International Journal of Agriculture and Biosciences 2025 14(2): 185-192.
https://doi.org/10.47278/journal.ijab/2024.212

RESEARCH ARTICLE
eISSN: 2306-3599; pISSN: 2305-6622

Assessing Environmental Behaviors of Leguminous Crop Farmers in Kazakhstan through the New Environmental Paradigm

Zhansaya Bolatova[1]*, Zhanna Bulkhairova[2], Moldir Kulshigashova[1], Sait Engindeniz[3] and Gulaiym Aimukhambet[1]

[1]Kazakh National Agrarian Research University, Almaty, Kazakhstan
[2]Saken Seifullin Kazakh Agrotechnical University, Astana, Kazakhstan
[3]Ege University, Izmir, Turkey
*Corresponding author: zhbolatova@mymail.academy

ABSTRACT

Kazakhstan is a leading exporter of leguminous crops, which play a vital role in sustainable agriculture due to their nitrogen-fixing capabilities and low environmental impact. However, climate change poses significant challenges, including droughts and extreme weather, affecting crop yields and production sustainability. This study aims to evaluate the environmental attitudes and behaviors of Kazakh farmers growing leguminous crops, using the New Environmental Paradigm (NEP) scale. The study data were collected from 115 farmers in Kazakhstan, a leading exporter of legumes. The results showed that views on climate change as well as all aspects of NEP influence farmers' environmental attitudes. In addition, green identity plays a moderating role in the influence of ecocentric and anthropocentric subdimensions on attitudes towards ecological farming practices. Factor analysis of the new environmental paradigm variables were used to determine the ecological attitudes of farmers in the groups divided by the size of their production. Study demonstrates that Kazakh farmers have a moderate attitude towards the environment; with an average score of 3.27 out of a maximum of 5. Four different groups of environmental attitudes were identified: progress towards ecological balance, environment and living things, natural resources, and nature. The cluster analysis helped to identify that 50% of the farmers are sensitive towards climate changes and and its adverse effects, 22% of the farmers have a moderate attitude, and 28% classify less sensitive. Educated farmers and owners of large-scale production turn out to be more sensitive towards the environment and human-made implications. The results can be used in several theoretical and practical implications for sustainable management of crop production.

Keywords: Climate change, Leguminous crops production, NEP analysis, Farmers opinion, Attitude, Strategy

Article History
Article # 24-935
Received: 29-Oct-24
Revised: 09-Dec-24
Accepted: 13-Dec-24
Online First: 27-Dec-24

INTRODUCTION

Before the general commercialization of agriculture, approximately 400 thousand hectares of leguminous plants (soybeans, peas, chickpeas, beans, beans, lentils) were grown in Kazakhstan for personal use (Yakhnik et al., 2024). The role of leguminous crops has become more significant since the introduction of efficient agricultural practices, which contribute to a significant reduction in greenhouse gas emissions into the atmosphere and reduce the need for fertilizers (Amantayev et al., 2025). Notably, in agroecosystems, pulses help maintain and/or increase the volume and activity of microbial biomass in the soil (Bolatova & Engindeniz, 2020). Grain legumes have been of great interest for growth in Kazakhstan due to the volatility of grain prices and the demand for grain legumes in foreign markets (Poberezhskaya & Bychkova, 2022). Legumes are the most reliable and profitable component of mixed crops due to their abilities to actively fix nitrogen and resist extreme droughts. Kazakh farmers widely grow legumes for

Cite this Article as: Bolatova Z, Bulkhairova Z, Kulshigashova M, Engindeniz S and Aimukhambet G, 2025. Assessing environmental behaviors of leguminous crop farmers in Kazakhstan through the new environmental paradigm. International Journal of Agriculture and Biosciences 14(2): 185-192. https://doi.org/10.47278/journal.ijab/2024.212

A Publication of Unique Scientific Publishers

their use in traditional cuisine, and among them peas are one of the most productive and economically profitable crops. It takes at least 450 $/ton to produce lentils, while for peas this number equals to approximately 250 $/ton (Bahramloo & Nasseri, 2019; Oladejo et al., 2023). However, recent climate change phenomena, including extreme droughts and cold spells, have increasingly impacted the production of leguminous crops in Kazakhstanwhich (Carec, 2022).

The ecological paradigm is a specific form of the social paradigm that is concerned with those extreme changes within the climate. It is a concept that expresses a relatively stable system of views, norms, principles, attitudes and value orientations that are decisive for a given time in the relations of the "Nature-Society" system (Mulvey et al., 2024). An ecological paradigm is formed at certain stages of the development of ecological consciousness. The processes of globalization occurring in the current world presuppose the moral content of human activity, especially in terms of its relationship to nature. The philosophical understanding of the "Nature-Society" system is associated with the perception of the dichotomy of social thinking, which is the basis for the existence of several varieties of the ecological paradigm. The complexity and contradictory nature of the perception of environmental problems and their solution has acquired a worldwide character in the modern world (Samuel & Sibongile, 2019).

Using systems analysis, scientists have developed new scientific research directions within the paradigm, such as global modeling (Anderson, 2012). An objective need has arisen for a philosophical rethinking of human existence in the modern world, the values of life and the prospects for the development of humanity. On this basis, such conceptual approaches as “limits to growth”, “limited growth”, “new humanism”, “revolutions of world solidarity”, etc. have been formed. The study aims to determine the attitudes and environmental sensitivities of farmers and evaluate the level of climate change impacts on leguminous crops via opinion of Kazakh farmers towards the New Environmental Paradigm scale.

MATERIALS & METHODS

Research Design

The research took place in 2022-2023 and was based on the data obtained from face-to-face and online surveys of Kazakh farmers, the second of which was made using Google forms. Their environmental concerns and opinions were gathered using the ‘New Environmental Paradigm’ analysis, first developed by Dunlap & Van Liere (1978). Attitudes towards climate change consequences were also identified via survey with a limited set of response options. Primary evaluations of Kazakh farmers’ socio-economic characteristics were done in order to maintain the study’s integrity. For this same reason, the mass of survey responses was processed using statistical methods after the completion of the research. The study was conducted with consideration of such climatic data as climate change impact on production area, yield and economic efficiency of leguminous crops.

Participants

During the course of the research, 115 Kazakh leguminous crop farmers were asked to share their opinions on environmental concerns. Primary evaluations included the examination of their age and education level, family size, labor force availability and use, land availability and use, capital availability, crop and animal production activities and annual activity results. Considering that the leguminous crop production area may affect the level of participants’ tolerance to climate change, the farmers were divided into three groups according to the size of their production area. The first group of farmers cultivated an area of 19 hectares of land or less, the second group of farmers had production areas between 20 and 40 hectares, the third had production area larger than 41 hectares. The first group consisted of 45 farmers (39.13% of the whole focus group), the second – 39 farmers (33.91%), and the third – 31 famers (26.96%). The total production area has been determined to be 2912 hectares, and the average leguminous crop production area of farmers was 25.32 hectares (Table 1).

Participants’ Environmental Sensitivities Measurement

The environmental sensitivities of the farmers were measured by the ‘New Environmental Paradigm’ (NEP) analysis set of questions (Table 2). NEP was first developed in 1978 as 12 statements for the new worldview on environmental attitudes, later being reconsidered and increased to 15 statements in 2000 (Dunlap et al., 2000). This set of statements was addressed to the farmers in the survey, and responses were received according to the farmers' level of agreement or disagreement with them. Likert scale was used in the evaluation of NEP and climate change impact analysis. The Likert scale was used to evaluate the factors that farmers care about within the problems of climate change and irrigation, farmers' strategies for leguminous crops, and future trends and expectations. Based on the scale, the expressions in the attitude were evaluated on a 5-point scale, 1 being the state of complete disagreement and 5 – complete agreement, with other values in-between (Awunyo-Vitor, 2017). The other part of the survey was dedicated to gathering knowledge on farmers’ use of irrigation methods. Participants were asked whether they use traditional methods of agricultural irrigation or the drip and rain method. The results were compiled to determine the overall attitudes of farmers towards irrigation and its impact on the environment. The same survey method was used to identify the causes of climate change in the eyes of the farmers, precautions and measures taken by them against climate change. Farmers were given questionnaires with the most popular methods and causes from which they had the chose the ones they agree with or apply in their own agricultural practice.

The drought impact on farmers’ activity was determined using the scale from 1 to 5, 1 being determined as having little to no effect, and 5 – being very impactful. To reveal the problems arising from climate change in leguminous crops production, farmers were asked to evaluate to what extent leguminous crops production area, yield, fertilizer and pesticide use, irrigation number, product

Table 1: Grouping according to leguminous crop production area and average yield

Groups	Total number of farmers	%	Total/average production of leguminous crop area (ha)	%	Average yield (kg/ha)
1st group (≤19 ha)	45	39.13	589/13.08	20.23	3524
2nd group (20-40 ha)	39	33.91	847/21.71	29.09	4097
3rd group (≥41 ha)	31	26.96	1476/47.61	50.69	10545
Total	115	100.00	2912/25.32	100.00	18166

Table 2: Questions of the New Environmental Paradigm scale

We are approaching the limit of the number of people the Earth can support.
Humans have the right to modify the natural environment to suit their needs.
When humans interfere with nature it often produces disastrous consequences.
Human ingenuity will insure that we do not make the Earth unlivable.
Humans are seriously abusing the environment.
The Earth has plenty of natural resources if we just learn how to develop them.
Plants and animals have as much right as humans to exist.
The balance of nature is strong enough to cope with the impacts of modern industrial nations.
Despite our special abilities, humans are still subject to the laws of nature.
The so-called "ecological crisis" facing humankind has been greatly exaggerated.
The Earth is like a spaceship with very limited room and resources.
Humans were meant to rule over the rest of nature.
The balance of nature is very delicate and easily upset.
Humans will eventually learn enough about how nature works to be able to control it.
If things continue on their present course, we will soon experience a major ecological catastrophe.

cost and product price were affected by climate change. Effects of climate change on leguminous crops production were evaluated by farmers on scale of 1 to 3: 1 – unchanged, 2 – increased, 3 – decreased.

Survey Results Processing

During the course of work, various statistical programs such as SPSS, ArcGIS, GRETL, and Python were used. Statistical testing was implemented to determine whether there was a difference in opinion between the farmer groups. The Chi-square test was applied in comparisons regarding the data obtained by counting. For continuous variables, first, the Kolmogorov-Simirnov test and the normal distribution test were applied, and variables with or without normal distribution were determined. For normally distributed variables, t-tests and analysis of variance were performed. Mann-Whitney U and Kruskal-Wallis tests were used for variables that do not show normal distribution (Günden & Miran, 2008). Also, Cronbach's Alpha Coefficient and Hotelling T2 test were used to determine the reliability of the farmers' statements in the survey.

RESULTS

The results of the analysis of farmers' attitudes via NEP testing is presented in Table 3. The analysis showed that the environmental sensitivity of leguminous crop farmers is within a moderate range. Farmers believe that 'When humans interfere with nature it often produces disastrous consequences' (4.28); 'Plants and animals have as much right as humans to exist' (4.41); 'Humans will eventually learn enough about how nature works to be able to control it' (4.31); and 'If things continue on their present course, we will soon experience a major ecological catastrophe' (4.82). On the other hand, farmers do not believe that humans have learned to control nature (2.0), and that nature will cope with industrialization (2.2). The Cronbach Alpha Coefficient of the NEP scale, which consists of 15 statements directed to businesses to measure their environmental sensitivity, was calculated to be 0.463.

It was observed that the scale had low reliability, and the following statement was included in the survey: 'There will be an ecological disaster in the future because of what people do'. Statements 'Population has approached the limit' and 'Man plans to dominate nature' were removed, and the highest reliability was reached in the analysis with the remaining 13 statements. The Cronbach Alpha Coefficient of the NEP scale in the modified test was calculated as 0.635, and this value shows that the scale used is statistically highly reliable. However, the values obtained after the Hotelling T2 test ($P<0.05$) showed that the answer averages were equal and that the questions were perceived by the farmers with the same thinking (Table 4). When looking at the opinions of farmers of a larger scale, the highest mean shows the agreement with the statement Man plans to dominate nature' (4.8), but between the other groups statements 'Intervention in nature will bring disaster' and 'Man learns to control nature' are evaluated much lower (2.1). The average agreement to the statement 'Man is subject to the laws of nature' is among the lowest in all groups (1.6). The lowest average in small-scale farmers' opinions is in the statement 'Humans learn to control nature' (1.99), and for bigger scale farmers it is 'Humans will not harm nature' (1.8) (Table 5).

The general average of the participating farmers' agreement was found out to be 3.36 on a 5-point Likert scale for NEP, the lowest average of agreement to the statement being 1.60. However, according to the results of the Kruskal-Wallis H test, the differences between leguminous crop producer groups were not found to be statistically significant ($P>0.05$). This finding was supported by the Mann-Whitney U test, according to the results of which the difference between the leguminous crop farmers of different scales was not statistically significant ($P>0.05$) (Table 5). In Kazakhstan, farmers participate in seminars dedicated to agricultural irrigation, new technology, agricultural practices, and government support initiatives. Traditional surface irrigation methods are mostly used in leguminous crops production. When farmers use new irrigation methods (drip and pressurized irrigation) and new applications, they are supported by the state and the bank reduces loan interest. When the sensitivity of farmers regarding irrigation in leguminous production is examined, producer groups generally comply with irrigation issues and

Table 3: NEP analysis results

Items	Mean	SD
1. We are approaching the limit of the number of people the Earth can support.	2.88	1.48
2. Humans have the right to modify the natural environment to suit their needs.	2.15	1.22
3. When humans interfere with nature it often produces disastrous consequences.	4.28	1.03
4. Human ingenuity will ensure that we do not make the Earth unlivable.	2.38	1.31
5. Humans are seriously abusing the environment.	3.92	1.17
6. The Earth has plenty of natural resources if we just learn how to develop them.	3.83	1.16
7. Plants and animals have as much right as humans to exist.	4.41	0.51
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	2.16	1.27
9. Despite our special abilities, humans are still subject to the laws of nature.	3.73	1.16
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.	2.07	1.35
11. The Earth is like a spaceship with very limited room and resources.	2.00	1.09
12. Humans were meant to rule over the rest of nature.	3.80	1.03
13. The balance of nature is very delicate and easily upset.	2.31	1.39
14. Humans will eventually learn enough about how nature works to be able to control it.	4.31	0.88
15. If things continue on their present course, we will soon experience a major ecological catastrophe.	4.82	0.44

Table 4: Reliability test results of the scale based on environmental attitudes and behaviors

Number of expressions	Cronbach's Alpha value	Hotelling's T2 Value	Hotelling's T2 F value	Hotelling's T2 P value
5	0.635	672.303	87.00	0.000

Table 5: Average between groups according to NEP analysis

Groups	Lowest	Highest	Mean	SD
1st group	1.60	4.80	3.20	1.50
2nd group	2.10	4.80	3.45	2.00
3rd group	2.10	4.80	3.45	1.86
Total	1.93	4.80	3.36	1.78

Kruskal-Wallis H test value=1874.500; P=0.705

are knowledgeable. It was determined that 30.6% of the farmers were moderately knowledgeable, 35.7% were knowledgeable and 31.6% were very knowledgeable about agricultural irrigation. Cronbach's Alpha Coefficient of this survey was calculated to equal to 0.910. Determined value shows that the implied scale is statistically reliable. In addition, the values obtained from the Hotelling T2 test ($P<0.05$) showed that the question averages were equal and that the farmers had the same perception and approach while answering the survey (Table 6).

Farmers' Views and Attitudes on Climate Change

Due to climate change of recent years, Kazakhstan's agricultural production has decreased. Agricultural production suffers from droughts and extreme colds. It seems that water volume decreases due to increasing temperatures. The decrease in water also affects the different plants on the fields. In recent years, it is registered that climate change in the Almaty region affected leguminous crop production (Parmanova et al., 2023). When farmers were asked whether they believed in climate change 83.33% stated that they did, with the other 16.67% being skeptical. Since the land of the Almaty region is large, it has a differing climate and soil. Cold weather is experienced in mountainous regions and drought is experienced in hot plain regions. The farmers of this region were asked whether there was a drought in the last 5 years, to which 70.83% answered positively. The survey also identified problems arisen in leguminous crop production due to climate change. When farmers were asked about the causes of climate change, 34.37% stated that it was caused by anthropogenic impact (the effect of human activities), 33.33% agreed to the cause being natural climatic transformation, and 29.17% thought that the climate change is happening due to the general warming (Table 7).

Participating farmers cultivate various agricultural products in the region of the conducted research. When farmers were asked how drought affected their agricultural production, 40.8% stated that it affected it very much, 37.8% said it affected it slightly, 12.2% stated that it affected it moderately, and the rest stated that it did not affect it at all. Climate change affects Kazakhstan with drought, water scarcity and extreme cold. Because of it, leguminous crops production and yield decrease in the provinces experiencing drought in the Almaty region. 26.5% of the farmers stated that drought affected Kazakhstan's agricultural products and leguminous crops production by a lot, 25.5% noticed the slight effect, and 22.4% – moderate. However, these numbers varied for leguminous crops production in the Almaty region: 35.7% of the farmers stated that it was affected greatly, 31.6% – slightly, and 21.4% – moderately (Table 8). According to the Mann-Whitney U and Kruskal-Wallis H tests, which were performed to reveal whether the differences in attitudes between producer groups are significant, the variation in terms of the impact levels of drought turned out to be not statistically significant ($P>0.05$). Cronbach Alpha Coefficient was calculated as 0.839, and this value showed that the scale used was statistically quite reliable. The values obtained in the Hotelling T2 test ($P<0.05$) show that the farmers have similar perceptions in this case as well (Table 8).

The results of a survey on climate change effects showed that the product price is affected by rapidly decreasing or increasing temperatures. It was observed that the leguminous crops production area did not change whether there was drought or cold (58.2-61.2%); crops' productivity decreased by 34.7% in hot weather and by 28.6% in cold weather. Changes in the use of fertilizers and pesticides were also recorded. 64.3% of the farmers stated that fertilizer use remains unchanged during temperature jump, 58.2% said the same for the changes in the use of pesticides.

Table 6: Irrigation methods in leguminous crops production

Irrigation method	Business groups			Total	%
	1st group	2nd group	3rd group		
Traditional methods	32	20	10	62	53.91
Drip and rain Irrigation	13	19	21	53	46.09
Total	45	39	31	115	100.00

Table 7: Causes of climate change according to farmers

Causes of climate change	Number of farmers	%
Anthropogenic impact	39.53	34.37
Climatic transformation	38.33	33.33
Warming	33.55	29.17
Uncontrolled irrigation systems	3.6	3.13
Total	115	100.00

Table 8: Farmers' involvement in drought impacts

Groups	Effect on leguminous crops			
	Min.	Max.	Mean	SD
1st group	2.53	5.00	3.76	1.34
2nd group	3.55	5.00	4.27	0.76
3rd group	3.46	5.00	4.23	0.86
Total	3.18	5.00	4.06	1.47

Mann-Whitney U test value=804.000; P=0.09; Kruskal-Wallis H test value=2720; P=0.257

25.5% of the farmers say that fertilizer costs increase in drought, and 24.5% – in cold weather. 30-31.6% of the farmers say that their use of pesticides increases in the hot and cold weather respectively. The average determined effect of climate change on production area equals to 1.66, on fertilizer use is 1.46, on pesticide use is 1.53 (Table 9). Farmers stated that the amount of irrigation increases by 48% in drought and by 45.9% in cold weather, and the average effect on irrigation comes down to 1.91. Although 56.1% of the farmers stated that the cost of leguminous crops increased in drought and 54.1% noticed the increase during the cold weather, they stated that it did not change overall as of lately. Farmers also think that leguminous crop seed quality will decrease due to drought and cold. In terms of product quality, 55.1% of the participants indicate that it decreases in drought and 50% say the same for cold weather. Since climate change affects leguminous crop production and cost, it also affects the price. According to the farmers, the average price of leguminous crops is affected by 1.96 on the survey scale, and they stated that the prices increase by 51% in drought and 50% in cold.

Similar to the last results, Mann-Whitney U and Kruskal-Wallis H tests showed that the differences in attitudes between the farmers of different groups were not significant (P>0.05). Cronbach's Alpha Coefficient was calculated as 0.939, which shows the reliability of the survey. When farmers were asked about the precautions they took against climate change, it was determined that the most repeated measure was choosing resistant and suitable crop varieties (63.54%). Other precautions taken by farmers are shown in Table 10. When producers were asked what measures the government should take in response to climate change, it was found that the most repeated measure was increasing support for irrigation (76.04%) (Table 11). Judging by the results of NEP analysis, four different groups of farmers' environmental attitudes were identified: focus on ecological balance, environment and living things, natural resources and nature. Based on the cluster analysis, farmers were divided into three different groups depending on their attitude: 50% of farmers were classified as sensitive towards climate change effects and consequences, 22% as moderate and 28% as less sensitive. Results show that educated and large-scale farmers are more sensitive to the environmental causes.

The lands of the participating farmers are mostly irrigated by state irrigation (43.76%) and irrigation cooperatives (32.29%). In legume production, 18.75% of the producers' land is irrigated by streams, creeks, and rivers. Flood irrigation (42.71%), rain irrigation (35.42%) and drip irrigation (17.71%) methods are used in other crops production in the studied enterprises. As a result of climate change, water scarcity in Kazakhstan is increasing day by day, which affects the income of agricultural producers of different sizes (Kerimray, 2016). This trend is evident worldwide: in the research of Kim & Chavas (2003), it is found that in rain-irrigated regions irrigation income and produce yield are seen to have great detrimental effects, making these areas vulnerable to the decrease in irrigation and an increase in evapotranspiration. Farmers see the most important problem in irrigation as the decrease in underground water resources. This is followed by insufficient rainfall and high fuel prices, because of which farmers believe that the state should support producers in irrigation and effective crop production. When the results given so far are evaluated, it is revealed that legume and other crop production can be economically sustained in enterprises (Zougmoré et al., 2016). In recent years, producers have been trying to increase yield by using hybrid varieties and high maintenance work as an alternative to heavy chemical use. As they have limited organizational tendencies, farmers want to receive more support from the state in order to withstand the climate change and its negative effect on production (Kim et al., 2018). In addition to the demanded measures, they try to upkeep crop growth by their own means, as is evident by the conducted research.

DISCUSSION

Drought is a common problem faced by many regions of the world, and it has a significant impact on agriculture (Zafar et al., 2023; Zafar et al., 2024). Overuse of water resources, poor water management, lack of modern technologies and poor choice of crop varieties are

Table 9: Effects of climate change (drought and cold) on leguminous crops production according to farmers

Measures	Impact	Items	1st group	2nd group	3rd group	Total avg.
Production cost	Drought	Average	1.84	2,03	2,12	1,97
		SD	0,83	0,88	0,52	0,78
	Cold	Average	1,89	2,06	2,07	2
		SD	0,87	0,89	0,48	0,79
Yield	Drought	Average	2,14	2,39	2,46	2,31
		SD	1,06	0,99	0,81	0,97
	Cold	Average	2,14	2,39	2,5	2,32
		SD	1,06	0,99	0,81	0,98
Product quality	Drought	Average	2,16	2,3	2,5	2,3
		SD	1,04	1,02	0,76	0,96
	Cold	Average	2,11	2,27	2,46	2,26
		SD	1,02	1,01	0,76	0,95
Product price	Drought	Average	1,81	1,97	2,12	1,95
		SD	0,84	0,88	0,65	0,81
	Cold	Average	1,81	1,97	2,15	1,96
		SD	0,84	0,88	0,67	0,82
Cultivation area	Drought	Average	1,57	1,94	1,81	1,76
		SD	0,89	0,96	0,94	0,94
	Cold	Average	1,35	1,97	1,73	1,66
		SD	0,72	0,95	0,92	0,89
Number of irrigations	Drought	Average	1,76	1,94	2,07	1,91
		SD	0,86	0,93	0,56	0,82
	Cold	Average	1,78	1,97	2,12	1,94
		SD	0,88	0,95	0,58	0,84

1: unchanged, 2: increased, 3: decreased; Mann-Whitney U test value=1067.000; P=0.1067; Kruskal-Wallis H test value=2087; P=0.352

Table 10: Precautions taken by farmers against climate change

Items	Groups			Total
	1st group	2nd group	3rd group	
Choosing durable and suitable varieties of crops	25	21	15	61
Monitoring climate data	21	17	13	51
Improve drainage system	17	16	12	45
Paying attention to maintenance operations	17	14	11	42
Get product insurance	16	13	10	39
Using new irrigation technologies	15	11	10	36
Save water	13	11	10	
Other actions	12	10	7	29
Information and guide	-	3	5	8

Table 11: Measures farmers expect the state to take against climate change

Items	Groups			Total
	1st group	2nd group	3rd group	
Irrigation support should be increased	27	25	21	73
New irrigation technologies and techniques	23	21	18	62
Must be informed	21	19	17	57
Warehouses should be built and put into use	19	16	14	49
Controls should be made on product prices	17	15	12	44
Drip irrigation should be encouraged	15	13	11	39
Climate data must be delivered on time	14	12	10	36
New varieties should be bred	12	10	7	29
Insurance should be popularized	9	9	6	24

worsening the situation (Cohen et al., 2020; Dietz et al., 2021). Global climate change is exacerbating these problems, threatening food security, especially in developing countries (Kulkarni et al., 2020; Santini et al., 2022; Zafar et al., 2022). Kazakhstani farmers, like those in other countries, observe that their crops are suffering as a result of climate change (De Matos et al., 2019; Ojo & Baiyegunhi, 2021; Sorvali et al., 2021). Large landowners' awareness of the impact of ecological and anthropogenic variables probably comes from their understanding of plant physiology. Plant growth processes are disturbed by high air temperatures and low soil and atmospheric humidity (Noein & Soleymani, 2021). As stress causes turgor to be lost, cells cannot grow, which results in a reduction in photosynthetic area and a smaller leaf. Drought also lowers agricultural productivity what affect production cost (Cohen et al., 2020; Zafar et al., 2021). Our results also showed that larger landowners were more sensitive to higher production costs and lower yields than smaller farmers.

To address these issues, proper water management, regular monitoring of drought severity and the application of climate-smart agricultural technologies are needed. These measures can help mitigate the effects of drought and enable more efficient production of legumes on marginalized lands, contributing to sustainable agricultural development (Haroon et al., 2022). Ulyanych et al. (2021) confirmed that drip irrigation, which allows water to be supplied directly to the roots, resulted in a strong increase in the yield of different varieties of Vicia faba L. var. Major in Ukraine. The results of the analysis showed that the use of irrigation contributed to an increase in plant height by 4.7–12.2%, the number of branches per plant by 17.3–30.0%, and the leaf area of bean crops by 21.2–24.9%. Lastly, overall yield of Vicia faba L. increased by 31.3–39.2%. Moreover, the

study in the arid region of China, Xinjiang, compared flood and drip irrigation of Alfalfa (*Medicago sativa* L.). The activities of soil enzymes, urease and neutral phosphatase, that allow easier transport of salts, in the rhizosphere under drip irrigation were significantly higher than in the rhizosphere of alfalfa under irrigation (Deng et al., 2022).

In addition to the studies on drylands, there are studies on growing legumes in cold climates. Karges et al. (2021) studied cold-resistant soybean varieties grown in northern Germany. It is known that a temperature range of 8–12°C are necessary for successful growth and germination of soybean, and lower temperatures reduce plant density, yield, ovule fertilization and flower drop (Staniak et al., 2021). The forage soybean varieties Sultana and Merlin demonstrated better adaptation to growing conditions and temperature, providing higher and more stable yields (on average 2,700kg/ha) compared to the food variety Protibus (on average 1,300kg/ha). Additional drip irrigation increased the soybean grain yield by an average of 41%. Gross profits from organic soybeans ranged from €750/ha for rainfed food soybeans to €2,000/ha for irrigated forage soybeans (Karges et al., 2021). Our survey data also showed that farmers are turning to more climate-resilient crops and are noticing that efforts to produce higher yields are driving up the price of their crops. Despite extensive research and cutting-edge technology, climate change remains a serious threat to agriculture as a whole. Rising temperatures, changing rainfall patterns, increasing atmospheric carbon dioxide levels, as well as increasing extreme weather events and changing pest and pathogen activity pose additional challenges to legume productivity. Only an integrated approach to addressing these issues can ensure sustainable agricultural development and food security.

Conclusion

The environmental sensitivity of leguminous crops producers was analyzed using the New Environmental Paradigm (NEP) questionnaire. Their responses were found to be quite moderate when evaluated with a Likert scale, calculated as 3.27 out of 5 possible. The results of the climate change perceptions survey show that decreased rainfall and increased temperatures or frost damage the yield of leguminous crops, as the farmers suggest. Different regions have various climates, and climate change will have a positive effect on crop yields in the North and Southeast Regions. It will allow farmers to cultivate economically efficient production. The cultivated land area is expected to decrease in the Southern and Northwestern regions of large-scale farms in the country. Farmers adapt to climate change by using hybrid seeds and new irrigation technologies. Frost days will impact the yield of small-scale farms. Leguminous crops are important export crops, and, in some regions, climate change will impact agricultural productivity and food security of Kazakhstan.

Author's Contribution: Zhansaya Bolatova and Zhanna Bulkhairova designed the study, Moldir Kulshigashova performed the experiments, while Sait Engindeniz and Gulaiym Aimukhambet conducted laboratory analysis. Zhansaya Bolatova supervised the project and coordinated the experimental work. Gulaiym Aimukhambet performed statistical analysis of the collected data. Moldir Kulshigashova and Sait Engindeniz prepared the first draft of the manuscript. All authors critically revised the manuscript and approved the final version.

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