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Constraints of Climate Change Adaptation Wheat Producers in Yalvaç District

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Abstract—This study analyzed the constraints limiting farmers' adaptation to climate change. A stratified random sampling method was used to select 116 producers, who were interviewed face-to-face using a structured questionnaire. The Constraint Facing Index (CFI) was employed to evaluate and rank the obstacles encountered. The results indicate that the primary obstacle is the lack of information on climate change adaptation measures, with a CFI of 313. Other constraints include insufficient knowledge of specific adaptation strategies and the absence of training or seminars on managing climate impacts. These findings highlight the importance of implementing agricultural policies aimed at overcoming these barriers by improving access to up-to-date information, offering tailored training programs, and providing increased technical and financial support. Such measures would better equip producers to face the challenges of climate change and enhance their adaptive capacity.

Keywords—Barriers, Wheat, Farmers, Turkey

I. INTRODUCTION

Climate change is one of the primary threats to global food security, significantly impacting agricultural production [1], [2]. Cereal crops, such as wheat, are particularly vulnerable due to their sensitivity to climatic variations, especially shifts in temperature, precipitation, and extreme events like droughts and floods [3]. In Turkey, the effects of climate change on wheat production are already well-documented, with numerous complaints from farmers [4], [5], [6]. Given the crucial role of wheat in daily consumption, farmers are compelled to adopt adaptation measures to ensure continued production. However, many constraints limit these efforts. Previous studies by [7], [8], [9] have identified key obstacles such as limited access to financial resources, infrastructure, and adequate information. These barriers whether socio-economic, institutional, or technical restrict farmers' ability to adopt effective adaptation strategies. Understanding these specific constraints is essential for developing agricultural policies and adaptation strategies tailored to local realities. The objective of this study is to identify and analyze the main obstacles hindering wheat producers in Turkey from adapting to climate change, while proposing solutions to enhance their resilience. Additionally, this research will serve as a valuable tool for policymakers, extension agents, and planners in designing agricultural policies aimed at overcoming these barriers. For academics, it will also provide a foundational database for future research on agricultural adaptation to climate change.

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II. MATERIALS AND METHODS

A. Study Area

The Yalvaç district is located in the Mediterranean region of southwestern Turkey, specifically within the province of Isparta (Figure 1). It spans a total area of 141 500 hectares, consisting of 40.44% agricultural land, 40.75% forest area, 7.07% lake area, 5.89% meadows and pastures, and 5.85% roadways and residential zones. The primary economic activity of its residents is agriculture, with a particular focus on wheat production [10].

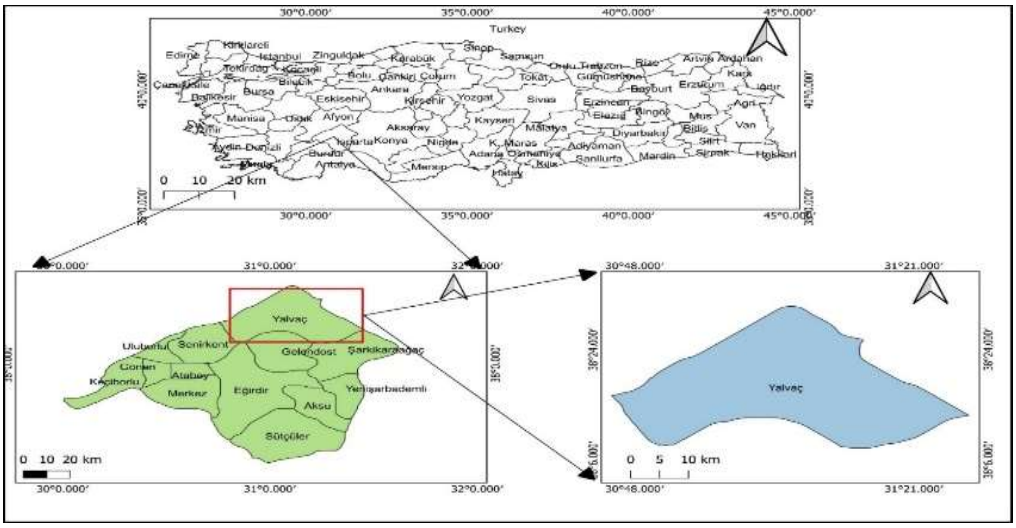

Figure 1: Study area

Source: Based on [11]

The analysis of meteorological data for Yalvaç (figure 2) indicates an increase in temperature from 10.98°C to 11.58°C between 1981 and 2021. Simultaneously, precipitation has decreased over the past four decades, dropping from 490.43 mm to 410.82 mm [12]. [13] predict a further decline in precipitation in the Yalvaç district in the coming decades. These variations highlight the impact of climate change in the Yalvaç district, which is likely to significantly affect agricultural production, particularly wheat. According to [14], the region is also at risk of agricultural drought due to diminishing surface water resources.

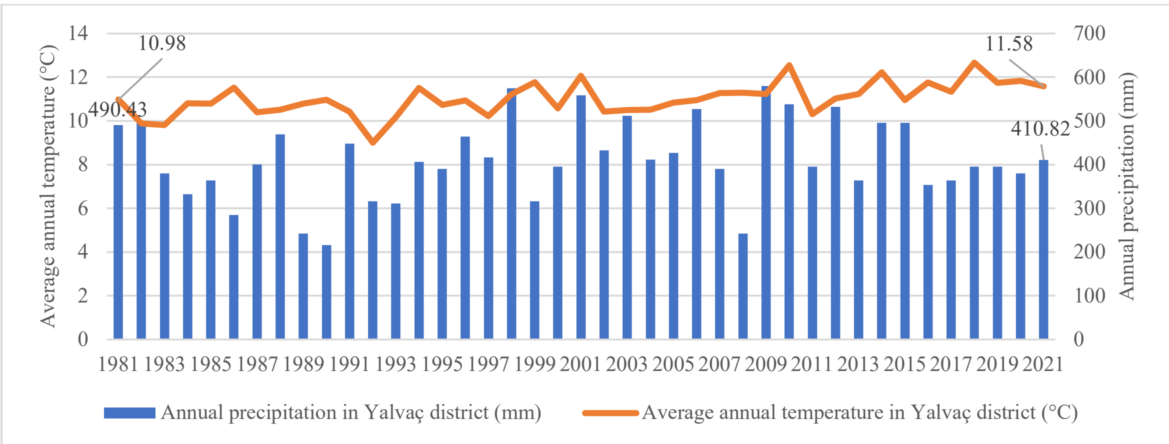

Figure 2: Temperature and precipitation between 1981 and 2021 at Yalvaç
Source: [12]

B. Data Collection

The data for this study were collected through face-to-face interviews with wheat producers in the Yalvaç district. The data collection instruments included closed-ended questions, open-ended questions, and a Likert scale, which were used to gather most of the responses from the farmers. The target population consisted of wheat producers registered in the producer registration system for the 2022 production season. The sample size was determined based on the area of agricultural land dedicated to wheat cultivation, measured in decares. The number of producers included in the sample was calculated using the stratified random sampling method [15]. The distribution of farmers across different strata was conducted using the Neyman method [16], according to the following formulas:

$$n = \frac{\sum(N_h * S_h)^2}{N^2 D^2 + \sum N_h {S_h}^2} \quad (1)$$

$$n_i = \frac{N_n S_n n}{\sum (N_n S_n)} \quad (2)$$

In (1) and (2):

n represents the sample size; N is the total number of units (after excluding producers with less than one decare from the total of 2308, the new N becomes 2247); N_h is the number of units in stratum h; S_h is the standard deviation of stratum h; D is calculated as d/Z, where d is the deviation from the mean, and Z represents the number of degrees of freedom in the t-distribution diagram (N-1), The z-value corresponds to a certain confidence level 95% confidence with a margin of error of 5%.

$$n = \frac{(19352)^2}{(2247)^2 \left(\frac{1.50}{1.96}\right)^2 + (256933.7)}$$

Table 1: Frequency of farmers by strata

Stratum	Stratum margins (da)	Average	N_h	S_h	N_hS_h	Stratum Sample Number
I	1.00-20.00	10.39	1121	6.50	7281.51	44
II	20.01-50.00	32.03	793	6.73	5341.31	32
III	50.01-100.00	68.16	233	13.22	3082.54	18
IV	100.00 +	134.18	100	36.46	3646.59	22
	Total	30.09	2247		19352	116

C. Constraint Analysis

A constraint measurement scale was used to assess the level of constraints. This scale includes ratings from 3 to 0 assigned by each farmer to each constraint. The meaning of the scores indicates the extent of the constraint and can be interpreted as follows: 3 = high, 2 = medium, 1 = low, and 0 = no constraint. The overall constraint score for each farmer was determined by summing the scores of all constraints. A total of 12 constraints were presented to the producers, who rated them based on the perceived degree of constraint. Each respondent's constraint score ranges from 0 to 36. A score of 0 is assigned to a farmer who gives a rating of 0 to all constraints, indicating no constraint. Conversely, a respondent receives a score of 36 if they assign a rating of 3 to all 12 predefined constraints. The score for each constraint can range from 0 to 348, with a score of 0 indicating that all 116 respondents rated it 0, and a score of 348 indicating that all 116 respondents rated it 3. A score of 0 represents the lowest level of constraint, while a score of 348 represents the highest level of constraint. Based on the constraint facing index (CFI) scores for each constraint, a ranking was established following the methodology of [17], [18].

$$CFI = (C_h \times 3) + (C_m \times 2) + (C_l \times 1) + (C_0 \times 0) \quad (3)$$

Where: C_h is the number of producers indicating that the constraint is high, C_m is the number of producers indicating that the constraint is medium, C_l is the number of producers indicating that the constraint is low, C_0 is the number of producers indicating that the constraint does not exist.

III. RESULTS AND DISCUSSION

A. Constraint Analysis

Producers assessed the importance of each constraint they face using a Likert scale. The results of this assessment, stratified by categories, are presented in Table 1. These results indicate that the main constraints identified by producers include: a lack of information about the climate (76%), a lack of knowledge about adaptation measures for climate change (76%), a lack of financial resources (45%), a lack of water resources (49%), a lack of labor (40%), and the absence of training or seminars on managing the impacts of climate change (60%). Constraints of moderate importance involve a lack of technology (44%) and weather information (40%). The constraints faced by wheat producers in this study are comparable to those observed in other regions or countries. In India, for example, wheat producers encounter difficulties such as the unavailability of raw materials, a lack of agricultural credit, and high diesel costs [19]. In central Vietnam, major obstacles for producers engaged in climate-smart agriculture include a lack of financial resources, information, technical support, and land ownership [20]. In Pakistan's Punjab region, the lack of institutional support, information and financial resources limits the adoption of climate-smart agriculture measures [7]. In Burundi, obstacles to adaptation include a lack of climate information, producer poverty, and a lack of knowledge about adaptation strategies [8]. According to [21], high input costs, the absence of irrigation systems, and a lack of climate information also limit farmers' ability to adapt to climate change effects. These findings highlight the diversity of challenges faced by producers worldwide in adapting to climate change.

Table 1: Distribution of constraints in each stratum

	Stratum I	Stratum II	Stratum III	Stratum IV	Total : n (%)
Lack of technology					
No	3	0	0	1	4 (3.4)
Low	5	5	2	2	14 (12.1)
Medium	14	15	11	11	51 (44)
High	22	12	5	8	47 (40.5)
$\chi 2$ =8.57 ; p=0.48 ; avg.=3.2 ; Std Dev: =2.8					
Lack of finance (money)					
No	2	1	0	2	5 (4.3)
Low	4	1	3	4	12 (10.3)
Medium	17	14	7	9	47 (40.5)
High	21	16	8	7	52 (44.8)
$\chi 2$ =6.97; p=0.64; avg.=3.3 ; Std Dev: =2.8					
Lack of water					
No	2	0	0	3	5 (4.3)
Low	8	4	2	4	18 (15.5)
Medium	13	11	8	4	36 (31)
High	21	17	8	11	57 (49.1)
$\chi 2$ =9.88; p=0.36; avg.=3.3 ; Std Dev: =2.8					
Labor shortage					
No	3	5	0	3	11 (9.5)
Low	11	5	2	6	24 (20.7)
Medium	15	11	7	4	37 (31.9)
High	15	11	9	9	44 (37.9)
$\chi 2$ =8.48; p=0.49; avg.=3.0 ; Std Dev: =2.6					
Lack of knowledge on climate change					
No	2	2	0	1	5 (4.3)
Low	2	0	0	1	3 (2.6)
Medium	8	5	2	5	20 (17.2)

High	32	25	16	15	88 (75.9)
$\chi2$ =4.84; p=0.85; avg.=3.6 ; Std Dev: =3.2					
Lack of knowledge about climate change adaptation measures					
No	1	1	0	0	2 (1.7)
Low	2	0	0	1	3 (2.6)
Medium	8	6	3	6	23 (19.8)
High	33	25	15	15	88 (75.9)
$\chi2$ =4.51; p=0.87; avg.=3.7 ; Std Dev: =3.2					
Provincial/District Directorate of Agriculture does not provide sufficient support					
No	9	4	4	5	22 (19)
Low	21	11	9	5	46 (39.7)
Medium	8	14	1	6	29 (25)
High	6	3	4	6	19 (16.4)
$\chi2$ =15.26; p=0.84; avg.=2.4 ; Std Dev: =2.1					
Weather forecasts are not always accurate					
No	3	2	3	1	9 (7.8)
Low	13	8	7	6	34 (29.3)
Medium	18	15	6	7	46 (39.7)
High	10	7	2	8	27 (23.3)
$\chi2$ =6.83; p=0.65; avg.=2.8 ; Std Dev: =2.4					
Poor road conditions limit market access					
No	26	22	11	14	73 (62.9)
Low	10	5	5	4	24 (20.7)
Medium	7	3	1	2	13 (11.2)
High	1	2	1	2	6 (5.2)
$\chi2$ =6.83; p=0.65; avg.=1.6 ; Std Dev: =1.3					
Training/course/seminar on managing the impacts of climate change					
No	3	2	2	3	10 (8.6)
Low	6	0	0	1	7 (6.0)
Medium	16	6	5	3	30 (25.9)
High	19	24	11	15	69 (59.5)
$\chi2$ =15.81; p=0.71; avg.=3.4 ; Std Dev: =3.0					
I do not adopt the recommendations of experts					
No	23	13	14	10	60 (51.7)
Low	12	10	2	4	28 (24.1)
Medium	6	4	1	4	15 (12.9)
High	3	5	1	4	13 (11.2)
$\chi2$ =9.76; p=0.37; avg.=1.8 ; Std Dev: =1.6					
I do not find the experts' recommendation appropriate/accurate					
No	22	14	14	13	63 (54.3)
Low	12	12	2	5	31 (26.7)
Medium	6	2	0	1	9 (7.8)
High	4	4	2	3	13 (11.2)
$\chi2$ =4.51; p=0.35; avg.=1.8 ; Std Dev: =1.5					

avg.= average ; Std Dev: = Standard Deviation

The classification of producers based on their constraint scores is presented in Table 2. Producers were categorized into three levels (low, medium, and high) according to the degree of constraints they face. The results indicate that constraint scores range from 6 to 36, with a mean of 21.77 and a standard deviation of 4.52. The majority of surveyed producers (70.7%) face medium-level constraints, while 25% encounter high-level constraints and 4.3% experience low-level constraints. The predominance of medium-level constraints underscores the significant impact these obstacles have on the implementation of climate change adaptation measures. The 25% of producers facing high-level constraints represent a particularly vulnerable subgroup. This group warrants special attention in targeted policies, as these producers are likely to be more adversely affected by climate changes and less capable of adopting innovative practices. Similar findings were reported by [18] and [22], who observed that most producers encounter medium-level constraints in ensuring food security and adopting climate-smart agricultural practices. Likewise, in India, [23] found that the majority of rice farmers face medium-level constraints when classified into three categories. [24] also showed that in the agricultural sector, most producers confront medium-level constraints. The increased vulnerability of producers to climate change effects highlights the importance of targeted interventions aimed at enhancing their capacity to overcome these challenges.

Table 2: Classification of producers according to constraint scores

Classification of producer constraint scores	Number	%	Average	Standard Deviation
Low (< 12)	5	4.3	21.77	4.52
Medium (13 - 24)	82	70.7		
High (>24)	29	25		
Total	116	100		

B. Ranking Constraints

Table 3 presents the classification of difficulties based on the constraint index calculation. The results show that the lack of information on climate change adaptation measures is the most frequently cited constraint by the majority of wheat producers in the Yalvaç district, with an index reaching the highest score (313). These results highlight the critical importance of increasing awareness among producers and disseminating information about climate change adaptation practices. [25] also found that a lack of knowledge about appropriate adaptation measures constitutes a barrier for producers. In contrast, the poor condition of roads, which limits market access, is the least mentioned constraint by producers, with a score of 68. Although this constraint is relatively less concerning, it nonetheless underscores the importance of transport infrastructure for ensuring optimal market access. The analysis of these indices thus provides valuable insights for prioritizing constraints, guiding interventions toward priority areas that require increased attention to strengthen the resilience of Yalvaç producers in the face of climate change challenges. Similar studies using the constraint index have shown comparable results. [9] revealed that the unpredictability of weather conditions is the major constraint limiting adaptation to climate change. [26] observed that the shortage of high-quality seeds was the primary constraint for producers, while [23], through the calculation of the CFI, identified a lack of knowledge and technical support in integrated pest management as a major constraint for farmers.

Table 3: Results of the CFI

Constrains	Low	Medium	High	CFI	Ranking
Lack of technology	14	102	141	257	6.
Lack of finance (money)	12	94	156	262	4.
Lack of water	18	72	171	261	5.
Labor shortage	24	74	132	230	7.
Lack of knowledge on climate change	3	40	264	307	2.
Lack of knowledge about climate change adaptation measures	3	46	264	313	1.
Provincial/District Directorate of Agriculture does not provide sufficient support	46	58	57	161	9.
Weather forecasts are not always accurate	34	92	81	207	8.
Poor road conditions limit market access	24	26	18	68	12.
Training/course/seminar on managing the impacts of climate change	7	60	207	274	3.
I do not adopt the recommendations of experts	28	30	39	97	10.
I do not find the experts' recommendation appropriate/accurate	31	18	39	88	11.

C. The Future of Wheat Production

Producers (65.6%) report that the challenges they face in adapting to the effects of climate change persist or have not yet been overcome. This significant proportion highlights the complexity of the obstacles and underscores the need for continuous and diverse adaptive approaches. However, it is encouraging to note that 23% of producers have proactively sought information, particularly through the internet or by participating in agricultural fairs, to explore potential solutions. This proactive effort reflects a willingness to innovate and find new strategies to address climate-related challenges. Despite these ongoing difficulties, a large majority of producers (89%) expressed their intention to continue cultivating wheat in the future, emphasizing the economic and cultural importance of this crop in the region. This perseverance shows a deep commitment to wheat production despite climate uncertainties. Nevertheless, the fact that a minority of producers are considering switching to sectors like trade or livestock suggests that adaptability and agricultural diversification are becoming strategic considerations.

IV. CONCLUSION

This study analyzed the constraints limiting farmers' adaptation to climate change. Using the calculation of the CFI, the primary challenges faced by producers were ranked. The most significant constraint, with a CFI of 313, was the lack of information on climate change adaptation measures. Many other constraints were also identified, further restricting farmers' capacity to adapt. Based on these findings, it is recommended that public policies be implemented to provide targeted support to farmers most affected by these barriers, specifically through information dissemination, technical assistance, and financial support. Provincial agricultural authorities should plan training and extension initiatives in collaboration with local stakeholders to enhance farmers' resilience to the effects of climate change. Regular workshops and seminars, organized in partnership with agricultural engineers from provinces and districts, could facilitate the sharing of best practices and the introduction of agricultural innovations. It is also crucial for farmers to actively participate in these training sessions to strengthen their ability to adapt to the impacts of climate change on their farms. Lastly, collaboration with research institutes and climate change experts would allow for the development of specialized training programs tailored to farmers' specific needs. These programs could cover topics such as sustainable farming practices, efficient water management, energy-saving irrigation techniques, and other adaptation strategies.

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