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Risk management in Mongolian vegetable production - opportunities and challenges

German – Mongolian Cooperation Project Sustainable Agriculture

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1. Introduction

Agriculture and in particular the livestock sector play an eminent role for employment and food security in Mongolia. In order to improve nutrition quality and food security, also crop production receives increasing attention. Grain products, meat and milk products contribute 86% to the daily calorie intake (FAO UNICEF UNDP, 2007). While vegetable consumption is very limited in traditional Mongolian diet, demand has been increasing over the past years, especially in the cities. After the production of potatoes and vegetables in Mongolia declined in the early 1990s, imports have been surging since the late 1990s, particularly from China (FAOSTAT, 2020), to make up for the lacking domestic production but potentially also due to trade liberalization since the WTO accession of Mongolia.

Increasing domestic production and stabilizing local prices of vegetables have become important goals of the Mongolian government during recent years (ADB, 2020). Several governmental programmes have been implemented, such as the Atar-3 Campaign National Programme (on virgin land) under the National Development Action Plan for 2008-2012, the Mongolian National Programme for Food Security (NPFS) 2009-2016, the National Programme on Vegetables for the years 2018-2020, or the Parliamentary Decree No. 12 of 2008 (ADB, 2020; Pöschk, 2016). Based on statistical data, the Asian Development Bank (ADB, 2020) reports an increasing self-sufficiency rate in terms of vegetable products, which might be the result of the above-mentioned policy programmes. However, despite many programmes and best intentions to develop vegetable production, both production and consumption have increased only at slow rates since the late 2010s (see Figure 1).

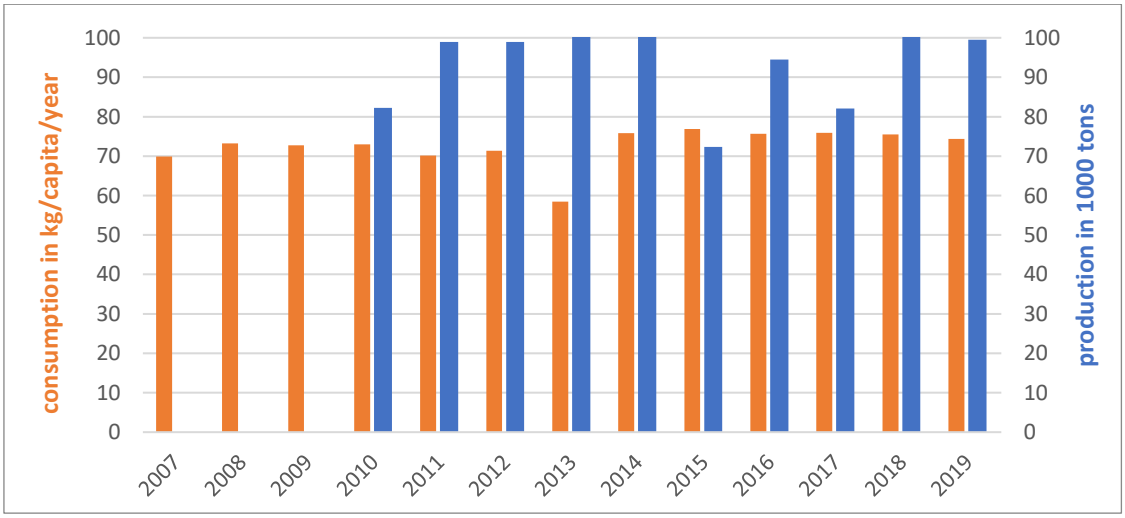

Figure 1: Vegetable production and consumption

Source: (MSIS, 2020)

One of the main reasons for the slow production growth is the stagnation or only slow increase in vegetable yields. Figure 2 shows yield developments in Mongolia and the neighbouring countries China, Kazakhstan and Russia. First of all, yields in Mongolia are low, when compared to other countries. Second, we have also observed no or only little progress in yields since 1992, while other countries increased their yields by more than 200% in the same period. Generally, low yields can be traced back to a low level of investment in production inputs.

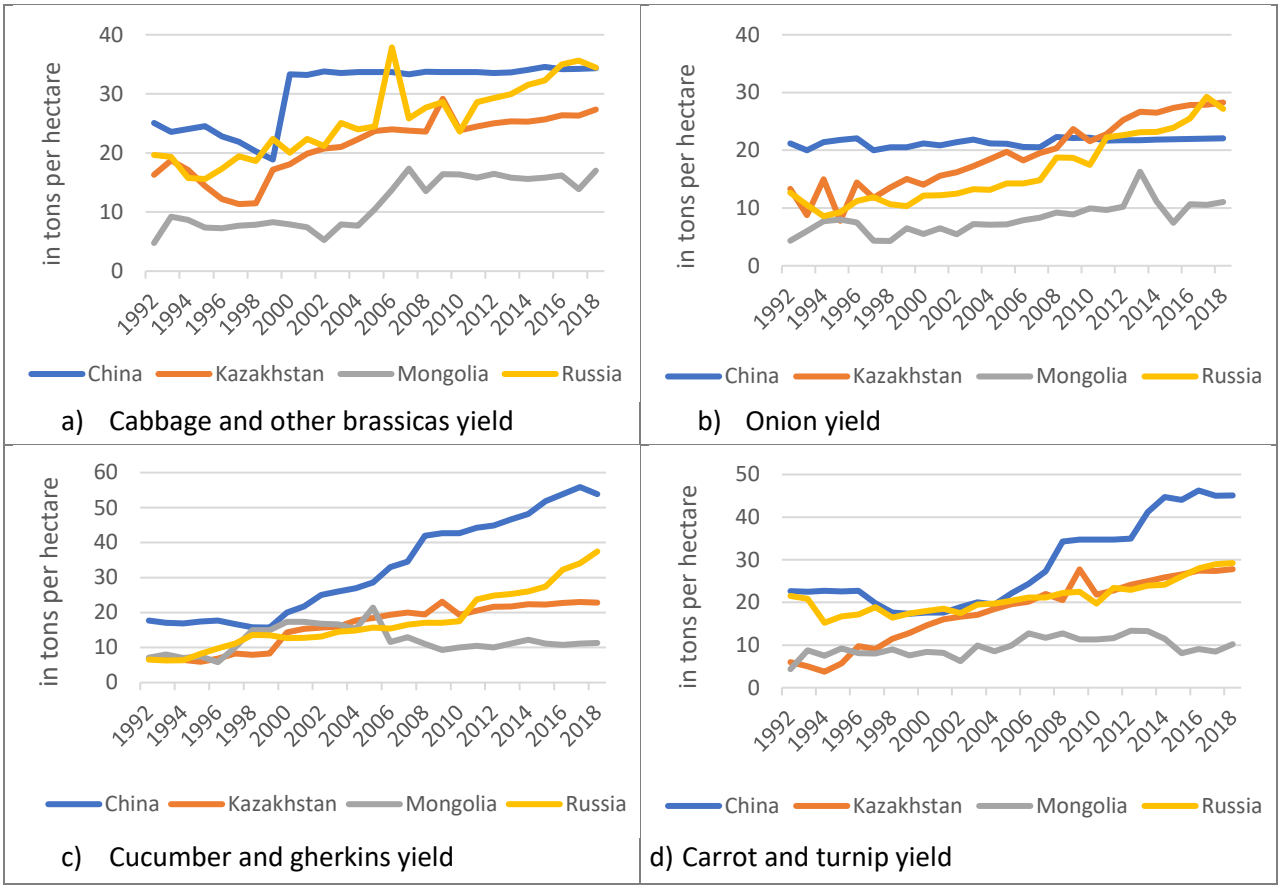

Figure 2: Vegetable yields in Mongolia in comparison with neighbouring countries

Source: (FAOSTAT, 2020)

Farmers' vulnerabilities to production risks may be at the root of this stagnation in production, as uncertainties typically inhibit investment. First, the Mongolian vegetable sector is constrained by natural development challenges due to unfavourable climatic conditions. Similar to other countries in the region, Mongolia is also confronted with a variety of natural risks which can potentially influence farming activities. The Asian Disaster Reduction Center lists droughts, earthquakes, epidemics, famine, floods, forest fires, wind damage, snow damage (dzud) as major disasters in Mongolia (ADRC, 2020). According to data from the National Statistical Office (NSO), the damage of on average 4200 natural disasters reached an annual mean of 95 billion MNT between 2009 and 2019 (28.4 million euros). In the mentioned ten years, about 2008 forest and field fires burned around 28 million hectares (MSIS, 2020). Changing climatic conditions in Mongolia would further aggravate the harsh conditions that already exist. While the increasing temperature trends may seem favourable for the Mongolian vegetable production, the more frequent weather extremes associated with global warming may result in production uncertainty and yield default. Second,

these climatic risks are further aggravated by production risks which are caused by underdeveloped supply chains. A special challenge is, for instance, the underdevelopment of the local seed production. Seed materials are usually imported from China and Russia. It should be stated, however, that imports from China are not adapted to local climatic conditions (Pöschk, 2016).

Especially farmers' perspectives on production and markets risks, as well as their responses to this uncertainty, have been under-investigated so far. In the past, opportunities and constraints in the Mongolian vegetable sector were mainly analysed based on aggregated statistical data and expert knowledge as well as case study discussions. To date, no comprehensive empirical analysis of development constraints based on in-depth farm level data has been conducted. A comprehensive analysis of risk perception as well as existing coping and adaptation strategies may shed light on this presumed bottleneck to the further development of vegetable value chains in Mongolia. This report constitutes the first step to explore development constraints based on detailed farm survey data with a main focus on challenges associated with production and market risks.

2. Data collection

For a thorough analysis of risk and risk management among Mongolian vegetable consumers, we conducted a farm-level survey covering the most major vegetable production regions of Mongolia. The data collection was implemented in July and August 2020 among 308 farmers. To identify a representative sample, we followed a near-random probability sampling approach. The number of interviewed farmers for each sample province was determined based on the share of vegetable production of the relevant province in national production. Furthermore, special attention was paid to sampling all three common forms of producers, namely household farms, production cooperatives and farming enterprises. The number of sampled farms for each farm type was identified based on its share in overall vegetable production. On Sum level, a mixture of random and convenience sampling was used to select farmers, based on a full list of farms provided by the respective Sum level agricultural office. The distribution of farms across provinces and farm types is shown in Figure 3. Inside the provinces, the distribution across Sums was also determined based on probability sampling, depending on production shares of the various Sums. The geographical distribution of interviewed farms is illustrated in the Appendix.

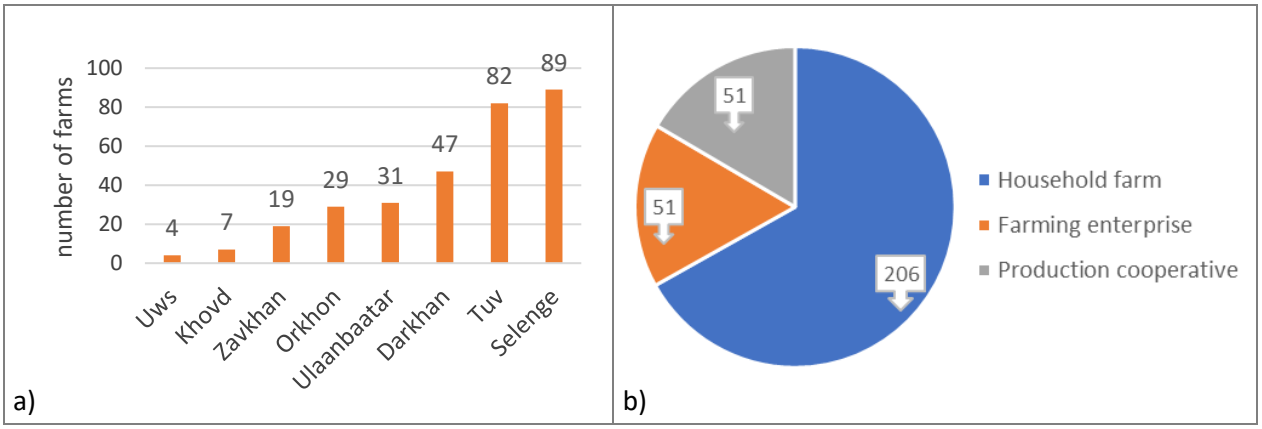

Figure 3: Sample by province (a) and farm organization (b)

3. Sample description

3.1. Farm characteristics

Overall, the education level of sampled farmers was comparatively high. 37% of farm heads have a university degree, 27.6% have attended a technical school. Only a sixth has a junior level education (13%), whereas a fifth (21.8%) has a senior school education. Regardless the education level, an overall of 52.8% of farm managers enjoyed a special agricultural education. The average age of farm heads with about 49 years is comparatively young by international standards. On average, farmers had 17 years of farming experience. More than half of the farmers (56.5%) were no full-time farmers and had still another job outside of agriculture.

As one could expect, there is a large difference in farm structure among the farm types. The total land areas of household farms and production cooperatives are relatively small. The average overall land area of household producers is 3.6 hectares on average in the sample. Farming enterprises and cooperative farms have 69.1 and 4.3 hectares, respectively. While the irrigation rate is on average 79.4% of the land, only about half of the area was irrigated in farm enterprises. Across all farm types, farms had 2.4 permanent farm workers per hectare, supplemented by on average 29.9 hired workers per hectare, a ratio which can be explained by the seasonality of vegetable production. While the ratio of hired workers did not differ significantly across farm types, the rate of permanent labour was higher in household farms and production cooperatives. While the larger farms are very specialized (producing on average 1.8 various types of vegetable), the smaller or medium sized farms in the other provinces were more diversified (2.4-2.7 different vegetables).

Table 1: Average farm characteristics of vegetable growers, by province

	Total land (ha)	Irrigated land (in %)	Permanent workers (persons/ha)	Hired labour (persons/ha)	Number produced crops	Number produced vegetables
Household farms	3.60	82.91%	3.00	29.11	3.41	2.42
Farming enterprises	69.08	53.15%	0.52	28.93	3.24	1.84
Production cooperatives	4.25	91.29%	2.06	33.83	3.69	2.73
Total	14.55	79.37%	2.44	29.86	3.43	2.37

3.2. Production patterns, technology and productivity

Table 2 presents some basic statistics on production structures. Potato and carrot were found to be the main crops grown by vegetable producers in our sample, both in terms of numbers of producers (244 and 201 farms, respectively) and of total harvest (25.4 thousand tons and 5.5 thousand tons, respectively). Further major crops were onion, cabbage, turnip and cucumber/gherkin. Differences across provinces in terms of crops produced were small, except for Orkon, Selenge, Tuv and Ulaanbaatar, where carrot was by a slight margin, the second most important vegetable crop. Also, the distribution of cropland among different vegetable cultures was similar across provinces.

Table 2: Vegetable production, total sample

	Carrot	Turnip	Onion	Cabbage	Cucumber and gherkin	Potato
Producing farms	201	114	135	124	95	244
Total harvest (in tons)	5504.8	1259.1	623.2	7551.7	335.0	25412.6

Table 3 presents the yield of main vegetables across different farm organization types. Contrary to expectation, farming enterprises did not exhibit the largest hectare yields. Depending on the crop, the highest yields were achieved by production cooperatives. Generally, yields in farming enterprises ranged only slightly above or even below household farms. When differentiating by farm size, we found a U-shaped yield pattern for most vegetables. The largest hectare yields were found for farms with total land holdings less than 5 hectares and for farms with land holdings of more than 50 hectares. Mid-sized farms between 5 and 50 hectares typically achieved lower hectare yields, except for cabbage. While large farms seemed to be able to realize some efficiencies of scale, small farms tend to be more flexible, particularly concerning labour input and crop structures.

Table 3: Yield of main vegetable crops in tons per hectare, by farm organization

	Carrot	Turnip	Onion	Cabbage	Cucumber and gherkin	Potato
By farm type						
Household farm	15.36	12.21	11.59	21.30	31.35	15.38
Farming enterprise	16.38	8.82	8.99	25.15	32.46	15.91
Production cooperative	18.22	16.14	13.43	30.67	57.76	16.92
By farm size						
<5ha	16.37	14.34	12.58	23.14	34.23	15.99
5-10ha	14.35	8.59	7.15	24.29	18.98	15.40
10-50ha	13.79	8.74	10.70	27.87	19.07	14.67
>50ha	21.20	12.94	14.08	21.47	25.00	17.16
Total	16.00	12.50	11.63	23.81	36.28	15.74

About 89% of the surveyed farms indicated that crop diversity can increase their revenues, which they express to be the main motivation for a high diversification or aspiring for a higher diversification. When asked about the subjective assessment of their crop mix, 52.9% percent of farmers indicated to be satisfied with their level of diversification, while 44.8% aimed at achieving a higher level of diversification. The main inhibitors for more diversification were reported to be a lack of suitable machinery (62.3%), unstable prices (59.4%), credit constraints (49.3%) and a lack of family labour (42%) (see Figure 4). Among other reasons were the increased production and market risks (four mentions), lack of suitable land (four mentions), lack of funds for necessary investments (two mentions), and lack of labour (two mentions). Especially the item “unstable prices” and the open statements about an increased risk of a more diversified production show that market and production risks are inhibiting a further expansion of vegetable production, in addition to general constraints in terms of production factors.

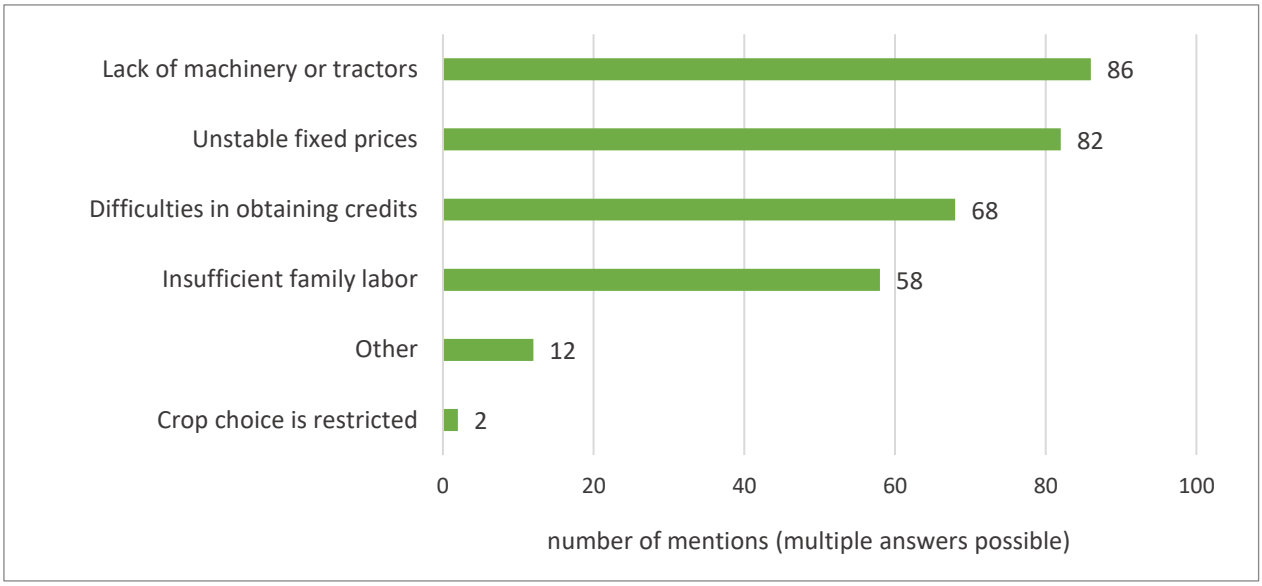

Figure 4: Barriers against crop diversification (n=138)

Furthermore, we also inquired into problems associated with input purchase (see Figure 5). Overall, about 66% of farmers reported problems associated with input purchase. Surprisingly, no large differences across farm types could be observed: While household farms and farming enterprises had problems to a similar degree (64-65%), production cooperatives in 76% of the cases reported purchase problems, possibly because they required more advanced inputs than household farms but lacked the more advanced sourcing channels of farming enterprises. The main reasons given were a complete lack of physical access to stores (32.0%), a lack of required inputs in accessible stores (40.5%) and high prices of required inputs (23.6%). While production inputs usually serve to increase yields and thus profits of agricultural production, they can also support the production of new, more drought tolerant varieties. With the observed problems of purchasing suitable inputs, we can assume, however, that this form of risk management was no option for most of our sample farms.

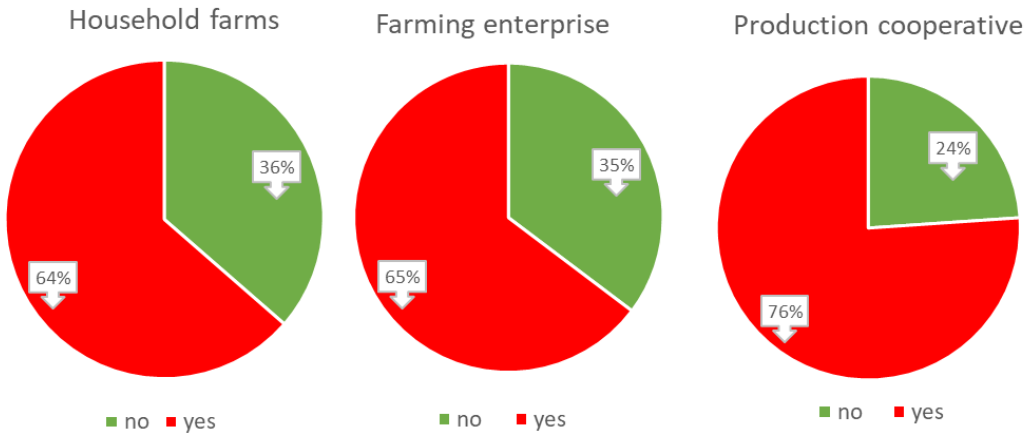

Figure 5: Problems with purchasing production inputs (fertilizers, pesticides, seed)

Finally, an important factor for vegetable production is the adoption of greenhouse technology. This technology reduces the exposure to certain natural hazards and may thus decrease the vulnerability of vegetable production. As illustrated in Figure 6, among our sample farms, overall only 40 farms used greenhouse production, most of them producing cucumbers and gherkins. For cucumbers and gherkins, a third of the total production area (33%) was covered by greenhouses. The most widespread application was found in farming enterprises (56%), a medium adoption in production cooperatives (47%) and the lowest in household farms (26%). For once, the switch to greenhouse production is connected with a considerable investment, which is most likely achieved by enterprises with higher capital stocks. Further reasons might be a lack of labour, problems with marketing, or a lack of know-how. This finding underlines the impression that capital access is positively connected with a better farm-based risk management.

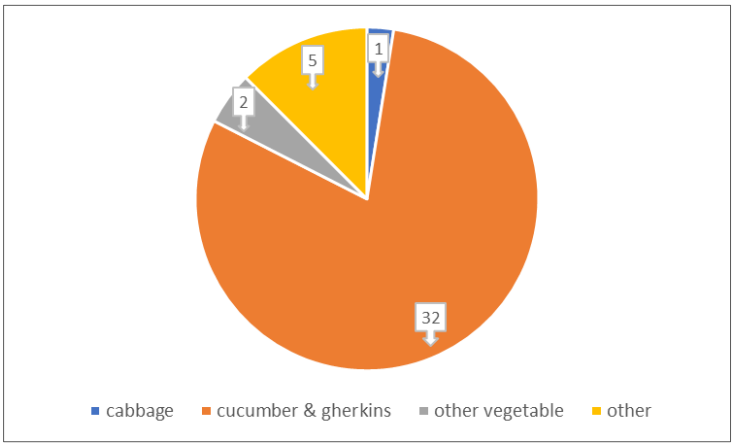

Figure 6: Adoption of greenhouse technology (number of farms)

4. Climate and market risks of vegetable producers

Farmers in Mongolia face a wide range of natural risks. As risk exposure may vary regionally and for different crops, the individual perception of natural and other risks is of high interest. In order to identify options to boost farmers' adaptive capacities, we need to understand the risks they face as well as the individual risk and vulnerability perceptions.

4.1. Farmers' risk perception

Figure 7 below illustrates the major risks perceived by interviewed vegetable farmers. Across our sample, farmers reported a wide range of production or market risks they had experienced at some point over the previous years. Among the most frequently reported risks were price volatility (78%), labour shortage (71%), lack of rainfall during the vegetation period (64%), high summer temperature (54%) as well as seasonal heavy rainfall or floods (49%). When assessing these subjective risk reports, we notice two major issues: Firstly, the high level of experienced risk from volatile crop market prices confirms our previous assessment of poorly developed and informal supply chains. Unless considerable efforts are taking place in increasing the number of formal sales contracts which would make farmers less dependent on spot market prices, no significant improvement can be expected in this regard. Secondly, three out of the five major risks were weather-related. Should climate change proceed according to the recent projections, an increase of weather risks is likely. The IPCC (2014) report estimates a high likelihood for increasing temperature across all areas of Asia. Also higher levels of precipitation are very likely, however, only at higher

latitudes and for Southern and Eastern Asia. On the one hand, there is high agreement that cooler regions like Mongolia will on average likely benefit from warmer temperature that increases arable areas. On the other hand, temperature increases are likely to have negative impacts on grassland and thus the livestock sector. Furthermore, increased probability of weather extremes might increase systemic risk also for vegetable producers (IPCC, 2014). Thirdly, labour shortage is a problem that many agricultural systems are facing worldwide and is likely to increase as well. For Mongolia, the number of employments in agriculture dropped to its lowest level in 2019, most likely due to more attractive income options in urban centres. Concerning for producers is in particular that the strongest drop between 2009 and 2019 could be observed for the youngest age cohorts, in detail a drop by 70% for the cohorts 15-19 years, 67% for 20-24 years, 43% for 25-29, and a drop by 19% for 30-34 years (NSO, 2020). While the generally low availability of farm work remains an issue that cannot easily be solved, fixed work contracts could contribute to reduce uncertainty.

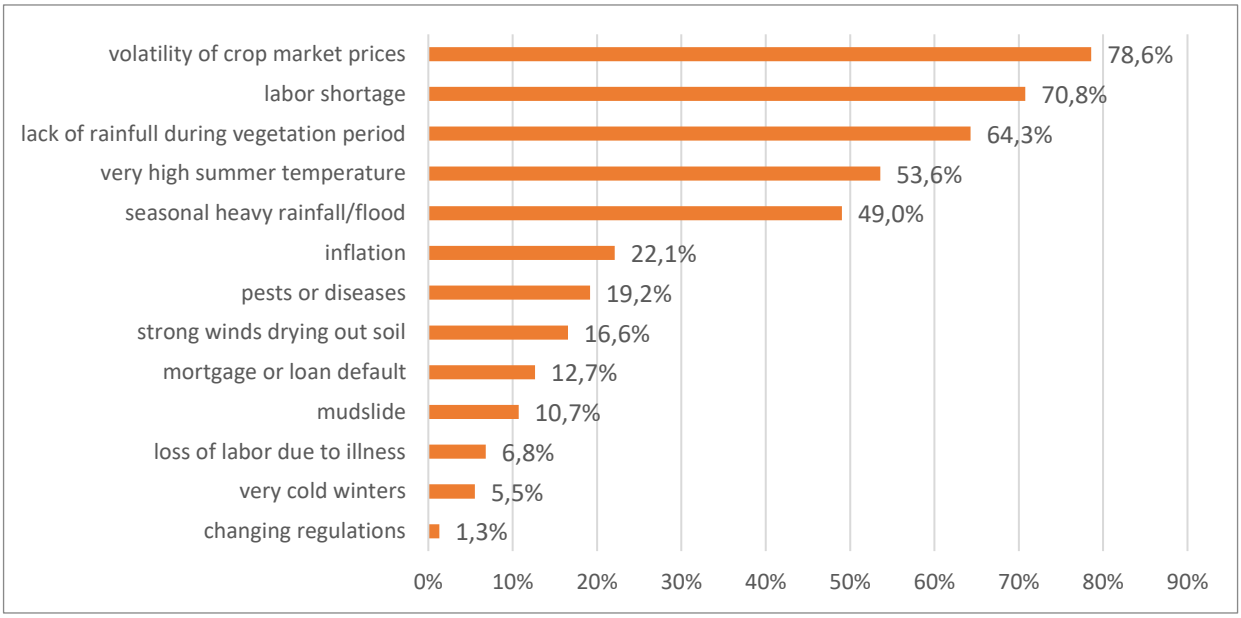

Figure 7: Experience of risks in the last 10 years

Meanwhile, the mere incidence of certain risks does not yet provide any information on their actual impact on farming activities. Figure 8 therefore illustrates the impact of major risks as perceived by interviewed vegetable farmers. While most risk types were rated between 3 (manageable) and 4 (high), some risks were perceived particularly threatening by those farmers that had so far experienced them. High or very high impact was stated by most farmers for mudslides (82%), lack of rainfall (76%), seasonal heavy rainfall (72%), or volatility of crop market prices (68.6%).

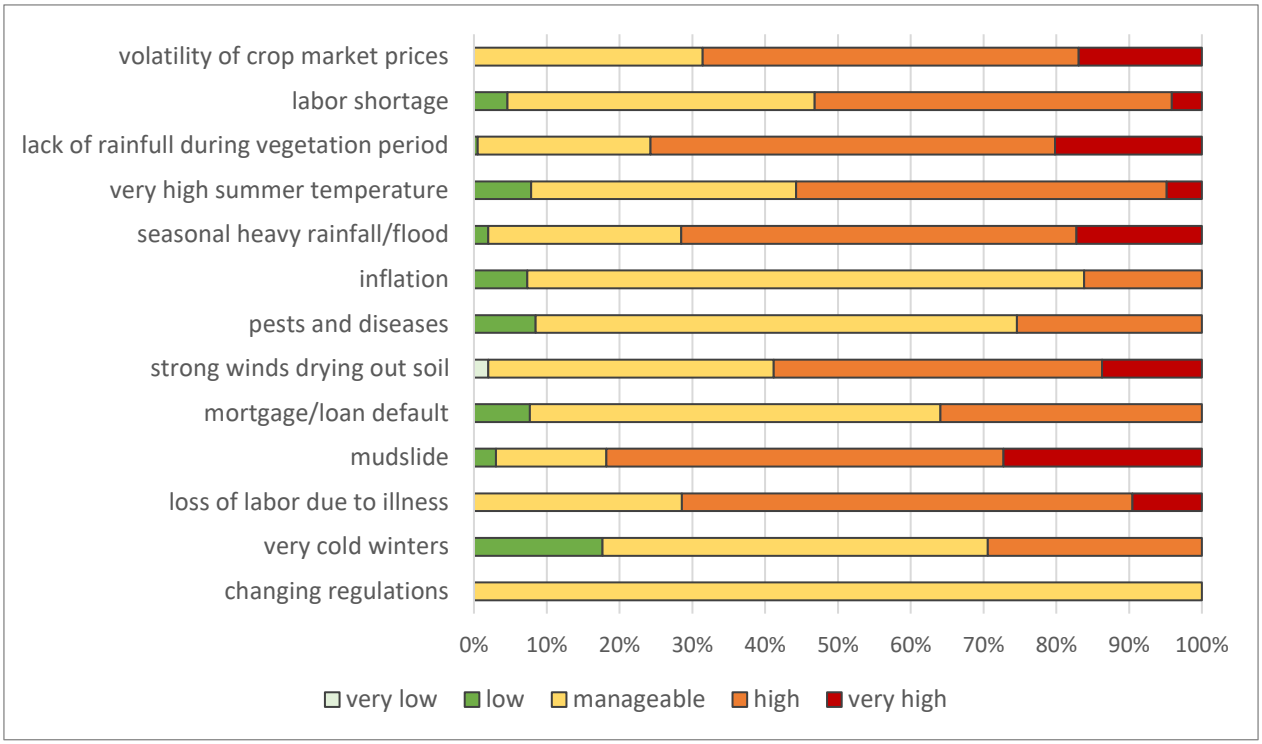

Figure 8: Perceived impact of risks

Further, farmers were asked about their general risk attitude. More than half of the farmers (53%) stated that they generally like to avoid risk, which means that in the presence of production risk they would choose some less risky farming activity. Only 6.5% of farmers assessed themselves as risk adverse, meaning they would also invest in more risky production activities. In addition to this self-assessment, the survey also attempted to elicit risk behaviour. One question measured delayed gratification: In the whole sample, only 29.6% of the farmers were willing to delay a payment by one month for increasing the benefit by a third. This delayed gratification is usually regarded as the more risky choice, as participants perceive uncertainty whether or not the payment is actually going to happen after the waiting period. A second question was less abstract, giving participants the choice between a hypothetical safe investment with low benefit but zero default risk and a more risky investment with a benefit twice as high as the gain of the safer investment and a default probability of 50%. In this case, more than half of the farmers chose the more risky investment when the risk was transparent and the potential reward high enough. These findings indicate that mechanisms making risk more transparent or calculable by providing additional information could bring even generally risk-averse farmers to invest into their production.

4.2. Coping with production and market risks

The most frequent coping options were stated to be borrowing money from relatives and friends, borrowing money from a bank, selling livestock and selling farm assets, which are shown to be important options (Figure 9). Especially, borrowing money from friends, relatives or from a bank has shown to be the most important strategy. Less frequent options were selling livestock, farm or household assets. Reduction of consumption took place only in exceptional cases, while families avoided at all costs to take their children out of school.

The role of commercial credits as the most widely used risk coping technique is also confirmed by the high rate of outstanding loans. 41.9% of farmers in the survey indicated to have outstanding loans at the time of interview. The average interest rate was reported at 21.8%, a level which is typical for countries with underdeveloped credit markets and also a level at which financial pressure on farms and potential credit default are high.

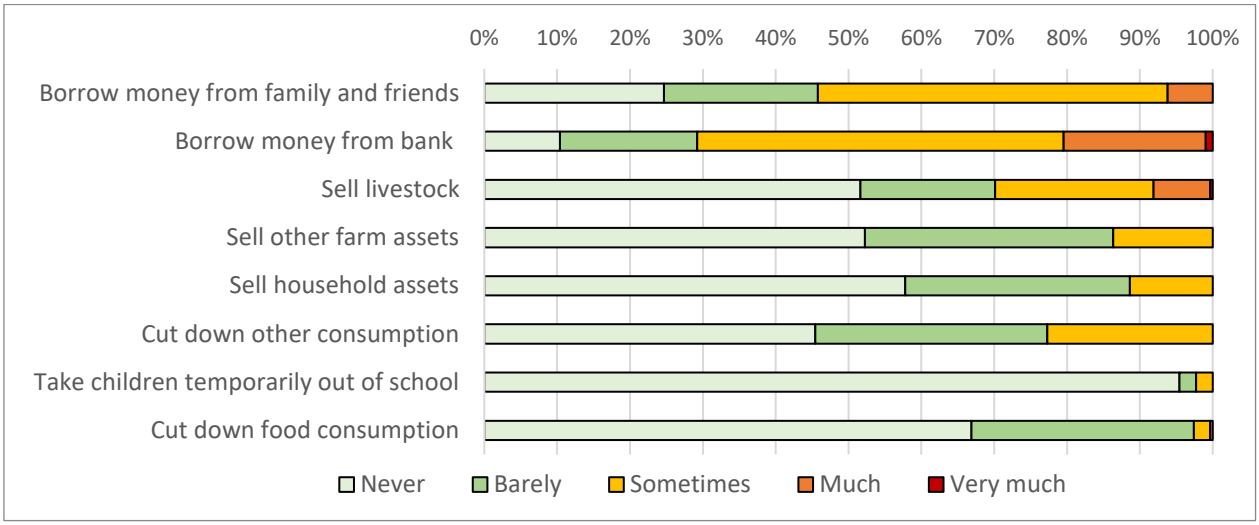

Figure 9: Risk coping strategies

4.3. Strategies to improve risk resilience

4.3.1. Adoption of ex-ante risk management strategies

Figure 10 presents risk management strategies that farmers might apply ex-ante to increase their resilience against future events. Most farmers chose rather traditional risk management strategies like storing part of the harvest, investing in lower yield but safer crops or irrigation, or producing several crops (crop diversification), search off-farm employment and building up savings. Other risk management techniques did not seem to be very relevant to Mongolian vegetable producers, either because of not providing sufficient protection or because of being too costly or not accessible. Strikingly, agricultural insurance was barely used as risk management technique among our sample farmers. Only three farmers reported to "sometimes" make use of this form of risk management. Two farmers reported to own harvest insurance, while one farmer owned a livestock insurance. Only 22% of farmers had ever heard of index-based agricultural insurance at all. This low participation in crop insurance markets certainly is due to the still few available products. Meanwhile, demand for this type of risk management was certainly present: 97.7% of farmers reported to be interested in such a product under the condition that it qualified as a collateral for bank loans. Furthermore, a careful review of Figure 10 shows that very few farmers indicated to use a particular risk management strategy intensively ("very much"). This may be associated with lacking trust in the potential of these strategies to enable them to fully avoid negative consequences of risks or the actual unsuitability of existing risk management methods at disposal.

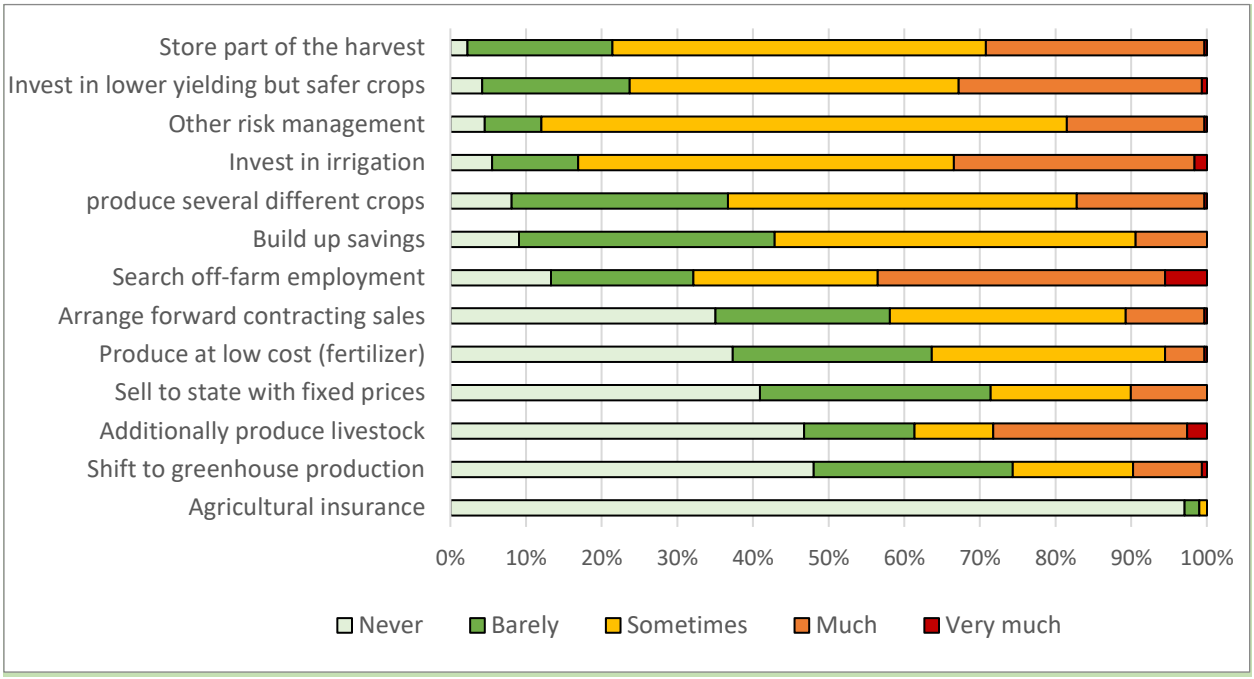

Figure 10: Ex-ante risks management strategies

4.3.2. The role of extension services

Extension services are one tool to advise farmers on suitable risk management strategies and support them in implementing modern production methods that can either reduce production risks or help mitigate their consequences. Although many farmers indicated that they found the quality of extension services good to average (Figure 11A), they did not receive visits by extension agents very frequently (Figure 11B). According to local experts, those agricultural offices who are currently the only actors to provide regular extensions services, can only dedicate part of their time to the actual provision of extension services as they are responsible for other tasks at the same time. In our sample, the content of extension services was mostly on variety specification, soil retention or weather information (Figure 12). In fewer cases, information was shared on crop rotation, irrigation or residue management.

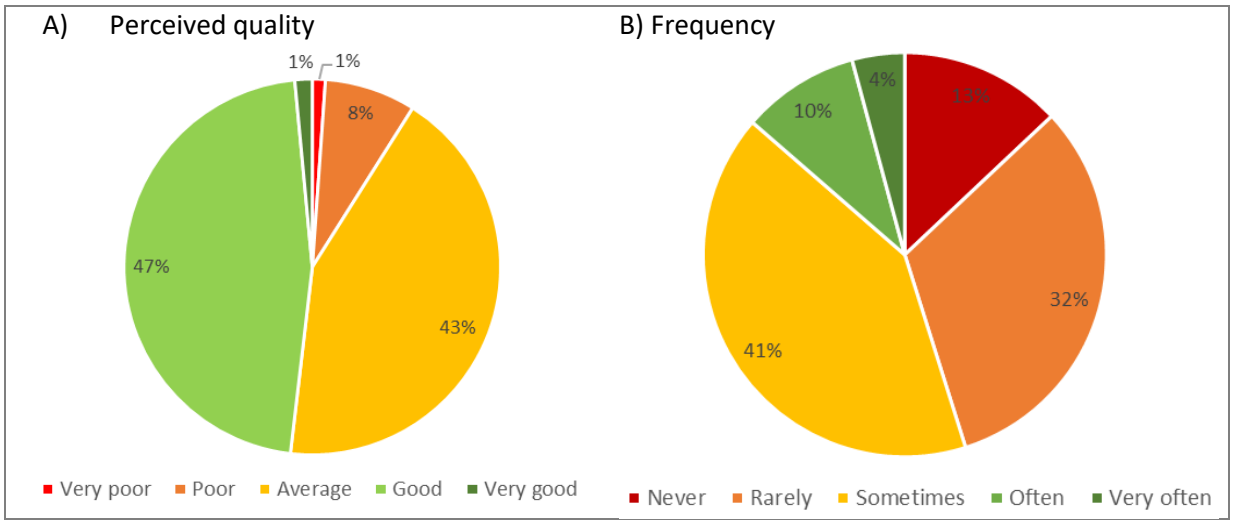

Figure 11: Extension services

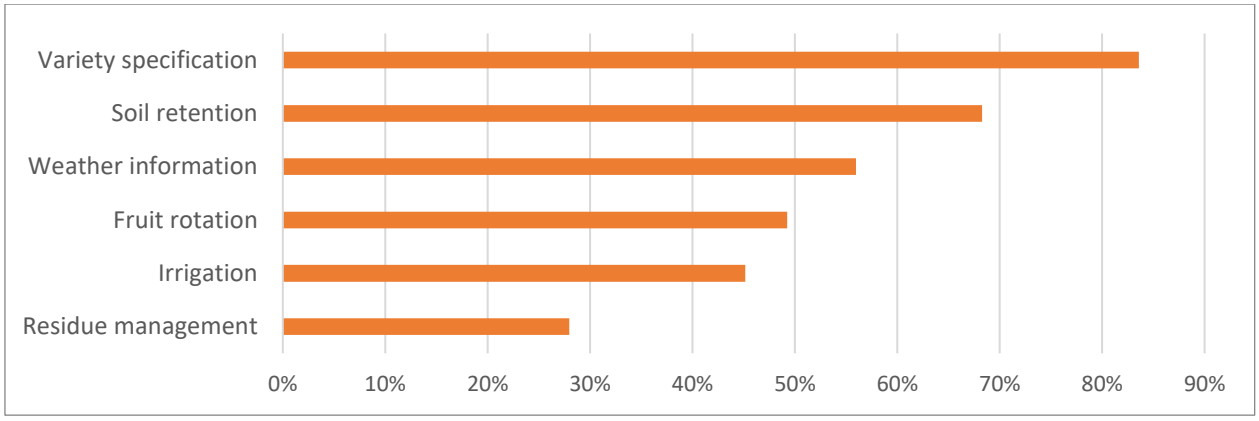

Figure 12: Type of extension information (multiple choices possible)

4.3.3. The role of digitalization

Also digital technologies may provide information and risk management tools. In fact, we found that most vegetable farmers had the necessary hardware to access online information: The majority of farmers (91%) indicated that they used smartphones, some used computers (20.8%), and a few even tablets (7.8%) (Figure 13). Even though there are so far no dedicated agricultural apps in Mongolian language, farmers used this hardware for activities that could be helpful for their risk management, for instance for checking weather information (81%), checking market prices (61.2%), selling the harvest (44.1%) or buying agricultural inputs (42.4%).

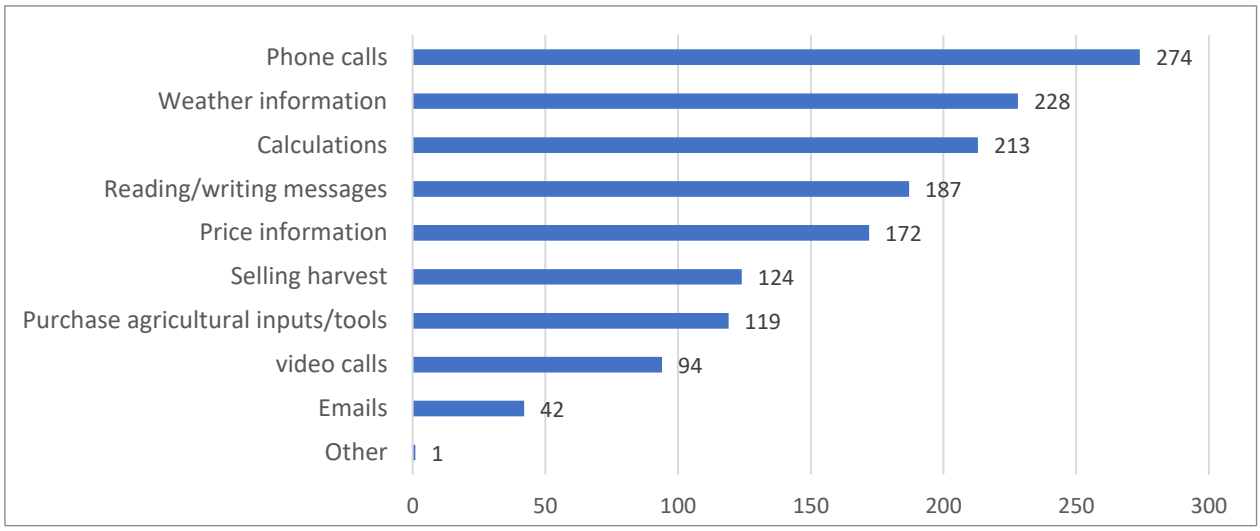

Figure 13: Digital activities (multiple choices possible)

4.3.4. The role of supply chains

A high commercialization rate is observed in all provinces. Between 50.0% and 92.9% of products are sold (in contrast to private consumption), depending on the crop and region. Table 4 presents different forms of market access across farm types. A great number of the farmers sold their products directly to the local markets, on average 50.3%, which is the most risky form of marketing due to the low shelf-life of vegetable and lack of cooling on traditional markets (Table 4). Customer pick-up (10.7%) relieves farmers of transportation cost, but still leaves time pressure when cutting the deal, requires storage expenditure and leaves a certain risk of the customer rejecting the product upon pick-up. Contract farming, which is an important safeguard against fluctuations of spot market prices, remains rare and is used only by 7.8% of farmers. When differentiating between farm types, it becomes obvious that contract farming is mostly an option for farming enterprises (27.5%), but hardly for the other farm types. About 23.7% of the farmers chose to join a marketing cooperative, which shifts the burden of contacting a buyer to another entity. However, this option was predominantly practiced by members of production cooperatives, but very rarely by farm households (10.2%) or farming enterprises (11.8%). For farm households, the predominant method to control a part of the risk was to sell their production via a middleman (62.3%), which shifts the risk of cutting a deal with customers in time to another actor. Other than this, farm households did barely use other methods of risk sharing. Overall, formal contractual agreements (written contract) are underdeveloped across all farm types (15.3). The highest rate of formal contracts was observed for farming enterprises (33.3%), the lowest for household farms (7.3%). The low level of formality again made farmers vulnerable against market risks and short-term price fluctuations or non-compliance of business partners, in particular small household farms with low market power and few means of enforcing informal agreements.

Only a limited number of farmers (7.1%) have storage facilities with temperature control, which means that they had no measure against delays in making a deal and their product losing value in the process. Simple storage was available to 68.5% of farmers, which allows to wait out spot market fluctuations for some products and store a part of the harvest for own consumption. Meanwhile, simple storage does not help to retain the value of a farm's whole production over a longer period.

Table 4: Supply chain characteristics

	Sales agreements Market access							Storage		
	Member marketing cooperative	Direct market sale	Contract farming	Middlemen	Customer pick-up	Via another cooperative	Written contract	Simple	Temperature control	No storage
Household farm	10.2%	55.8%	3.4%	62.1%	8.7%	4.4%	7.3%	69.9%	3.4%	27.2%
Farming enterprise	11.8%	43.1%	27.5%	64.7%	11.8%	2.0%	33.3%	54.9%	25.5%	19.6%
Production cooperative	90.2%	35.3%	5.9%	60.8%	17.6%	25.5%	29.4%	76.5%	3.9%	19.6%
Total	23.7%	50.3%	7.8%	62.3%	10.7%	7.5%	15.3%	68.5%	7.1%	24.7%

5. Discussion and recommendations

This study aimed at discussing the exposure of Mongolian vegetable farmers to production risks as well as current and potential risk management and coping strategies. Based on farmers' statements, the study identified risks in three dimensions: Environmental risk, market risk and personal risk. Among the most frequent and harmful risks for vegetable producers were price volatility, labour shortage, high summer temperature, lack of rain and flooding. Based on our analysis of the Mongolian vegetable sector and its production characteristics as well as international climate change projections, we can assume that the incidence of these events — as well as their impact — are likely to increase in future.

What makes the Mongolian vegetable sector rather susceptible to production and market risks are the persistently low market integration and underdeveloped and informal supply chains. These deficiencies are leading to high transaction cost and low resilience against price fluctuations or inflation. A large number of farmers do not have contractual agreements but sell their products at spot markets. Furthermore, access to inputs also remains a big challenge in almost all provinces of Mongolia, reducing for instance the ability to diversify the production or invest into more stress-resilient varieties. The lack of stores in general or the lack of required inputs in the existing stores seems to be a deficit that would need to be dealt with in order to develop the vegetable sector in the country. Input stores are located remotely from farms, so that the initial costs of input will be too high when transport costs are also included.

Mongolian farms to a large degree chose to respond to risk by using private or commercial credits. While an assessment of Mongolian credit markets did not lie within the scope of this study, we note a decreasing interest rate of loans in domestic currency, which could increase the access also to agricultural loans. Low interest rates of credits may allow farmers to invest into farming technologies, which make them less vulnerable to climate risks. High interest rates or other unfavourable credit conditions meanwhile can turn this form of risk coping strategy into a factor rather increasing than decreasing the vulnerability of farmers. This type of credits leads to a high financial burden of repayment and potential loss of collateral. In terms of risk management — ex-ante measures which aim at decreasing the vulnerability to risks in the first place

— Mongolian vegetable farmers are not yet very diversified. The most common risk management factors were very traditional measures like storage, low risk crops or irrigation. More modern tools of risk management, for instance agricultural insurance or forward contracting sales, were typically not in the risk management portfolio of vegetable farmers.

Similar as with other world regions, an increased risk leads to an increased need to improve and diversify the risk management of agricultural producers. There are several risk management strategies, which could provide more sustainable solutions than the small range of those risk management tools already in use. So far, the intensity of using these risk management options is not very high, a finding which might be explained by a lack of confidence that those technologies help to smooth farm income, a lack of infrastructure, and market integration and by underdeveloped supply chains. All these risks and supply chain constraints keep investments into agricultural production and thus yields low when compared to neighbouring countries. Several measures need to be implemented to improve farmers' resilience and motivate them to invest into technologies and inputs to increase the productivity as observed in neighbouring countries.

First, a potential solution for decreasing inefficiencies in supply chains and market access might be digitalization. Most farmers are equipped with the necessary technology, which can reduce transaction cost and improve access to information such as market prices, etc., also for farmers in more remote areas. In particular, mobile apps can serve this purpose due to the fact that the marginal cost of their distribution tends towards zero. Once developed, an app can be downloaded and used by all farmers for free, providing information at zero direct cost and close to zero transaction cost. In order to achieve significant improvements in this respect, one starting point would be the enhancement of mobile internet coverage as well as the provision of Mongolian language software solutions.

Second, digitalization could also help to improve the continued patchy extension services network. While most of the main vegetable producing areas are located relatively close to urban centres, the geographic conditions in Mongolia often make physical extension service costly and time-intensive. A full reliance on state extension services in these cases seems hardly sufficient. Other Asian transition economies, in particular China, show that a combination of traditional and modern extension services can yield the best results: For simple, current information, mobile apps are the fastest and cheapest tools. For the dissemination of new production methods or innovations, traditional extension services, in particular demonstration farms, can offer more detailed advice. The support of private extension services is another potential approach: Uzbekistan is an example of a transition economy, where state extension services in the past years have been complemented by private extension services on a pilot scale, thus improving the supply of information together with the supply of agricultural inputs.

Third, the results of this study support the need for establishing insurance markets. While earlier pilots in the Mongolian livestock sector demonstrated that there is a great demand for this financial risk management tool, also vegetable farmers have shown great interest, in particular in connection with access to credits or other financial resources. In the season of 2020, a pilot of an index-based agricultural insurance has been launched for the wheat sector, relying on satellite-based vegetation data. The impact and transferability of the pilot will be tested in the upcoming months.

Fourth, for studying the opportunities for improvements in the points mentioned above, further scientific studies will be required. In particular, it will be necessary to study and develop needs-based risk management tools and cooping strategies to respond to the individual needs of Mongolian vegetable farmers. The experience of agricultural development in other countries shows that adoption and impact of agricultural

policies crucially depend on how far they meet the actual requirements of farmers. Although there is a large volume of international literature on the benefits of several risk management and coping strategies, their suitability, implementation and impact in the specific case of Mongolia need to be analysed to deliver focussed advice to Mongolian farms. Only by doing so, these strategies' benefits and the farmers' confidence in the selected strategies can be increased. This report on individual risk perception is an effort to draw a picture of current production and market risks for Mongolian vegetable producers and could thus serve as a starting point for a development in the right direction. Econometric analysis of farm level data as well as field experiments or randomized controlled trials would be the next steps in determining factors and effects of risk management adoption.

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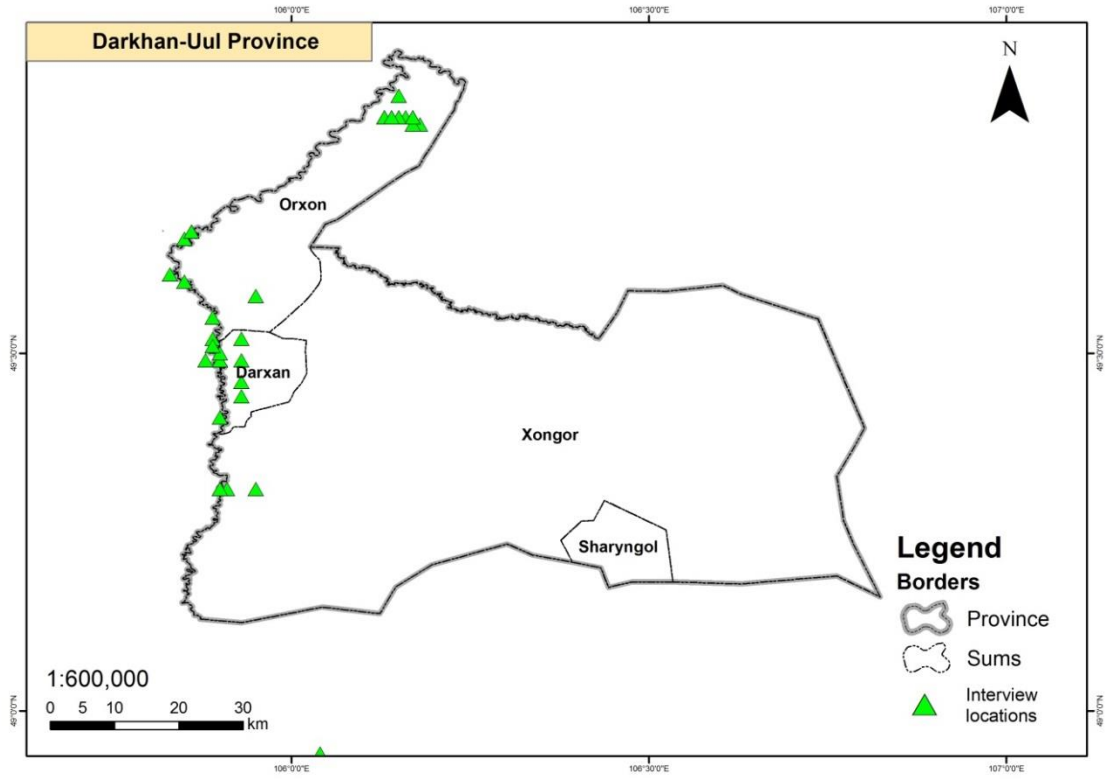
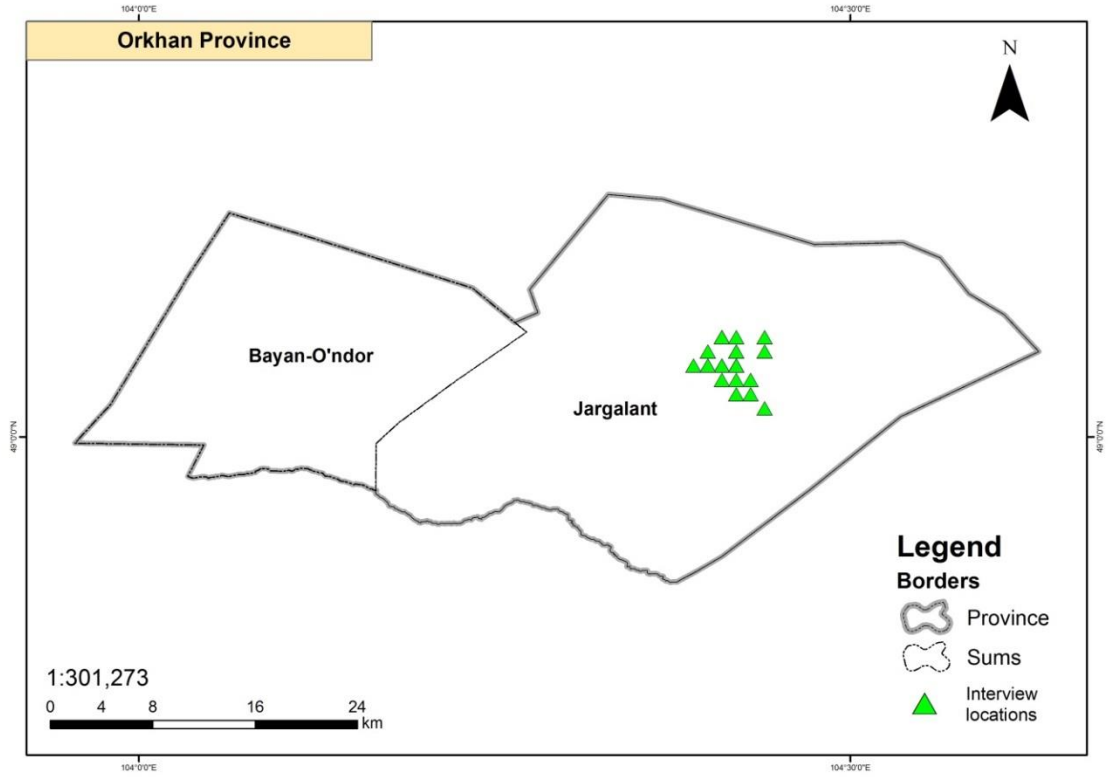
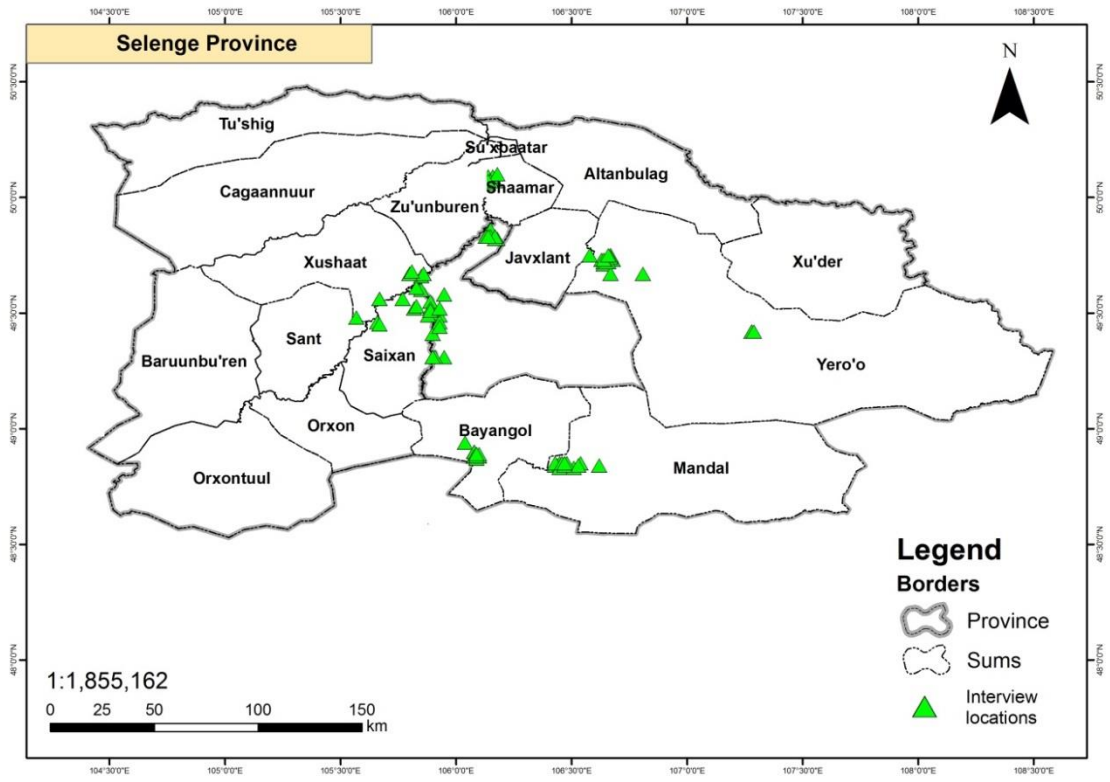
Appendix: Sample location



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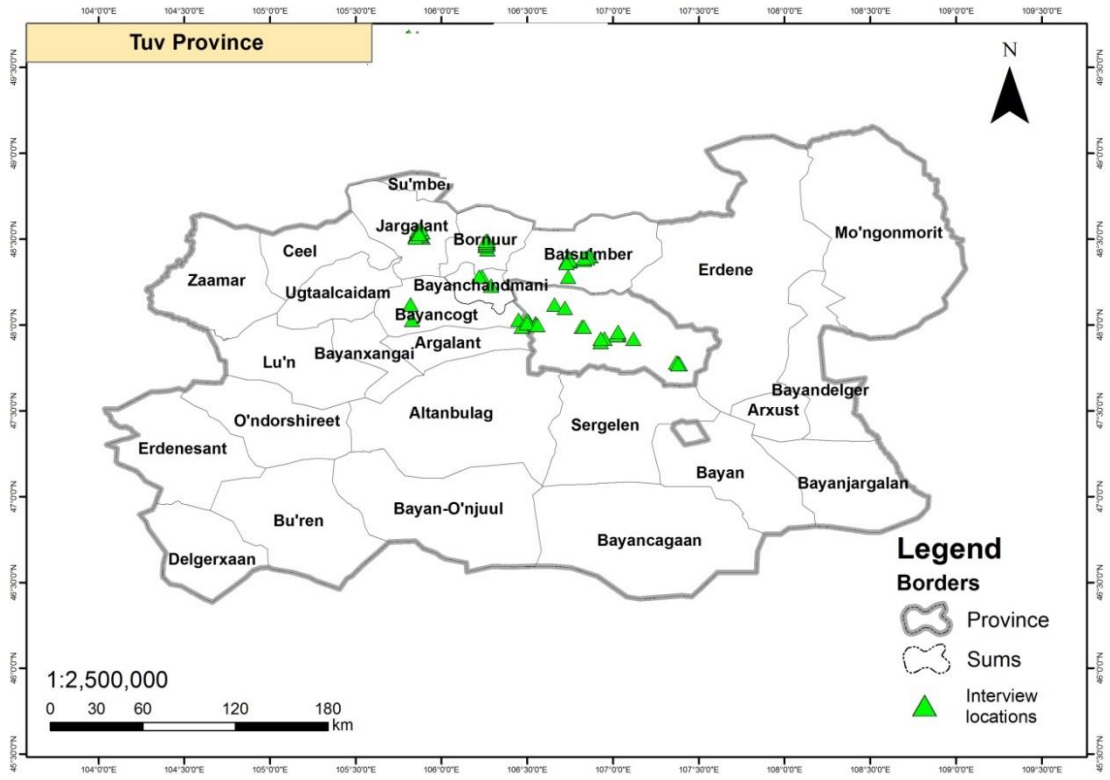
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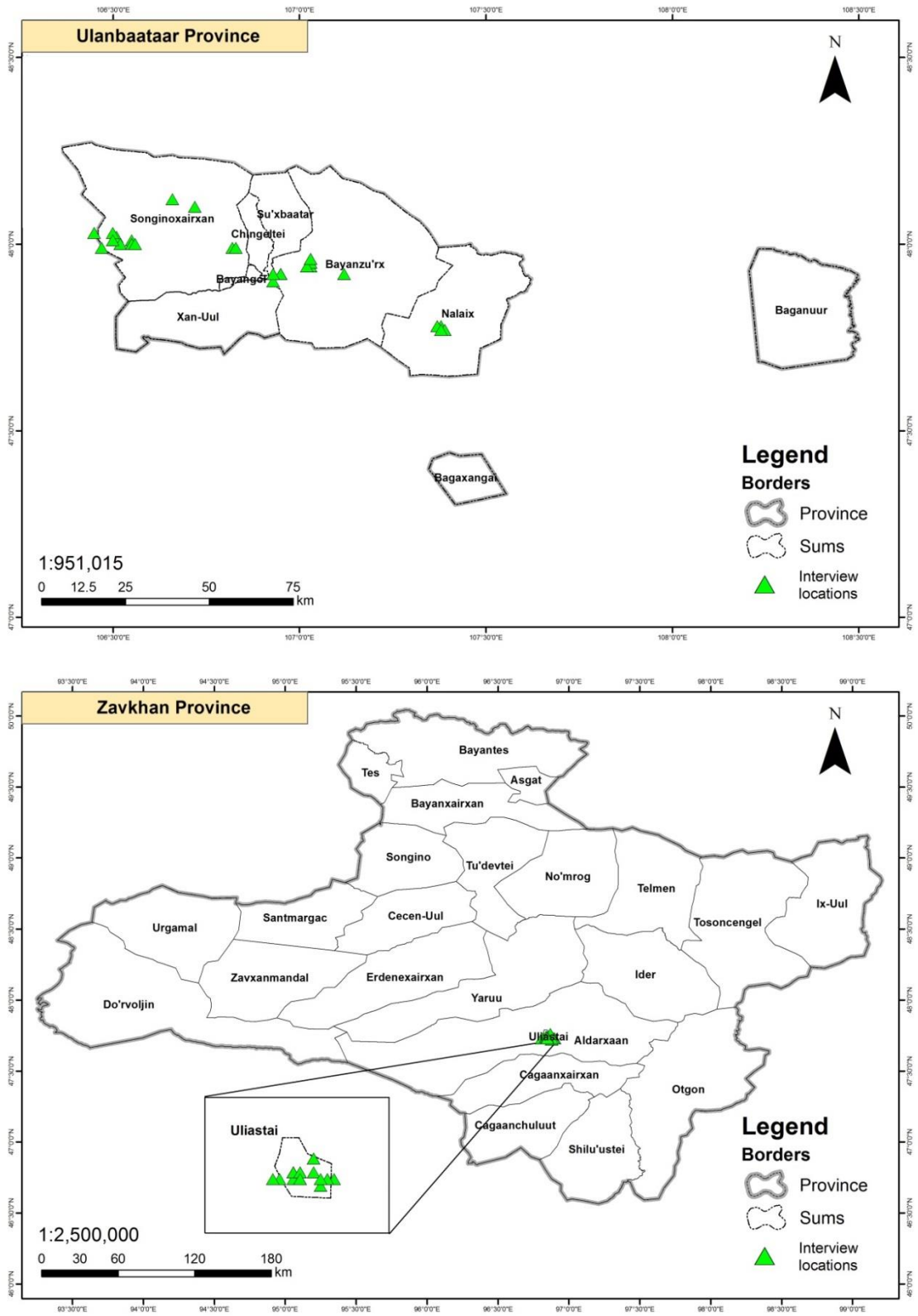

Source: Own presentation

Note: In some cases farmers were invited to an administrative building to participate in the surveys. Therefore, the place of interview may differ from the exact location of the sample farm fields.