	1973					X	X
2	0.333	1974					X	X
6	1.000	1975	X	X	X	X	X	X
		Number of drought years	11	12	8	9	14	13
		Percentage of drought years	0.42	0.46	0.31	0.35	0.54	0.50

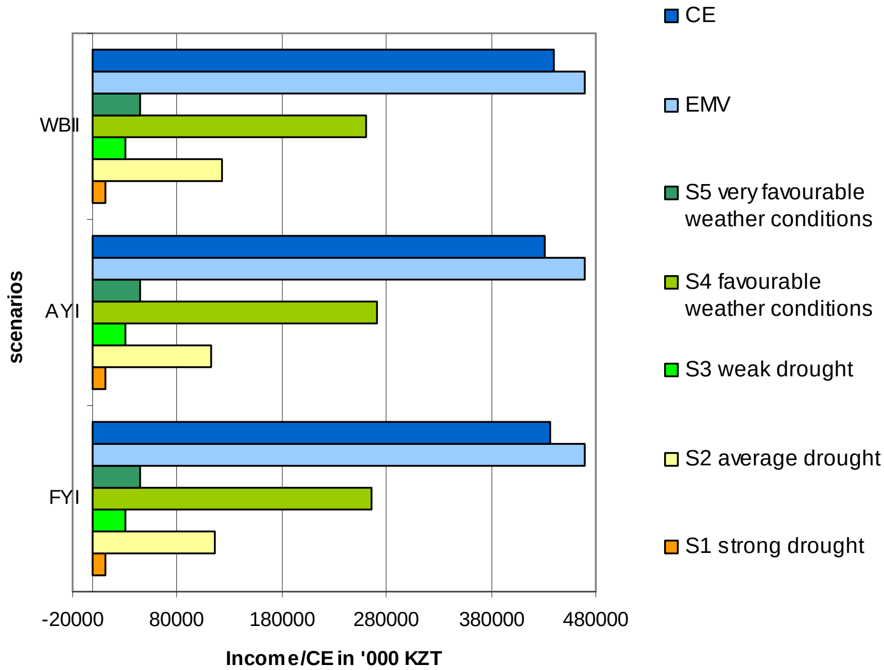
Source: Own formation; data based on RAUNER (1977).

Figure A-6: Income by states of nature, expected monetary value (EMV) and certainty equivalent (CE) for different scenarios – Study farm East Kazakhstan



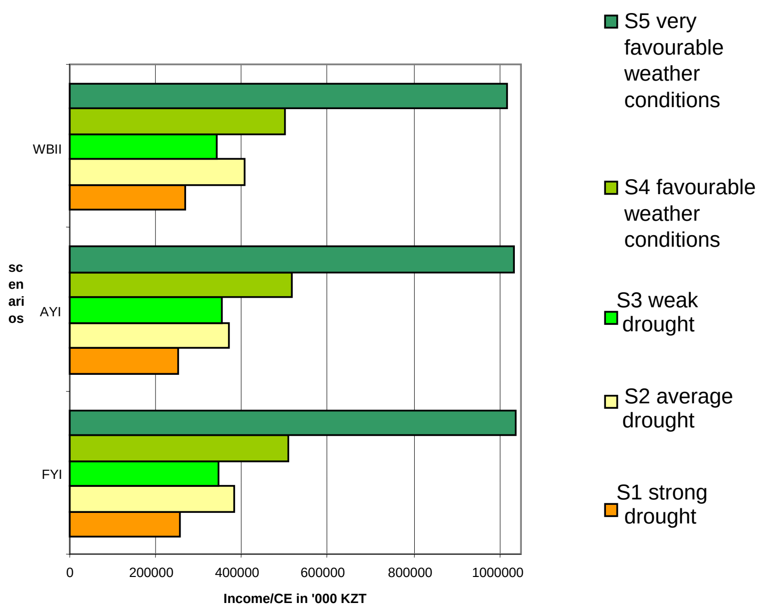
Source: Own figure.

Figure A-7: Income by states of nature, expected monetary value and certainty equivalent for different insurance products – Study farm Akmola



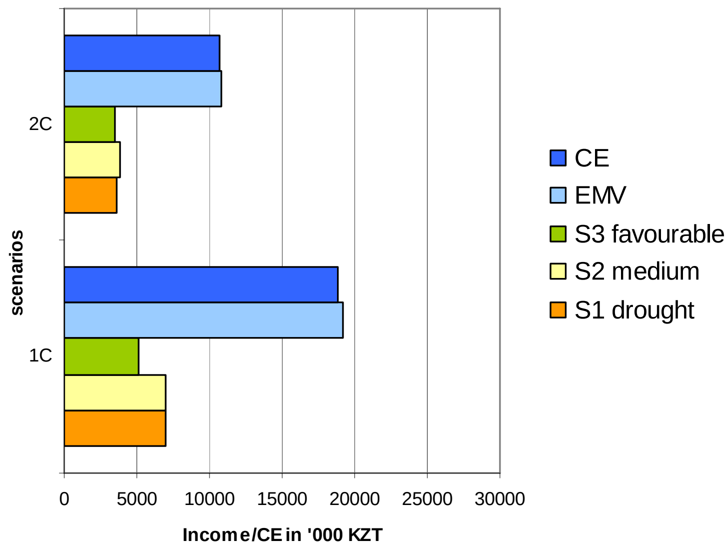
Source: Own figure.

Figure A-8: Income by normalised states of nature for different insurance products (WII=Selyaninov index insurance, AYI=Rayon yield insurance, FYI=Farm yield insurance) – Study farm Akmola



Source: Own figure.

Figure A-9: Income by states of nature, expected monetary value (EMV) and certainty equivalent (CE) for different scenarios – Study farm South Kazakhstan



Source: Own figure.

Table A-7: Ranking of investigated insurance products (IP) according to gross margin coefficients of variation (CV) – Akmola

Wheat	TI	Wheat	TII	Wheat	TIII	Barley	TI	Barley	TII	Barley	TIII
IP	CV	IP	CV	IP	CV	IP	CV	IP	CV	IP	CV
NYF_100	0.296	FYI_100	0.320	FYI_100	0.302	FYI_100	0.422	FYI_100	0.357	FYI_100	0.340
FYI_100	0.312	NYF_100	0.327	NYF_100	0.308	RF_100	0.422	RF_100	0.357	RFI_100	0.340
FYI_90	0.323	FYI_90	0.338	FYI_90	0.317	FYI_90	0.447	FYI_90	0.392	FYI_90	0.373
RYI_100	0.324	Sel_100	0.338	Sel_100	0.320	RF_90	0.447	RF_90	0.392	RFI_90	0.373
Sel_100	0.326	Sel_90	0.339	Sel_90	0.321	NYF_100	0.459	FYI_80	0.429	FYI_80	0.408
Sel_90	0.326	Sel_67	0.339	Sel_67	0.321	FYI_80	0.473	RF_80	0.429	RF_80	0.408
Ped_100	0.327	Sel_80	0.340	Ped_100	0.322	RF_80	0.473	NYF_100	0.440	NYF_100	0.419
Ped_90	0.327	Sel_75	0.340	Ped_90	0.322	Ped_80	0.478	Ped_80	0.441	Ped_75	0.419
Sel_80	0.327	Ped_100	0.341	Sel_80	0.323	Ped_75	0.478	Ped_75	0.441	Ped_80	0.419
Sel_75	0.327	Ped_90	0.341	Sel_75	0.323	Ped_100	0.481	Ped_100	0.443	Ped_100	0.421
Sel_67	0.328	Ped_80	0.342	Ped_80	0.324	Ped_90	0.483	Ped_90	0.444	Ped_90	0.422
Ped_80	0.328	Ped_75	0.342	Ped_75	0.324	Ped_67	0.485	Sel_90	0.445	Sel_90	0.424
Ped_75	0.328	Ped_67	0.342	Ped_67	0.324	FYI_75	0.485	Sel_100	0.445	Sel_100	0.424
Ped_67	0.328	RFI_90	0.346	RFI_90	0.328	RFI_75	0.485	FYI_75	0.447	FYI_75	0.425
RF_90	0.329	RF_100	0.346	RF_100	0.328	Sel_100	0.493	RF_75	0.447	RFI_75	0.425
RF_100	0.329	RF_80	0.347	RF_80	0.330	Sel_90	0.493	Ped_67	0.452	Ped_67	0.431
RYI_90	0.330	RF_75	0.347	RF_75	0.330	Sel_67	0.494	Sel_80	0.453	Sel_75	0.431
RF_80	0.330	RYI_100	0.352	FYI_80	0.334	Sel_80	0.500	Sel_75	0.453	Sel_80	0.431
RF_75	0.330	FYI_80	0.357	RYI_100	0.337	Sel_75	0.500	Sel_67	0.455	Sel_67	0.433
FYI_80	0.333	RYI_90	0.358	RYI_90	0.339	FYI_67	0.502	RYI_100	0.463	RYI_100	0.441
RF_67	0.337	RF_67	0.361	FYI_75	0.343	RF_67	0.502	FYI_67	0.471	FYI_67	0.448
FYI_75	0.338	FYI_75	0.368	RF_67	0.347	RYI_100	0.505	RF_67	0.471	RFI_67	0.448
RYI_80	0.338	RYI_80	0.369	RYI_80	0.348	OYI_100	0.506	OYI_100	0.474	OYI_100	0.451
RYI_75	0.343	RYI_75	0.376	RYI_75	0.354	NYI_100	0.512	RYI_90	0.475	RYI_90	0.452
FYI_67	0.346	FYI_67	0.383	FYI_67	0.358	RYI_90	0.512	NYI_100	0.485	NYI_100	0.462
RYI_67	0.349	RYI_67	0.388	RYI_67	0.364	OYI_90	0.514	OYI_90	0.486	OYI_90	0.462
NYI_100	0.365	NYI_100	0.417	NYI_100	0.395	RYI_80	0.520	RYI_80	0.486	RYI_80	0.463
OYI_100	0.370	NYI_90	0.446	NYI_90	0.424	NYI_90	0.520	RYI_75	0.491	RYI_75	0.467
OYI_90	0.378	OYI_100	0.448	OYI_90	0.428	OYI_80	0.522	NYI_90	0.497	NYI_90	0.473
NYI_90	0.384	OYI_90	0.451	OYI_100	0.430	RYI_75	0.522	RYI_67	0.498	RYI_67	0.474
OYI_80	0.388	OYI_80	0.459	OYI_80	0.435	–	0.525	OYI_80	0.498	OYI_80	0.474
NYI_80	0.394	NYI_80	0.461	NYI_80	0.437	OYI_75	0.526	OYI_75	0.504	OYI_75	0.480
–	0.395	NYI_75	0.470	NYI_75	0.445	RYI_67	0.526	–	0.510	NYI_80	0.486
OYI_75	0.396	OYI_75	0.470	OYI_75	0.446	NYI_80	0.529	NYI_80	0.510	OYI_67	0.487
NYI_75	0.399	–	0.471	–	0.448	OYI_67	0.531	OYI_67	0.511	–	0.487
NYI_67	0.403	NYI_67	0.479	NYI_67	0.455	NYI_75	0.532	NYI_75	0.515	NYI_75	0.490
						NYI_67	0.535	NYI_67	0.519	NYI_67	0.494

Source: Own calculations.

Table A-8: Ranking of investigated insurance products (IP) according to coefficients of variation (CV) – East Kazakhstan

Wheat	TI	Wheat	TII	Wheat	TIII	Sunflow.	TI	Sunflow.	TII	Sunflow.	TIII
IP	CV	IP	CV	IP	CV	IP	CV	IP	CV	IP	CV
FYI_100	0.250	FYI_100	0.275	FYI_100	0.167	NYI_90	0.413	RYI_100	0.416	NYI_90	0.264
FYI_90	0.385	FYI_90	0.389	FYI_90	0.169	RYI_90	0.415	NYI_100	0.421	–	0.268
FYI_80	0.462	FYI_80	0.445	FYI_80	0.201	NYI_100	0.416	FYI_100	0.434	NYI_80	0.268
FYI_75	0.484	FYI_75	0.460	FYI_75	0.213	–	0.417	NYI_90	0.436	RYI_80	0.269
FYI_67	0.508	OYI_100	0.472	FYI_67	0.228	NYI_80	0.417	RYI_90	0.438	RYI_90	0.272
OYI_100	0.519	Ped_100	0.475	Sel_90	0.266	RYI_80	0.419	FYI_90	0.442	NYI_100	0.278
Ped_100	0.522	FYI_67	0.476	Ped_100	0.267	FYI_67	0.431	FYI_67	0.443	FYI_67	0.298
Sel_100	0.524	Sel_100	0.476	Sel_100	0.267	RYI_100	0.439	NYF_100	0.444	FYI_75	0.316
RF_100	0.526	RF_100	0.478	Ped_90	0.268	FYI_75	0.440	FYI_75	0.445	RYI_100	0.318
RF_90	0.526	RF_90	0.479	RF_90	0.268	FYI_80	0.449	FYI_80	0.447	FYI_80	0.329
OYI_90	0.537	OYI_90	0.487	OYI_100	0.270	FYI_90	0.459	NYI_80	0.455	FYI_90	0.354
Ped_90	0.540	Ped_90	0.493	OYI_80	0.270	NYF_100	0.463	RYI_80	0.455	NYF_100	0.360
RYI_100	0.540	Sel_90	0.493	OYI_75	0.271	FYI_100	0.465	–	0.456	FYI_100	0.381
Sel_90	0.540	RYI_100	0.494	OYI_90	0.271						
OYI_80	0.546	OYI_80	0.496	OYI_67	0.272						
OYI_75	0.551	OYI_75	0.501	–	0.272						
OYI_67	0.558	OYI_67	0.508	RF_100	0.273						
NYI_67	0.565	NYI_67	0.515	NYI_67	0.273						
RYI_90	0.566	–	0.516	RYI_80	0.276						
–	0.566	RYI_80	0.516	NYI_75	0.283						
RYI_80	0.567	RYI_90	0.516	NYI_80	0.293						
NYI_75	0.571	NYI_75	0.522	RYI_90	0.296						
NYI_80	0.577	NYI_80	0.528	NYI_90	0.312						
NYI_90	0.587	NYI_90	0.540	RYI_100	0.315						
NYI_100	0.603	NYI_100	0.554	NYI_100	0.333						
NYF_100	0.712	NYF_100	0.644	NYF_100	0.426						

Source: Own calculations.

Table A-9: Ranking of investigated insurance products (IP) according to coefficients of variation (CV) – South Kazakhstan

Wheat	TI	Wheat	TII	Wheat	TIII	Cotton	TI	Cotton	TII	Cotton	TIII
IP	CV	IP	CV	IP	CV	IP	CV	IP	CV	IP	CV
FYI_100	0.419	FYI_100	0.493	FYI_100	1.891	FYI_100	0.389	FYI_90	0.621	FYI_80	1.784
FYI_90	0.484	FYI_90	0.591	FYI_90	2.257	FYI_90	0.435	FYI_100	0.657	FYI_90	1.793
OYI_100	0.543	OYI_100	0.685	FYI_80	2.672	RYI_100	0.544	FYI_80	0.783	FYI_75	1.900
FYI_80	0.550	FYI_80	0.685	RYI_100	2.854	FYI_80	0.583	RYI_100	0.792	FYI_67	2.154
RYI_100	0.553	RYI_100	0.691	FYI_75	2.871	FYI_75	0.650	FYI_75	0.868	NYI_90	2.243
OYI_90	0.554	OYI_90	0.695	OYI_90	2.901	NYI_100	0.660	NYI_100	0.904	NYI_100	2.253
OYI_80	0.569	OYI_80	0.715	OYI_80	2.908	RYI_90	0.676	RYI_90	0.943	RYI_67	2.267
RYI_90	0.578	FYI_75	0.726	OYI_75	2.943	FYI_67	0.740	FYI_67	0.991	RYI_100	2.329
FYI_75	0.578	RYI_90	0.727	OYI_100	2.959	RYI_75	0.751	NYI_90	1.013	RYI_75	2.338
OYI_75	0.579	OYI_75	0.727	RYI_90	2.992	RYI_80	0.753	RYI_75	1.020	RYI_90	2.384
OYI_67	0.593	OYI_67	0.746	OYI_67	3.004	NYI_90	0.755	RYI_67	1.024	–	2.395
RYI_80	0.607	RYI_80	0.767	FYI_67	3.083	RYI_67	0.761	RYI_80	1.032	FYI_100	2.422
FYI_67	0.610	FYI_67	0.770	RYI_80	3.167	–	0.805	–	1.084	RYI_80	2.440
RYI_75	0.617	RYI_75	0.780	RYI_75	3.216						
NYI_100	0.625	NYI_100	0.791	NYI_67	3.275						
NYI_90	0.631	NYI_90	0.798	NYI_75	3.276						
RYI_67	0.632	RYI_67	0.801	NYI_80	3.285						
NYI_80	0.635	NYI_80	0.804	NYI_90	3.294						
NYI_75	0.637	NYI_75	0.806	RYI_67	3.303						
NYI_67	0.638	NYI_67	0.808	NYI_100	3.308						
–	0.643	–	0.815	–	3.314						

Source: Own calculations.

Table A-10: Variance reductions of selected risk management instruments by means of second-degree stochastic dominance (SSD) and mean-variance analysis (MV)

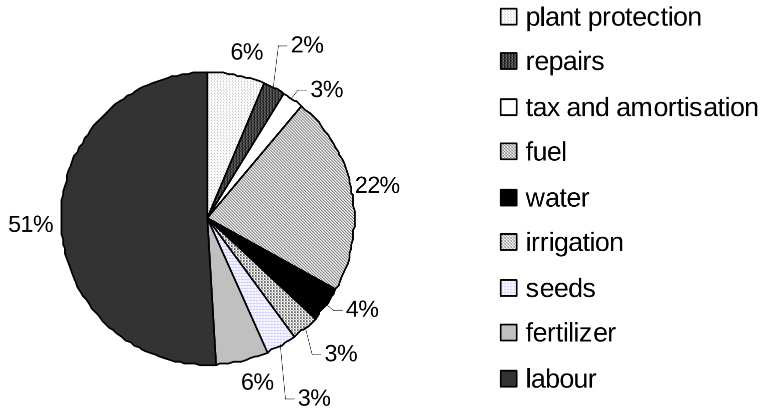
Tselinograd		Novoishim		Glubokoe	
Instrument	Variance reduction	Instrument	Variance reduction	Instrument	Variance reduction
FarmYI100SSD	0.627	FarmYI100SSD	0.62	FarmYI100SSD	0.717
FarmYI100MV	0.627	FarmYI100MV	0.62	FarmYI100MV	0.717
FarmYI90SSD	0.518	RYI_100SSD	0.531	FarmYI90SSD	0.452
FarmYI90MV	0.518	RYI_100MV	0.531	FarmYI90MV	0.452
RYI_100MV	0.438	FarmYI90SSD	0.509	OYI_100MV	0.36
RYI_100SSD	0.427	FarmYI90MV	0.509	Sel_100farmMV	0.336
N_Futures100SSD	0.408	N_Futures100SSD	0.507	RYI_100MV	0.323
N_Futures100MV	0.408	N_Futures100MV	0.507	RF_100farmMV	0.321
FarmYI80SSD	0.393	Sel_100farmSSD	0.485	Ped_100farmMV	0.32
FarmYI80MV	0.393	Sel_100farmMV	0.485	OYI_90MV	0.308
RYI_90MV	0.374	Sel_90farmSSD	0.476	Sel_90farmMV	0.284
OYI_100MV	0.365	Sel_90farmMV	0.476	Ped_100farmSSD	0.274
RYI_90SSD	0.359	RYI_90SSD	0.474	RYI_100SSD	0.27
RYI_80MV	0.335	RYI_90MV	0.474	RF_90farmMV	0.265
OYI_90MV	0.334	Ped_100farmSSD	0.461	OYI_75MV	0.255
Ped_100farmMV	0.332	Ped_100farmMV	0.461	OYI_80MV	0.254
Ped_90farmMV	0.329	RF_100farmSSD	0.461	Sel_100farmSSD	0.24
FarmYI75SSD	0.327	RF_100farmMV	0.461	Ped_90farmMV	0.235
FarmYI75MV	0.327	RF_90farmSSD	0.452	OYI_100SSD	0.234
RYI_67MV	0.321	RYI_80SSD	0.44	FarmYI80SSD	0.233
RYI_75MV	0.321	RYI_80MV	0.44	FarmYI80MV	0.233
Sel_100farmMV	0.306	RYI_75SSD	0.427	OYI_67MV	0.231
Ped_100farmSSD	0.305	RYI_75MV	0.427	RF_100farmSSD	0.23
Ped_90farmSSD	0.305	Sel_80farmMV	0.427	Sel_90farmSSD	0.23
RF_90farmMV	0.298	Ped_90farmSSD	0.425	RYI_90MV	0.213
Sel_100farmSSD	0.294	Ped_90farmMV	0.425	OYI_90SSD	0.2
RF_100farmMV	0.291	RYI_67SSD	0.416	RF_90farmSSD	0.192
OYI_100SSD	0.29	RYI_67MV	0.416	Ped_90farmSSD	0.172
Sel_90farmMV	0.282	RF_80farmMV	0.394	FarmYI75SSD	0.162
Ped_80farmMV	0.281	RF_90farmMV	0.394	FarmYI75MV	0.162
OYI_90SSD	0.279	Ped_80farmSSD	0.392	OYI_80SSD	0.154
RYI_80SSD	0.277	Ped_80farmMV	0.392	OYI_75SSD	0.153
RYI_67SSD	0.276	OYI_90SSD	0.391	RYI_90SSD	0.139
Ped_80farmSSD	0.272	OYI_90MV	0.391	OYI_67SSD	0.129
RYI_75SSD	0.27	OYI_100SSD	0.384	RF_80farmMV	0.128
RF_100farmSSD	0.262	OYI_100MV	0.384	Ped_80farmMV	0.124
Ped_75farmMV	0.248	FarmYI80SSD	0.38	Sel_80farmMV	0.124
Sel_90farmSSD	0.247	FarmYI80MV	0.38	FarmYI67SSD	0.09

Tselinograd		Novoishim		Glubokoe	
Instrument	Variance reduction	Instrument	Variance reduction	Instrument	Variance reduction
NYI_100MV	0.245	Sel_80farmSSD	0.374	FarmYI67MV	0.09
Sel_80farmMV	0.236	Sel_75farmMV	0.365	Sel_80farmSSD	0.09
RF_90farmSSD	0.233	Ped_75farmSSD	0.362	RF_80farmSSD	0.088
OYI_80MV	0.229	Ped_75farmMV	0.362	Ped_80farmSSD	0.087
FarmYI67SSD	0.224	RF_80farmSSD	0.346	RYI_80MV	0.064
FarmYI67MV	0.22	RF_75farmMV	0.335	NYI_100MV	0.043
NYI_100SSD	0.218	Sel_75farmSSD	0.323	N_Futures100MV	0.034
Sel_75farmMV	0.217	FarmYI75SSD	0.322	NYI_90MV	0.03
RF_80farmMV	0.206	FarmYI75MV	0.322	NYI_67MV	0.029
Sel_80farmSSD	0.205	OYI_80MV	0.298	Ped_75farmMV	0.027
Ped_75farmSSD	0.195	RF_75farmSSD	0.293	NYI_75MV	0.025
NYI_90MV	0.173	Ped_67farmMV	0.267	NYI_80MV	0.025
OYI_80SSD	0.168	Ped_67farmSSD	0.252	RYI_80SSD	0.024
Sel_75farmSSD	0.166	NYI_100MV	0.247	RF_75farmMV	0.024
RF_75farmMV	0.163	NYI_100SSD	0.242	Sel_75farmSSD	0.024
OYI_75MV	0.16	FarmYI67SSD	0.241	Ped_67farmMV	0.017
NYI_80MV	0.155	FarmYI67MV	0.241	RF_67farmMV	0.017
RF_80farmSSD	0.14	OYI_80SSD	0.239	NYI_67SSD	0.014
OYI_67MV	0.136	Sel_67farmMV	0.239	NYI_75SSD	0.013
Sel_67farmMV	0.127	RF_67farmMV	0.221	NYI_80SSD	0.013
NYI_90SSD	0.122	OYI_75MV	0.206	NYI_90SSD	0.012
RF_67farmMV	0.122	NYI_90MV	0.169	RYI_75MV	0.007
NYI_75MV	0.117	Sel_67farmSSD	0.141	N_Futures100SSD	0
NYI_80SSD	0.106	OYI_67MV	0.139	NYI_100SSD	0
OYI_75SSD	0.097	OYI_75SSD	0.137	RYI_67SSD	0
NYI_75SSD	0.094	NYI_80MV	0.123	RYI_67MV	0
Ped_67farmMV	0.092	RF_67farmSSD	0.123	RYI_75SSD	0
OYI_67SSD	0.091	NYI_90SSD	0.116	Ped_67farmSSD	0
RF_75farmSSD	0.077	OYI_67SSD	0.105	Ped_75farmSSD	0
NYI_67MV	0.06	NYI_80SSD	0.097	RF_67farmSSD	0
Sel_67farmSSD	0.053	NYI_75MV	0.081	RF_75farmSSD	0
Ped_67farmSSD	0.05	NYI_75SSD	0.047	Sel_67farmSSD	0
NYI_67SSD	0.026	NYI_67MV	0.026	Sel_67farmMV	0
RF_67farmSSD	0.02	NYI_67SSD	0	Sel_75farmMV	0

Source: Own estimations based on BOKUSHEVA et al., 2006.

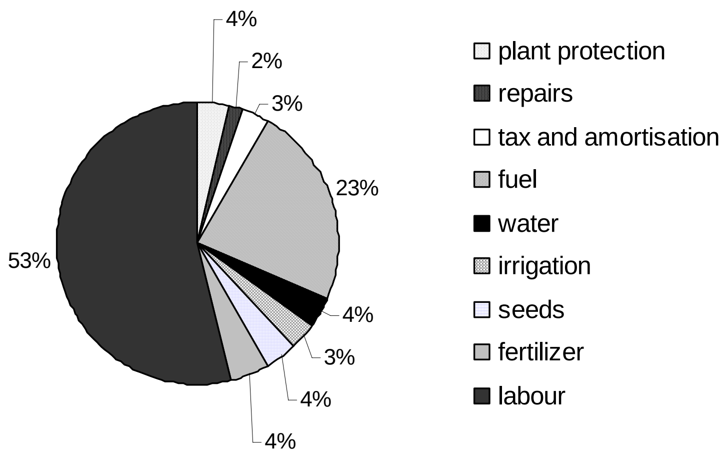
Note: Results are sorted according to the size of the variance reduction.

Figure A-10: Distribution of variable production costs – Cotton production, technology I, South Kazakhstan



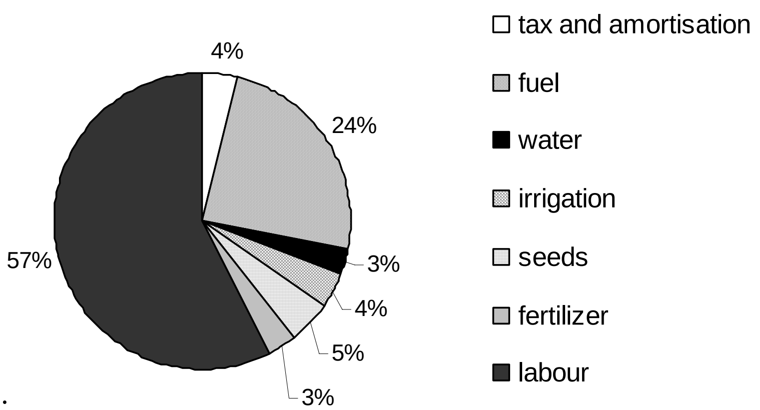
Source: Own figure.

Figure A-11: Distribution of variable production costs – Cotton production, technology II, South Kazakhstan



Source: Own figure.

Figure A-12: Distribution of variable production costs – Cotton production, technology III, South Kazakhstan



Source: Own figure.

Table A-11: Technology (T) and insurance product choices – Study farm Akmola including livestock production

No.	CE ('000 KZT)	Utility-ranking*	Expected Monetary Value ('000 KZT	Risk Premium	Scenario	Subscenario	Crop production: T	Wheat: Insurance product	Wheat: Area (ha)	Barley: Insurance product	Barley: Area (ha)	Fallow (ha)	Livestock production: T	Dairy cows	T	Cattle	T	Horses
1	509,396	1.000	537,790	0.055	1C	only FYI_100	I	FYI_100	17,636	FYI_100	8,818	8,818	III	246	I	1,000	II	400
2	507,833	0.997	537,790	0.059	1C	only WII	I	Sel_75	17,636	RF_100	8,818	8,818	III	246	I	1,000	II	400
3	507,180	0.996	537,790	0.060	1C	only RF	I	RF_100	17,636	RF_100	8,818	8,818	III	246	I	1,000	II	400
4	506,998	0.995	537,790	0.061	1C	only FYI	I	FYI_75	17,636	FYI_100	8,818	8,818	III	246	I	1,000	II	400
5	504,323	0.990	537,790	0.066	1C	only NYI_futures	I	NYF	17,636	NYF	8,818	8,818	III	246	I	1,000	II	400
6	502,822	0.987	537,790	0.070	1C	only Sel	I	Sel_100	17,636	Sel_100	8,818	8,818	III	246	I	1,000	II	400
7	502,816	0.987	537,790	0.069	1C	only Ped	I	Ped_67	17,636	Ped_100	8,818	8,818	III	246	I	1,000	II	400
8	502,411	0.986	537,790	0.070	1C	FYI_75 + lower	I	FYI_75	17,636	FYI_75	8,818	8,818	III	246	I	1,000	II	400
9	499,756	0.981	537,790	0.076	1C	only AYI	I	NYF	17,636	NYI_67	8,818	8,818	III	246	I	1,000	II	400
10	490,909	0.964	537,790	0.096	1C	only NYI	I	NYI_100	17,636	NYI_67	8,818	8,818	III	246	I	1,000	II	400
11	484,079	0.950	537,790		R	reference	I	–	17,636	–	8,818	8,818	III	246	I	1,000	II	400
12	399,957	0.785	412,585	0.032	2C	only FYI_100	II	FYI_100	17,636	FYI_100	8,818	8,818	III	246	I	1,000	II	400
13	392,644	0.771	402,767	0.026	3C	only FYI_100	III	FYI_100	17,636	FYI_100	8,818	8,818	III	246	I	1,000	II	400

Note: * Calculated as percentage of the highest attainable CE.

B-Appendix

Leibniz Institute of Agricultural Development in Central and Eastern Europe,Halle/Germany and
Agricultural University, Astana/Kazakhstan

CROP INSURANCE IN KAZAKHSTAN:
Options for Building a Sound Institution
Promoting Agricultural Production

On-Farm-Questionnaire

Farm name: ____________________ Number of questionnaire________
Farm specialization: ____________ Enumerated by________________
Type of enterprise: _____________ Date __________________________
LTD: 32(43.8%),
Individual Farm: 26(35.6%),
Producer Cooperative: 14(19.2%),
State Enterprise: 1(1.4%)

Rayon:________________________
Oblast:________________________
Year of Foundation: Min: 1988, Max: 2003, Mean: 1998

How is your crop area assembled?

Former Sowchos/Kolchos	**Area (in ha)**	**Average yield power**	**Year of purchase**
	Min: 3	*Min: 12*	
	Max: 77540	*Max: 66*	
	Mean: 9248	*Mean: 39*	

Confidentiality
This interview is anonymous. Farm data will not be given out to anybody. In the report only numbers of the farms will be mentioned!

1. Personal Data

1.1 Name of the interview partner:______________________________________

1.2 Age: *Min: 33, Max: 70, Mean: 51, St. Dev.: 9.17*

1.3 Telephone number: ____________________

1.4 Is the farm headed by a manager or is it a family farm?

1. o headed by manager (or group of managers) *29 (40.3%)*

2. o family farm *24 (33.3%)*

3. o other *shareholder* (Please, indicate) *19 (26.4%)*

1.5 What is the highest level of formal schooling/ university completed by you? **Code**	1.6 Have you achieved any agricultural education/ qualification? **Code**	1.7 Have you taken any additional professional training courses after schooling/ higher education **Yes (1)** *39 (53.4%)* **No (0)** *34 (46.6%)*	1.8 How many weeks of training did you receive? **Weeks** *Min: 0* *Max: 156* *Mean: 6.7* *St. Dev.: 19.5*	1.9 What was the subject of the last course you took? **Code**

Codebox for question 1.5

No studies and cannot read or write	0	*1(1.4%)*
No studies but can read or write	1	*0(0.0%)*
Elementary school	2	*1(1.4%)*
Vocational school	3	*1(1.4%)*
Secondary school, gymnasium	4	*9(12.3%)*
Vocational college	5	*8(11.0%)*
M.Sc. studies (university)	6	*51(69.9%)*
Ph.D. studies (university)	7	-
Other occupation-specific higher education	8	*2(2.7%)*

Codebox for question 1.9

Languages	1	-
Computers	2	-
Secretarial	3	-
Food processing	4	*2(2.7%)*
Accounting	5	-
Management	6	*10(13.7%)*
Other professional: _________	7	*11(15.1%)*
Other: ____________________	8	*8(11.0%)*
none		*34(46.6%)*

Codebox for question 1.6

None/only practical experience	0	*22(30.0%)*
Only short courses	1	*1(1.4%)*
Agricultural vocational school	2	*2(2.7%)*
Agricultural secondary school	3	*6(8.2%)*
Agricultural university	4	*42(57.5%)*
Post-) Graduate studies	5	-

2. General attitude towards crop insurance

2.1 Have you ever been insured?

o 1. Yes *23(31.5%)* o 2. No *50(68.5%)*

2.4 Would you like to insure your crop in next future?

o 1. Yes *47(64.4%)* o 2. No 26*(35.6%)*

[oh1]

2.4.1 **If No**, why?

- o 1. Insufficient liquidity (lack of funds) *1(4.3%)*
- o 2. You do not believe: Insurance can pay off its costs *8(34.8%)*
- o 3. You had bad experiences with insurance *3(13.0%)*
- o 4. other reasons ________________(please indicate) *5(21.7%)*
- o 99* *6(26.1%)*

2.5 What should be introduced to insurance contracts you can take one in?

- o 1. timing of the contract fulfilment *33(45.2%)*
- o 2. sensitivity to changes in weather conditions *45(61.6%)*
- o 3. differentiation in regional design of contracts *18(24.7%)*
- o 4. a possibility to select a coverage which is reasonable for you *21(28.8%)*
- o 5. the premium sum should not exceed *19.2% (μ)* of prod. cost *19(26.0%)*
- o 6. other (please indicate): *e.g. insurance contracts should be based on productivity indexes* *4(5.5%)*

2.6 Would you accept an insurance contract with deductibles?

o 1. Yes *49(66.2%)* o 2. No *25(33.8%)*

2.6.1 **If Yes**, how much deductibles can you sustain in average?

- o 1. 40% *1(2.1%)*
- o 2. 35% –
- o 3. 30% *15(31.3%)*
- o 4. 25% *4 (8.3%)*
- o 5. 20% *18(37.5%)*
- o 6. 15% *1(2.1%)*
- o 7. 10% *3(6.3%)*
- o 8. other __ (please indicate) *6(12.5%)*
- o 99 *1(2.1%)*

**99=no answer (missing value)*

2.7 Which crops have to be insured in your rayon? Which kinds of risks are to be insured for a particular crop? *(% of total)*

Crop	Price risks (induced by price fluctuations)	Risk of natural hazards (crop failure)	Both (income insurance)
1. Wheat *42(57.7%)**	❑ *3*	❑ *6*	❑ *23*
2. Barley *17(23.3%)*	❑	❑ *9*	❑ *8*
3. Maize *1(1.4%)*	❑	❑ *1*	❑
4. Rice	❑	❑	❑
5. Cotton *16(21.9%)*	❑ *1*	❑ *6*	❑ *9*
6. Sugar beet	❑	❑	❑
7. Sunflower seeds *5(6.8%)*	❑	❑ *4*	❑ *1*
8. Potatoes	❑	❑	❑
9. Melons	❑	❑	❑
10. Grapes *4(5.5%)*	❑	❑ *4*	❑
11. Fruits & berries	❑	❑	❑
12. Green maize	❑	❑	❑
13. Annual ley	❑	❑	❑
14. Perennial ley *1(1.4%)*	❑	❑ *1*	❑
15. Other ________	❑	❑	❑

2.8 Which prices would you prefer as reference prices in insurance contracts? Compare prices before evaluating this question)

Crop		in spring (*before-harvest prices*)	in autumn (*after-harvest prices*)
	1. Prices at the commodity-exchange	o *12(16.4%)*	o *14(19.2%)*
	2. Prices of forward contracts	o *4(5.5%)*	o *7(9.6%)*
	3. Prices of Food Contract Corporation	o *3(4.1%)*	o *21(28.2%)*
	4. other ____________ (please indicate)	o –	o –

99: 12(16.4%)

2.10 What kind of crop insurance would you prefer?

- o 1. all-risk insurance (rather expensive) *10(13.7%)*
- o 2. multi-peril insurance (moderate premium costs) *46(63.0%)*
- o 3. against only a particular risk (low premium costs) *9(12.3%)*
- o 99 *8(11.0%)*

2.11 Would you be willing to sign an insurance contract spanning 3-5 years?

o 1. Yes *39(53.4%)* o 2. No *34 (46.6%)*

2.12 Please, explain ______________________________________

2.13 Do you believe that crop insurance in Kazakhstan must be compulsory?

o 1. Yes 27*(37.0%)* o 2. No *27(61.6%) 99: 1(1.4%)*

2.14 Why?____

2.15 How do you define catastrophe for your enterprise (crop loss in percentage of harvest) (What percentage of crop loss is catastrophic for your enterprise?)
26.5%

3 Weather conditions/natural hazards

3.1 What are the most important natural hazards for your business?

- o 1. Drought *50(68.5%)*
- o 2. Spring Frost (after plant emergence) *15(20.5%)*
- o 3. Early Frost (inducing harvest failure) *10(13.7%)*
- o 4. Wind (sukhovei) *6(8.2%)*
- o 5. Storm *3(4.1%)*
- o 6. Varmints invasion *28(38.4%)*
- o 7. Hail *32(43.8%)*
- o 8. Flood –
- o 9. Winter killing *5(6.8%)*
- o 10. additionally_______(please indicate) *8(11.0%)*
- o 99 *1*

3.2 Please indicate for each of hazards you crossed in 3.1 *(table is analysed for the four most important perils according to question 3.1)*

Natural hazard	**Drought**	**Hail**	**Varmints**	**Spring frost**
3.2.1 Does it have an extensive character? (occurs at several sites at the same time)	*o 1. Yes 48(96.0%)* *o 2. No 1(2.0%)* *o 99 1(2.0%)*	*o 1. Yes 15(46.9%)* *o 2. No 15(46.9%)* *o 99 2(6.3%)*	*o 1. Yes 15(53.6%)* *o 2. No 8(28.6%)* *o 99 5(17.9%)*	*o 1. Yes 3(20.0%)* *o 2. No 12(80.0%)* *o 99 -*
3.2.2 What extension does it have? What area does it usually affect?	*o 1.Oblast 22(44.0%)* *o 2.Rayon 22(44.0%)* *o 3.Farms within a radius of < 50 km2) 5(10.0%)* *o 99 1(2.0%)*	*o 1. Oblast -* *o 2. Rayon 4(12.5%)* *o 3. Farms within a radius of < 50 km2) 22(68.8%)* *o 99 2(6.3%)*	*o 1. Oblast 7(25.0%)* *o 2. Rayon 5(17.9%)* *o 3. Farms within a radius of < 50 km2) 8(28.6%)* *o 99 8(28.6%)*	*o 1. Oblast 1(6.7%)* *o 2. Rayon 7(46.7%)* *o 3. Farms within a radius of < 50 km2) 5(33.3%)* *o 99 2(13.3%)*
3.2.3 How often do you experience this peril during last 20 years ? (e.g.: One time every 5 years?)	*Min: 6/100* *Max: 100/100* *Mean: 36.5/100* *St. Dev.: 19.3/100*	*Min: 5/100* *Max: 100/100* *Mean: 27.8/100* *St. Dev.: 20.1/100*	*Min: 5/100* *Max: 100/100* *Mean: 59.7/100* *St. Dev.: 40.2/100*	*Min: 20/100* *Max: 60/100* *Mean: 29.5/100* *St. Dev.: 13.6/100*
3.2.5 Please indicate, how much crop losses can it induce (in per cent of expected yield)?	*Min: 15* *Max: 100* *Mean: 57.8* *St. Dev.: 19.9*	*Min: 10* *Max: 100* *Mean: 39.4* *St. Dev.: 23.6*	*Min: 15* *Max: 100* *Mean: 45.3* *St. Dev.: 26.2*	*Min: 15* *Max: 100* *Mean: 55.8* *St. Dev.: 30.5*
3.2.6 What kind of risk management measures do you apply to combat negative impacts of this risk?	*Mostly agro-technical methods*	–	*Insecticides*	*Choosing the right sowing period; fumes and water film in grape and fruit production*
3.2.7 Do you see some additional possibilities to address this peril on farm?	*o 1. Yes 8(16.0%)* *o 2. No 41(82.0%)* *o 99 1(2.0%)*	*o 1. Yes -* *o 2. No 30(93.8%)* *o 99 2(6.3%)*	*o 1. Yes 7(25.0%)* *o 2. No 16(57.1%)* *o 99 5(17.9%)*	*o 1. Yes 2(13.3%)* *o 2. No 13(86.7%)* *o 99 -*
If Yes, 3.2.8 What kind of possibilities?	*e.g. drought-resistant varieties*	–	*e.g. biological pest management*	*e.g. organic fertiliser*
3.2.10 How efficient are they? (indicate approximately in per cent how far crop losses can be reduced)	*Min: 15* *Max: 50* *Mean: 35* *St. Dev.: 12.6*	*Min: -* *Max: -* *Mean: -* *St. Dev.: -*	*Min: 15* *Max: 100* *Mean: 53.6* *St. Dev.: 33.5*	*Min: 10* *Max: 10* *Mean: 10* *St. Dev.: -*
3.2.11 Would you prefer crop insurance to these risk reducing instruments?	*o 1.Yes 2(4.0%)* *o 2.No 47(94.0%)* *o 99 1(2.0%)*	*o 1. Yes -* *o 2. No 30(93.8%)* *o 99 2(6.3%)*	*o 1. Yes -* *o 2. No 23(82.1%)* *o 99 5(17.9%)*	*o 1. Yes -* *o 2. No 15 (100%)* *o 99 -*

4 Attitudes to risk

The following questions deal largely with your attitudes.
The results in brackets express percentages.

4.1 Please circle the number which best represents your response to the following statements *(*questions following a survey in the framework of the research project "An Economic Evaluation of Risk Management Strategies for Agricultural Production Firms." (see PATRICK et al., 1985))*

	Statement	1 (Strongly Agree)	2	3 (Neutral)	4	5 (Strongly Disagree)
1.	"I regard myself as the kind of person who is willing to take a few more risks than others."	*42(57.5)*	*1(1.4)*	*14(19.2)*	*2(2.7)*	*11(15.1)*
		99: 3(4.1)				
2.	"I must be willing to take a number of risks to be successful."	*59(80.8)*	*1(1.4)*	*4(5.5)*	–	*6(8.2)*
		99: 3(4.1)				
3.	"I am generally cautious about accepting new ideas."	*30(41.1)*	*6(8.2)*	*8(11.0)*	*2(2.7)*	*24(32.9)*
		99: 3(4.1)				
4.	"I am reluctant about adopting new ways of doing things until I see them working for people around me."	*35(47.9)*	*1(1.4)*	*6(8.2)*	*1(1.4)*	*27(37.0)*
		99: 3(4.1)				
5.	"I am more concerned about large loss in my farm operation than missing a substantial gain."	*50(68.5)*	*1(1.4)*	*1(1.4)*	*1(1.4)*	*16(21.9)*
		99: 4(5.5)				

Mean 1-5: 3.20, St. Dev.: 0.99
Mean 3-5: 2.52, St. Dev.: 1.35

4.2 Assume that a new method of growing cotton (C: n=14)/wheat (W: n=49) (main crop) is developed which results in the same yield every year at no additional cost. Please check the largest percentage of your current expected yield which you would be willing to give up to get the same yield every year.

C: 2(14.3) W: 7(14.3) **0%**	*C: 2(14.3) W: 12(24.5)* **10% or less**	*C: - W: 3(6.1)* **50%**
C: - W: 2(4.1) **2% or less**	*C: 6(42.9) W: 13(26.5)* **20% or less**	*C: - W: 2(4.1)* **90%**
C: 2(14.3) W: 5(10.2) **5% or less**	*C: 2(14.3) W: 5(10.2)* **30% or less**	

Mean C:15.00, St. Dev. C:10.00
Mean W: 18.14, St. Dev.: 19.69

The next set of questions deals with risk management issues.

4.3 How do you rate the following sources of risk in terms of their importance to your farm decision-making? *Please* ***circle*** *the number which best indicates the answer.*

Sources of Risk	Importance: Not Important 1	2	3	4	5 Very Important
1. Changes in government commodity programmes	**1**	**2**	**3**	**4**	**5**
	5(6.8)	*2(2.7)*	*28(38.4)*	*5(6.8)*	*30(41.1)*
	99: 3(4.1)		***Mean: 3.76, St.Dev.:1.25***		
3. Crop yield variability	**1**	**2**	**3**	**4**	**5**
	9(12.3)	*2(2.7)*	*25(34.2)*	*9(12.3)*	*24(32.9)*
	99: 4(5.5)		***Mean: 3.54 St. Dev. 1.35***		
4. Crop price variability	**1**	**2**	**3**	**4**	**5**
	1(1.4)	-	*10(13.7)*	*5(6.8)*	*53(72.6)*
	99: 4(5.5)		***Mean: 4.58, St. Dev.: .85***		
5. Changes in cost of inputs, such as feed, seed, fuel, machinery repairs, chemicals, custom services	**1**	**2**	**3**	**4**	**5**
	-	-	*16(21.9)*	*4(5.5)*	*50(68.5)*
	99: 3(4.1)		***Mean: 4.49, St. Dev.: .85***		
6. Changes in land rents	**1**	**2**	**3**	**4**	**5**
	14(19.2)	*1(1.4)*	*16(21.9)*	*7(6.9)*	*30(41.1)*
	99: 5(6.9)		***Mean:3.56, St. Dev.: 1.56***		
7. Changes in costs of capital items (e.g., land, machinery)	**1**	**2**	**3**	**4**	**5**
	4(5.5)	*2(2.7)*	*20(27.4)*	*6(8.2)*	*37(50.7)*
	99: 4(5.5)		***Mean: 4.01, St. Dev. 1.22***		
8. Changes in technology	**1**	**2**	**3**	**4**	**5**
	8(11.0)	*3(4.1)*	*21(28.8)*	*12(16.4)*	*26(35.6)*
	99: 3(4.1)		***Mean:3.64, St. Dev. 1.33***		
9. Changes in interest rates	**1**	**2**	**3**	**4**	**5**
	13(17.8)	*4(5.5)*	*19(26.0)*	*9(12.3)*	*25(34.2)*
	99: 3(4.1)		***Mean: 3.41, St. Dev.: 1.49***		
10. Changes in credit availability	**1**	**2**	**3**	**4**	**5**
	8(11.0)	*4(5.5)*	*16(21.9)*	*6(8.2)*	*34(46.6)*
	99: 5(6.8)		***Mean: 3.79, St. Dev.: 1.42***		
11. Other (specify),	*e.g. availability of qualified staff, general political and economic stability*				

4.4 What are your management responses to risk? Consider the list below and indicate the importance of your various responses to risk. *Please* ***circle*** *the number which best indicates your answer.*

Risk Management Responses	Importance: Not Important				Very Important
	1	**2**	**3**	**4**	**5**
1. Diversification of farming enterprises	*14(19.2)*	*4(5.5)*	*20(27.4)*	*8(11.0)*	*24(32.9)*
	99: 3(4.1)		***Mean: 2.24, St. Dev.: 1.50***		
2. Geographic dispersion of production	*21(28.8)*	*7(9.6)*	*21(28.8)*	*5(6.8)*	*16(21.9)*
	99: 3(4.1)		***Mean: 2.83, St. Dev.: 1.51***		
3. Being a low-cost producer	4*(5.5)*	*-*	*16(21.9)*	*9(12.3)*	*41(56.2)*
	99: 3(4.1)		***Mean: 4.19, St. Dev.: 1.15***		
4. Having back-up management/labour	*31(42.5)*	*4(5.5)*	*14(19.2)*	*6(8.2)*	*15(20.5)*
	99: 3(4.1)		***Mean: 2.57, St. Dev.: 1.62***		
5. Government farm program participation	*17(23.3)*	*5(6.8)*	*13(17.8)*	*9(12.3)*	*25(34.2)*
	99: 3(4.1)		***Mean: 3.29, St. Dev.: 1.61***		
6. Forward contracting the selling price of crops	*24(32.9)*	*1(1.4)*	*23(31.5)*	*10(13.7)*	*12(16.4)*
	99: 3(4.1)		***Mean: 2.79, St. Dev.: 1.48***		
7. Multiple peril crop insurance	*11(15.1)*	*1(1.4)*	*25(34.2)*	*11(15.1)*	*22(30.1)*
	99: 3(4.1)		***Mean: 3.46, St. Dev.: 1.37***		
8. Hail and fire insurance for crops	*13(17.8)*	*4(5.5)*	*16(21.9)*	*14(19.2)*	*23(31.5)*
	99: 3(4.1)		***Mean: 3.43, St. Dev.: 1.47***		
9. Life insurance for partners	*18(24.7)*	*4(5.5)*	*25(34.2)*	*8(11.0)*	*15(20.5)*
	99: 3(4.1)		***Mean: 2.97, St. Dev.: 1.44***		
10. Off-farm investments	*41(56.2)*	*4(5.5)*	*11(15.1)*	*4(5.5)*	*8(11.0)*
	99: 3(4.1)		***Mean: 2.03, St. Dev.: 1.45***		
11. Off-farm employment	*3(4.1)*	*1(1.4)*	*19(26.0)*	*10(13.7)*	*37(50.7)*
	99: 3(4.1)		***Mean: 4.10, St. Dev.: 1.12***		
12. Maintaining financial/credit reserves	-	-	*18(24.7)*	*10(13.7)*	*42(57.5)*
	99: 3(4.1)		***Mean: 4.34, St. Dev.: .87***		
13. Debt/leverage management	*13(17.8)*	*1(1.4)*	*20(27.4)*	*9(12.3)*	*27(37.0)*
	99: 3(4.1)		***Mean: 3.51, St. Dev.: 1.48***		
14. Other (specify)	e.g. *application of new technologies*				

4.5 About which consequences of risk are you most concerned? *Consider the list below and* ***circle*** *the number which best indicates your answer.*

	Degree of concern: Not Concerned				Very Concerned
1. Low income	**1**	**2**	**3**	**4**	**5**
	4(5.5)	*1(1.4)*	*23(31.5)*	*11(15.1)*	*31(42.5)*
	99: 3(4.1)		***Mean: 3.91, St. Dev.: 1.16***		
2. Insolvency	**1**	**2**	**3**	**4**	**5**
	20(27.4)	*2(2.7)*	*14(19.2)*	*11(15.1)*	*23(31.5)*
	99: 3(4.1)		***Mean: 3.21, St. Dev.: 1.62***		
3. No credits	**1**	**2**	**3**	**4**	**5**
	25(34.2)	*7(9.6)*	*7(9.6)*	*5(6.8)*	*26(35.6)*
	99: 3(4.1)		***Mean: 3.00, St. Dev.: 1.77***		
4. Loosing job	**1**	**2**	**3**	**4**	**5**
	39(53.4)	*3(4.1)*	*6(8.2)*	*6(8.2)*	*16(21.9)*
	99: 3(4.1)		***Mean: 2.39, St. Dev.: 1.71***		
5. Equity losses	**1**	**2**	**3**	**4**	**5**
	25(34.2)	*-*	*12(16.4)*	*6(8.2)*	*27(37.0)*
	99: 3(4.1)		***Mean: 3.14, St. Dev.: 1.76***		

4.6 How do you rate your willingness to take risks relative to other farmers? Please give your ratings for your willingness to take risks in farm production, product marketing, farm financial aspects, and in overall farm management. *Please* ***circle*** *the number which best indicates your answer.*

Management Area	Relative willingness to take risks: Much Less				Much More
1. Farm production	**1**	**2**	**3**	**4**	**5**
	7(9.6)	*1(1.4)*	*31(42.5)*	*9(12.3)*	*21(28.8)*
	99: 4(5.5)		***Mean: 3.52, St. Dev.: 1.23***		
2. Product marketing	**1**	**2**	**3**	**4**	**5**
	7(9.6)	*4(5.5)*	*33(45.2)*	*4(5.5)*	*22(30.1)*
	99: 3(4.1)		***Mean: 3.43, St. Dev.: 1.27***		
3. Farm finance	**1**	**2**	**3**	**4**	**5**
	10(13.7)	*6(8.2)*	*27(37.0)*	*7(9.6)*	*20(27.4)*
	99: 3(4.1)		***Mean: 3.30, St. Dev.: 1.36***		
4. Overall farm management	**1**	**2**	**3**	**4**	**5**
	6(8.2)	*3(4.1)*	*31(42.5)*	*7(9.6)*	*22(30.1)*
	99: 4(5.5)		***Mean: 3.52, St. Dev.: 1.23***		

4.7 Please assess the maximum possible and the average yield of the most important crops in your rayon and for your enterprise (unit 100 kg/ha).

Crop	Rayon		Farm	
	Maximum (µ)	*Mean (µ)*	*Maximum (µ)*	*Mean (µ)*
Wheat	18.06	13.06	20.23	12.09
Barley	19.50	13.50	20.60	12.30
Sunflowers	16.20	13.17	14.33	10.22

Thank you very much for your co-operation

5 Questions for the enumerator

5.1 What was the degree of co-operation and interest of the interviewed person?

1. didn't want to co-operate o –
2. had only little interest o *11(15.1%)*
3. were more or less indifferent o *10(13.7%)*
4. had some interest o *27(37.0%)*
5. was very interested o *21(28.8%)*

99: 4 (5.5%), Mean: 3.84, St. Dev.: 1.04

5.2 How well-versed was the person to answer the questions?

1. not well-versed o *13(17.8%)*
2. little well-versed o *21(28.8%)*
3. relatively well-versed o *21(28.8%)*
4. very well-versed o *14(19.2%)*

99: 4(5.5%), Mean: 2.52, St. Dev.: 1.02

5.3 With regard to your experience as enumerator, this enumeration worked…

1. quite bad o *3(4.1%)*
2. worse than normal o *6(8.2%)*
3. normal o *30(41.1%)*
4. better than normal o *11(15.1%)*
5. very good o *19(26.0%)*

99: 4(5.5%), Mean: 3.54, St. Dev.: 1.20

Comments by the enumerator:

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