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ASSESS THE LEVEL OF FARMERS' AWARENESS REGARDING CLIMATE CHANGES AND ITS IMPACTS ON AGRICULTURE IN SÉTIF PROVINCE (NORTH-EAST ALGERIA)

Abstract: The present study presents the phenomenon of climate changes through discussing its impacts on agriculture productions in Sétif Province, which is area of survey that located in the high plains of north-east Algeria. The study focuses to evaluate the perception degree of peasants toward the phenomenon via statistical analysis and discuss its futures challenges. It is presumed that climate changes have a significant effect on agriculture in the region; the water usage was increased in agriculture and the expansion of saline areas has increase soil degradation. Still, the vegetable and fruit crops reporting negative impacts living organisms are experiencing imbalances in natural biodiversity. In other point, the findings indicate that over half of the participants farmers (63.00%) have a moderate level of knowledge about climate changes, while 18.04% have a high level of knowledge. The status of the agriculture is in a critical condition and the findings indicate a relative gap in understanding the climate changes. Based on, some challenges have been revealed mainly: highlighting the need for effective dissemination of agricultural recommendations to improve farmers' knowledge that can support adaptation and mitigation toward climate change effects. In parallel, the agriculture is in need of continuous follow-up survey in the context of climate changes and socio-economic aspect to assure the quality of life in rural area and guaranteeing food security, where the environmental perspectives and sustainable development should be considered in the future spatial planning.

Key words: peasants' perception, agriculture system, rural development, food security, adaptation and mitigation

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Introduction

Agriculture is important for natural systems, human health, and development, where water resources, air pollution, and soil fertility are key factors affecting agricultural productivity (Noya et al., 2018). In this context, it should be noted that environmental changes lead to abiotic stresses that significantly affect crop productivity (Ashraf et al., 2018; Benevenuto et al., 2017). The climatic changes (Giorgi, 2006) and their impact on agriculture a current issue, where numerous studies have discussed its impact on agriculture (Fiwa et al., 2014; Osborne & Wheeler, 2013; Rosenzweig et al., 2014; Saadi et al., 2015).

The impact of climate change is assessed by examining periods of stress and their effects on life and crops (Raza et al., 2019), where living organisms are severely affected by harsh environmental conditions, and the threat of climate change raises concerns about crop yields and food security. Adverse weather conditions reduce crop yields and affect food security (Schmidhuber & Tubiello, 2007; Wheeler & von Braun, 2013). Climate change affects water resources (Rouibah & Belabbas, 2022b), which are vital natural resources and essential for agriculture. Water availability is expected to decrease due to climate change, while agricultural water consumption is projected to increase by 19% by 2050 (Baumgartner & Pahl-Wostl, 2013). Climate change is expected to cause greater fluctuations in crop production, food supply and market prices, exacerbating global food insecurity and poverty, and affecting the livelihoods of millions of people worldwide (Bandara & Cai, 2014; Schmidhuber & Tubiello, 2007; Wheeler & von Braun, 2013). Developed countries are 8-11% more vulnerable to climate change than developing countries (Altieri & Nicholls, 2017; Lesk et al., 2016). As a result, agricultural production has been negatively affected, raising concerns about the stability of the global environment.

In the Algerian context, the semi-arid region and arid region occupy the largest part of Algeria which is characterized by its specific activities and environmental systems including agriculture (Côte, 1996). However, it should be noted that several aspects related to the agriculture sector were discussed such as the agrarian landscape evolution (Hafiza 2013), farm diversity and crop growing practices (Ramdane & Christine, 2012), farming system, typology and the economic performance of the farming system (Rouabhi & Hafsi, 2012; Rouabhi et al., 2014). Agriculture in Algeria is facing several challenges including food security (Bessaoud, 2019). Besides, the water resource vulnerability state was discussed under climate change (Mohammed & Al-Amin, 2018; Nichane & Khelil, 2015; Rouibah & Belabbas, 2022b) and the climate changes and their impact on agricultural production in Algeria (Bouznit et al., 2022) was demonstrated. So, the farmer's awareness of environmental conditions and agricultural characteristics and challenges is needed.

The fact that a new participatory strategy was adopted in the development of rural areas in Algeria (Zahira & Bessaoud, 2011). As mentioned precisely and according to the literature, the estimated degree of peasants' awareness of climate change is needed. The peasant is one of the principal factors of agriculture development and rural area stability is very important in coping with the effects of climatic changes and improving production by adapting to the situation. This type of study is very limited in Alegria. Thus, the present study conducted us to choose the Sétif Province as the

study of an area located in the northeast of Algerian characterized by its semi-arid region and characterized by its large agricultural area and vocation. The region is subjected to climate changes (Rouabhi et al., 2018), where a detailed agricultural spatial information analysis of its general environmental and socioeconomic impact within the context of climate changes was provided and discussed (Rouabhi et al., 2019; Rouabhi et al., 2016).

The article aims to accomplish several objectives: Investigate the major issues resulting from climate change and its effect on agricultural growth and production in the study area. However, the study focused on understanding how local farmers perceive and respond to climate change and identify the future challenges they face. Therefore, explore and identify suggested strategies, where the reaction of paysans ultimately contributes to mitigating the negative impacts and enhancing resilience in the agricultural sector. Therefore, contribute to sustainable development.

Study area

Sétif Province is located in the northeastern part of Algeria (Figure 01). The natural landscape of Sétif Province is characterized by its heterogeneity due to its location between two distinct regions: the Tell Atlas Mountain range in the north, which covers 37% of the Province's total area, amounting to approximately 2,406.32 square kilometers. In contrast, the High Plains region is characterized by its flat and expansive terrain, covering 53.75% of the Province's area, with elevations ranging between 800 and 1,000 meters. This area lies between the mountainous regions to the north and south. To the south, the mountainous region is represented by the Hodna Mountains, which are noted for their steep slopes. The location of Sétif Province is illustrated in the (Figure 1).

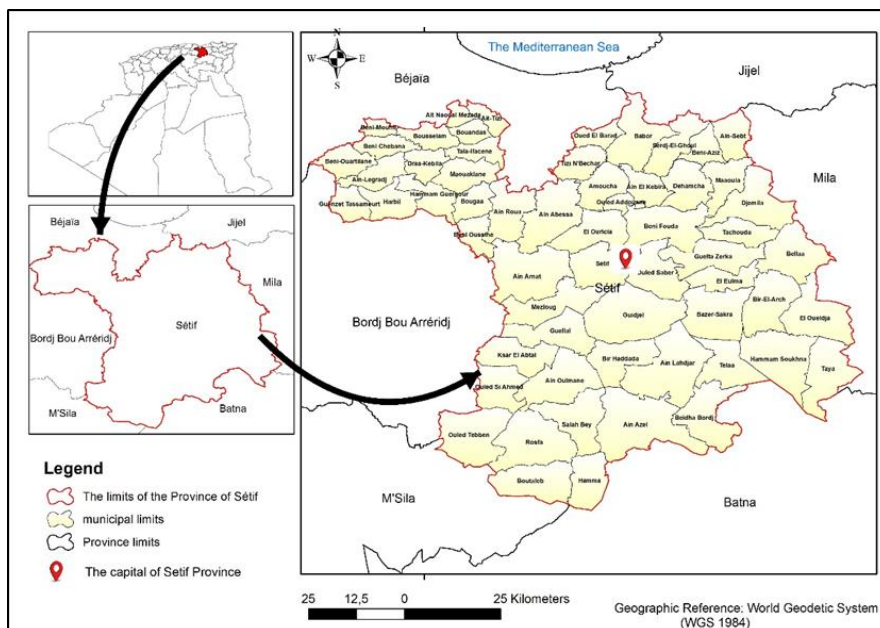


Fig. 1. the study area Sétif Province in north east of Algeria. Source: Authors 2023.

Sétif Province was selected for this study for several reasons mainly: the geographic diversity which presents unique challenges for the local population, since the varied terrain impacts irrigation practices in agriculture, especially given the recent rise in temperatures attributed to climate change. In other point, the region known innovative agricultural practices such as the widespread use of greenhouses in the southern areas. Also, it is observed that there has been a rise in projects beyond agricultural activities on the outskirts of cities and rural areas.

These factors collectively make Sétif Province a relevant and dynamic area for studying the impacts of climate change with associated agricultural and environmental issues.

Materials and Methods

Methods

The general presentation of the topic context, is based on the reports and literature review. In order to achieve objectives of this research, the following methodology were adopted: (i) general presentation of region characteristics and its climate changes status (iii) exploration its general effects over agricultural field, based on literature review, statistics analysis and fields work (iii) analysis of the field survey results for a better understanding of the perception degree of peasants toward the phenomenon of climate changes and its impacts on agriculture, more over to explore the challenges related; the general context and aspects of the topic, results obtained and strategies for sustainable agricultural development have been discussed throughout several points focusing to present a detailed adaptation point regarding farmers awareness.

Sampling, data collection and Statistical methods

A sample for the study was selected from the farmers registered with the Agricultural Services Directorate and the Agricultural Chamber of Sétif Province. The total number of registered farmers is 45,000, including 6,540 who specialize in tree and vegetable cultivation. A systematic random sample of 10% from the tree and vegetable farmers was chosen, resulting in a sample size of 654 farmers.

Collecting climate data and data recorded at the meteorological station at Sétif Province from 1990 to 2023. and statistical agricultural from the Department of Agricultural Services of Sétif Province. As for Data collection related to farmers, it took place during April and May 2023 via field surveys and practical experiences using a questionnaire administered through personal interviews, after conducting a preliminary test with several researchers. Additionally, meetings were held with representatives of farmers and relevant administrators to discuss the study topic and finalize the questionnaire.

Data analysis was performed using SPSS version 18.0. A two-step analysis, developed by Chiu et al. (2001), was employed to categorize and convert numerical variables into ordinal variables for use in multivariate analyses. Techniques such as Multiple Correspondence Analysis (MCA) (Le Roux & Rouanet, 2004; Greenacre & Blasius, 2006) and Categorical Principal Component Analysis (CatPCA) (Liu et al., 2009) were used. The Millennium Challenge Calculation was applied to describe the socio-economic context, while Cat PCA was utilized to assess changes in agricultural management practices and model construction.

Results

According to statistics regarding to the study area that obtained from the Department of Agricultural Services of Sétif Province and field survey we studied the following points.

Major Problems Resulting from Climate Change in the Study Area

The table 1 present the key issues major problems resulting from climate change in the study area are.

Table 1. Major Problems Resulting from Climate Change in the Study Area.

Issue	Count	%	Rank
Fruit drop before full growth	310	94.80	1
Decline in vegetable and fruit crop productivity due to high temperatures	298	91.13	3
Decrease in soil fertility due to surface erosion	210	64.22	9
Increase in saline areas (salt flats)	255	77.98	8
Expansion of lakes	297	90.83	4
Increased water use for agricultural land	296	90.52	5
Rising temperatures and humidity causing ecosystem imbalance	301	92.05	2
Reduced crop growth due to sand dune encroachment	256	78.29	7
Decrease in livestock productivity and natural pastures	269	82.26	6
Disruption of natural biodiversity	201	61.47	10

Source: Authors' Field Survey, 2023

Based on the table 1, the data indicates that the most significant issue is the increased water usage in agriculture, affecting 91.8% of the area. There is also a notable increase in the area of irrigated land, with a rise of 88.2%. The expansion of saline areas has increased by 84.1%. these impacts includes also Rising temperatures and humidity levels are impacting the ecosystem, with 83.2% of respondents noting these changes. Soil Degradation: There is a decline in soil fertility due to erosion of the topsoil, affecting 2.1% of the area.

As for its impact on vegetable and fruit crops, we find that crop productivity has been adversely affected by higher temperatures, with 80.3% reporting negative impacts, including fruit drop before full growth and poor growth of perennial trees (79.1%). besides the growth of crops has been hindered by desertification, with a 61.8% decrease in growth. and there has been a reduction in livestock productivity and natural pastures by 58.8%. Lastly, it should be noted that living organisms are experiencing imbalances in natural biodiversity, affecting 52.1% of the area.

Awareness of Farmers Regarding Climate Change and Its Negative Impacts (Temperature, Humidity, Winds, and Drought)

The results presented in Table 2 reveal the following key findings about the farmers studied and its characteristics regarding mainly distribution of farmers based on personal and economic characteristics.

Table 2. Distribution of Farmers Based on Personal and Economic Characteristics

<i>Variables</i>	<i>Age</i>	<i>Number</i>	<i>%</i>	<i>Occupation</i>	<i>Number</i>	<i>%</i>
<i>Age</i>	18-30 Years	58	17.74	Agriculture Only	226	69.11
	31-40 Years	92	28.13	Agriculture and Other Jobs	101	30.89
	41-50 Years	83	25.38	Product		
	50 Years and Above	94	28.75	Fruit Crops	89	27.22
<i>Educational Level</i>	Educational Level			Field Crops	107	32.72
	Illiterate	63	19.27	Mixed Crops	131	40.06
	Primary	93	28.44	Experience Duration		
	Intermediate	105	32.11	Low (3-15 Years)	106	32.42
	Secondary	40	12.23	Medium (16-30 Years)	123	37.61
	University	26	7.95	High (31 Years and Above)	98	29.97
	Number of Livestock			Household Size		
	2-6 Mem- bers	156	47.71	Low (1-10 Heads)	140	42.81
	7-10 Mem- bers	132	40.37	Medium (11-20 Heads)	96	29.36
	More than 10 Members	39	11.93	High (More than 21 Heads)	91	27.83

Source: Authors' Field Survey, 2023

Issues Resulting from Climate Change in the Study Area and Farmers' Perceptions of Negative Impacts

Farmers' Awareness of Climate Change and Its Causes

The results in Table 3 indicate that over half of the participants (63.00%) have a moderate level of knowledge about climate change, while 18.04% have a high level of knowledge (Figure 2a). This suggests a relatively high awareness among the respondents regarding climate change.

Table 3. Distribution of Farmers Based on Their Knowledge of Climate Change and Its Causes

<i>Knowledge Level</i>	<i>Number</i>	<i>Percentage</i>
Low (1-3)	62	18.96%
Medium (4-6)	206	63.00%
High (7-9)	59	18.04%

Source: Authors' Field Survey, 2023.

Farmers' Understanding of the Negative Effects of Environmental Conditions

Results in Table 4 show that 49.7% of the participating farmers have moderate knowledge of the recommendations related to negative effects of environmental conditions, while only 28.5% have low knowledge. These findings indicate a relative gap in understanding, highlighting the need for effective dissemination of agricultural recommendations to improve farmers' knowledge (Figure 2b).

Table 4. Distribution of Respondents Based on Their Knowledge of the Negative Effects of Environmental Conditions

Knowledge Level	Number	Percentage
Low (2-3)	86	26.29
Medium (4-5)	97	29.66
High (6-7)	144	44.03

Source: Authors' Field Survey, 2023.

Farmers' Knowledge of Soil Types and Suitable Crops

According to Table 5, more than half of the participants (50.46%) have a high level of knowledge about soil types and suitable crops, while slightly over a third (38.23%) have low knowledge. This indicates generally good awareness among farmers about soil quality and appropriate crops (Figure 2c).

Table 5. Farmers' Knowledge of Soil Types and Crops

Knowledge Level	Number	Percentage
Low (1-2)	125	38.23
Medium (3-4)	37	11.31
High (5-6)	165	50.46

Source: Authors' Field Survey, 2023.

Farmers' Understanding of Environmental Impact and Soil Use

Table 6 shows that over half of the farmers (55.05%) have moderate knowledge of the negative impacts of environmental conditions and soil use, while 36.09% have high knowledge. Only 8.87% have low knowledge, reflecting good overall awareness among farmers (Figure 2d).

Table 6. Distribution of Farmers Based on Their Knowledge of Environmental Impacts and Soil Use

Knowledge Level	Number	Percentage
Low (6-12)	29	8.87
Medium (13-18)	180	55.05
High (19-23)	118	36.09

Source: Authors' Field Survey, 2023.

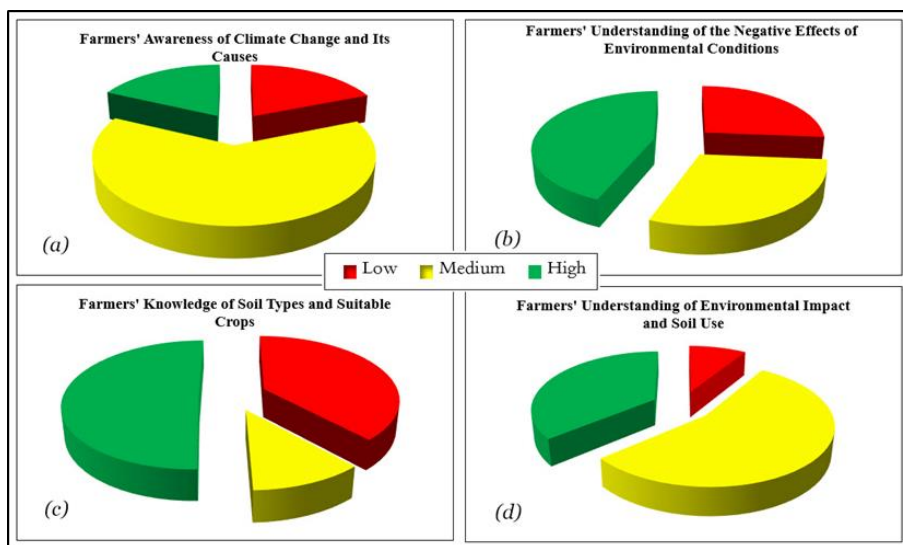


Fig. 2. Issues Resulting from Climate Change in the Study Area and Farmers' Perceptions of Negative Impacts. Source: Authors' Field Survey, 2023

Correlation Between Personal and Economic Variables and Farmers' Knowledge

The analysis in Table 7 indicates a positive correlation between farmers' knowledge of the negative effects of environmental conditions and soil quality with several personal variables: age, education level, household size, and crop type, with correlation coefficients of 0.208, 0.183, 0.169, and 0.485, respectively. Additionally, there is a positive correlation with agricultural experience, livestock number, and farm size, with coefficients of 0.125, 0.152, and 0.158, respectively, significant at the 0.05 level. No significant correlation was found between local organization membership and farmers' knowledge.

Table 7. Correlation Between Independent Variables and Farmers' Knowledge of Environmental Impacts

Independent Variables	Correlation Coefficient
Age	0.208**
Education Level	0.183**
Household Size	0.169**
Agricultural Experience	0.158*
Number of Livestock	0.125*
Farm Size	0.152*
Crop Type	0.485**

**Significant at 0.01 level

*Significant at 0.05 level

Source: Authors' Field Survey, 2023.

Discussion

Sétif Province that located in North-East Algeria, exhibits a semi-arid climate with a diverse topography that includes mountains and plains. Despite its significant developmental potential, the region is facing continuous environmental degradation. The ecological, hydrological, and agricultural systems in Sétif Province rely on a delicate balance between irrigation, drainage, and evaporation. Any disruption in this balance leads to rapid environmental degradation and loss of biological productivity. The increase in temperatures has affected multiple aspects of the region. In agriculture, higher temperatures have driven local farmers to rely more on crops that thrive in high temperatures, such as cereals and olives. However, this shift has had detrimental effects on livestock productivity, with a noticeable decline in meat and dairy production compared to other regions and previous periods. Traditional crops and vegetables have almost disappeared due to leaf burning and spoilage caused by the heat. Based on, the adaptation and mitigation strategies toward this actual situation of environments and agriculture state under climate change in Sétif Province is needed.

In fact, several literatures referred to the adaptation and mitigation strategies toward impact of climate change on agriculture (Altieri & Nicholls, 2017; Malhi et al., 2021; Ravi Shankar et al., 2014; Raza et al., 2019). As regarding our study area, this point was discussed previously, where local farmers have modified their farming systems to mitigate the negative effects of climate in the region (Rouabhi et al., 2019; Rouabhi et al., 2016). However, in this paper we focused on the point related to the procedures that can increase the farmers awareness regarding climate changes and agriculture issues that can contribute in agriculture panning and achieve a sustainable rural devotement in the future.

Developing countries are particularly vulnerable to environmental challenges, prompting scientists to innovate new strategies to address these issues (Rosenzweig et al., 2014). In this context, it should be noted that the agriculture sector adaptation to climate change is costing (Nelson et al., 2009). In Fact, agriculture is an important sector in Algerian rural area and have risks and challenges (Sahli, 2010). The peasant is one of the principal factors of agriculture development and rural area stability is very important in coping with the effects of climatic changes and improving production by adapting to the situation. So, its sustainable development required high level knowledge of suitable environment condition such as climate and soil types that is considered as a real challenge.

According to the respondents from authors' field survey, 2023 over the study area. Approximately 32.11% of the farmers have achieved an intermediate level of education. A significant majority of the participants (69.11%) are exclusively engaged in agricultural activities. In other point which is related to level of knowledge about climate change, the findings indicate that more than one-third of the participants (37.61%) have moderate agricultural experience and over half of the participants farmers (63.00%) have a moderate level of knowledge about climate change, while 18.04% have a high level of knowledge. besides, more than half of the participants (50.46%) have a high level of knowledge about soil types and suitable crops. Therefore, besides the status of the agriculture which is in a critical condition, the findings indicated a relative gap in understanding the climate changes. Based on, we focused in our study to present procedures that can increase the level of farmers' awareness regarding climate changes and its impacts on agriculture in Sétif Province since a the farmer awareness is one of the im-

portant factor to mitigate climate changes, because, this side can consolidate the new approach of part a new participatory strategy was adopted in development of rural areas in Algeria (Zahira & Bessaoud, 2011).

To the fact that abiotic stresses, such as drought, heat, cold, and salinity, are major threats to plant growth (Ashraf et al., 2018; Benevenuto et al., 2017). Some challenges have been revealed mainly. provide targeted support to farmers to address challenges related to climate change, including training programs to enhance their knowledge and skills. Also, enhance awareness of sustainable soil and water resource management through education on water issues and environmental pollution. Besides, prepare farmers to cope with potential water shortages by improving water use efficiency and exploring alternative irrigation methods. As for farmers awareness regarding agricultural practices and system, it should be noted that the dominant crop type is mixed crops and to address the negative impacts of climate change, the measures are recommended according mostly to the respondents obtained by authors' field survey on 2023 which are mainly:

- Developing and adopting crop and livestock varieties resistant to heat and drought, because achieving food security will require the development of climate-smart crop varieties (Wheeler & von Braun, 2013).
- Implementing crop rotation to improve soil properties and maintain soil health.
- Protecting rangelands from overgrazing and expanding them.
- Modifying planting schedules in response to climate changes to achieve optimal yields.
- Enhance agricultural practices such as soil conservation, no-till farming, improved irrigation and fertilization techniques, and integrated pest management using organic fertilizers. In same vein, focusing on agricultural practices for specific vegetable farming or trees cultivation such as olive farming practice (Rouibah & Belabbas, 2022a).
- Creating seed banks to preserve plant genetic resources.

In fact, in the last decade, the agricultural and rural development in Algeria known a great attention; firstly, Algeria launched the National Agricultural Development Plan (NADP) in 2000 and during the 2009–2014 period the Rural Renewal Policy (RRP) was launched, these agriculture politics supported mitigate climate changes. In this context, we find that fruit trees cultivation has strongly developed since 2000 (Bedrani, 2008). where for example, olive cultivation has, certainly, contributed to mitigate climate effect and the water irrigation shortage in addition to the stability of the rural populations in the countryside (Rouibah & Belabbas, 2022a), because the Algerian rural areas have long suffered from the phenomenon of rural exodus, especially in the past few years (Bessaoud, 2006). Despite the great effort of the government and the private sector for agriculture and rural devolvement, continuous taking proactive action to develop policies that can more adapted to climate change and suitable for each region characteristics, and to use measurement and early warning tools including on the improve of farmers awareness and to identify the negative effects of these phenomena and the mechanisms adopted by peasants to address these challenges given to its great importance of global climate effects adaptation and mitigation that support participatory strategy. So, a continuous list of adaptation projects can be developed in collaboration with relevant ministries and stakeholders, association and farmers to benefit from global adaptation funds. Providing financial and technical support to combat climate change effects.

In other point, Future important research required mainly Setting up research institutions to study climate change conduct similar studies in other climate-affected regions especially in vulnerable rural areas. to identify obstacles and develop appropriate solutions. Also, analyze seasonal risks and develop strategies for managing them to help farmers adapt to climate changes. In this context, advanced remote sensing data and technics is required for accurate modeling and monitoring agriculture land use that permit to provide accurate information for better understand reliable solution in order to be used by stockholder for planification and by farmers for agriculture practice, where the great objectives are a good resources management and sustainable agriculture and rural development.

Conclusion

This study providing an overview of climate change, its effects on agricultural crops. It emphasizes the importance of understanding and managing the effects of climate change on agricultural systems in Sétif Province. By assessing farmers' perceptions of climate change and analyzing various explanatory variables, the study aims to identify strategies for sustainable agricultural development and address the challenges posed by changing climatic conditions.

The findings explore the pressures of climate change on agricultures, and negative impact crop production, in contrast the increase in water use and irrigation area in other point the investigation and fields work indicate that over half of the participants farmers (63.00%) have a moderate level of knowledge about climate change, while 18.04% have a high level of knowledge. Also, the result show that 49.7% of the participating have moderate knowledge of the recommendations related to negative effects of environmental conditions. besides, more than half of the participants (50.46%) have a high level of knowledge about soil types and suitable crops.

The study has revealed some challenges where the principal procedures are support the farmers increase their Awareness Regarding Climate Changes And its Impacts on Agriculture environmental and water awareness via climate adaptation projects, improvement of crop and livestock varieties improvement of agricultural practices to guaranteeing food security and environmental perspectives.

The status of the agriculture is in a critical condition and is in need of continuous follow-up survey in the context it is proposed to carry out further studies using suitable remote sensing technics and data for the future spatial planning and sustainable development not only over in the area but related to the Algerian territory. these studies can discuss the landcover changes and crop classification identification irrigated area and its expansion and garniture mutations and impacts in the context of climate changes. socio-economic aspect.

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