
An Inductive Study of the Iraqi Agricultural Reality and the Availability of Fodder with Climate Changes

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Abstract. *This study investigated the implications of climate change on Iraqi agricultural sector and the feed availability, aiming to extrapolate these effects on essential livestock resources and crop production to suggest an adaptation strategies or interventions being considered to mitigate the effects of climate changes. All data were collected up to 31/ December/ 2023 from ministry of agriculture in Iraq. The results indicated political and economic stability, proper water management, support for agricultural development and farmer education create a strong agricultural environment capable of facing climate change. In addition, most tips to reduce climate change aren't effective especially in the developing countries, so, we have to begin with the simplest way, by urban greening and increasing trees in and around cities, that leads to absorbing and decreasing carbon dioxide. Using drought-resistant varieties. Using efficient irrigation techniques.*

Keywords: desertification, forage crops, global warming, grain crops, rainfall.

1. INTRODUCTION

Agriculture is one of the oldest crafts practiced by humans, which over time has become an important part of the economies of countries, eventually turning to modern agricultural mechanization to facilitate work and increase production in developed countries. However, in developing countries that do not know the amount of their agricultural production and cannot predict it, the sector declines and cannot achieve sustainable development. So, recording all agricultural information and improving the by-products have become essential to increase

sustainability and face global climate change [1]. Climate change poses significant challenges to agricultural systems worldwide and is worsening in developing countries, affecting the availability of essential resources for livestock and crop production and fluctuations in water availability for agriculture. This variability in rainfall directly impacts the cultivation of crops in Iraq, productivity and sustainability of cultivated areas. Currently, in Iraq, despite its complete reliance on oil extraction, a fragile and unsustainable economy, its true identity is that of a country with a primarily agricultural economy, and it is essential to address and preserve this identity. The impact of changing climatic conditions on the availability of animal feed is a major concern. Rising temperatures resulting from climate change have negative effects on agriculture, leading to decreased crop yields, water scarcity, and increased pressure from pests and diseases. We recommend planting trees along highways and creating green spaces in urban areas (Why?), because of one tree sequesters about one ton over its lifetime of carbon dioxide, and other pollutants like nitrogen oxides, sulfur dioxide, and particulates, filter dust, produce oxygen, indirectly reducing smog and greenhouse gases [2] and decreasing the diseases caused by these pollutants. This study aimed to investigate the implications of climate change on the availability of fodder in the Iraqi agricultural sector in order to contribute to a better understanding of the challenges faced by Iraqi farmers in maintaining livestock and producing crops.

2. MATERIALS AND METHODS

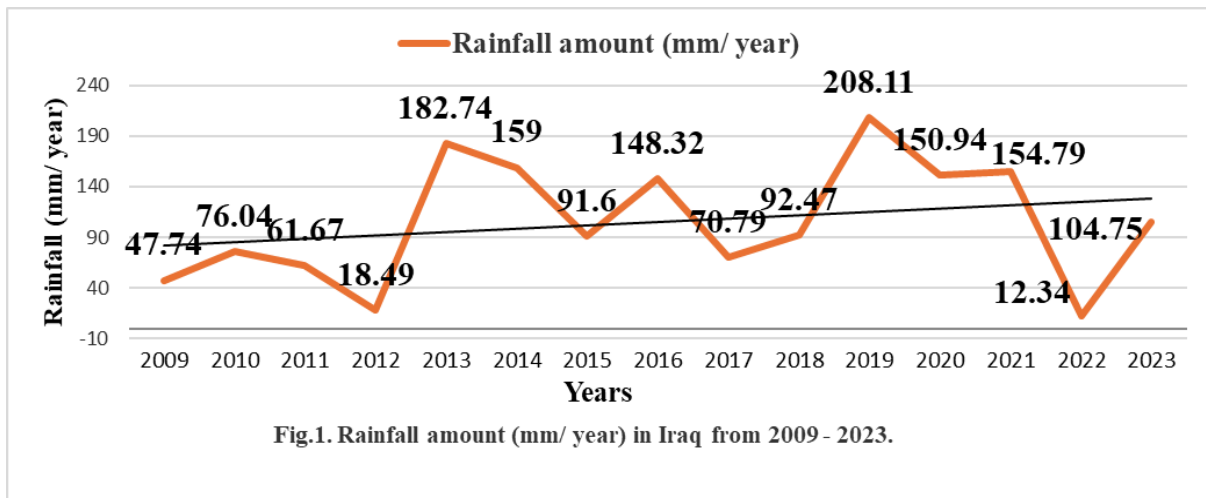
This study was conducted at the College of Agricultural Engineering Sciences/ University of Baghdad with cooperation of Ministry of Agriculture, Iraq. There is a big problem in providing data due to the events that Iraq has faced during the last two decades, and despite that, we have noticed an increase in the number of rains measuring stations that were created during the year 2023. The rainy season is measured for the period from 1/October to 31/May for each rainy season.

3. RESULTS AND DISCUSSION

3.1. Rainfall in Iraq

Climate change has led to a further decrease in rainfall in Iraq, and there are noticeable annual variations in these quantities are evident (figure 1). Rainfall effect is significantly leading to water scarcity and environmental challenges, as changes in precipitation patterns directly impact crop growth and forage production. Insufficient rainfall led to drought conditions, affecting agricultural productivity and reducing the availability of fodder for livestock. Climate change has intensified extreme weather events like droughts (in Iraq) and floods (in other countries), with reduced rainfall and rising temperatures being key consequences of these changes. Studies have indicated a steady decline in daily rainfall over all future periods, negatively impacting water levels in the Tigris and Euphrates rivers, altering their distribution patterns, and increasing salinity. This has affected agriculture, exacerbated desertification, and led to increased dust storms, impacting human health and the

environment. The marshes in southern Iraq have also deteriorated significantly, with over 70% now dry. Overall, studies agree that Iraq's water resources are vulnerable to climate change, necessitating strategic management across all regions of the country. If we draw a trending line, we will find gradually increasing in rainfall. The increased construction of dams and the failure to adhere to water quotas have led to a decrease in the amount of water reaching Iraq as a downstream country. Traditional farming methods and the failure to use modern irrigation systems have exacerbated the crisis.



3.2. Cultivated area in Iraq

The cultivated area in Iraq with approximately 22% of total suitable area for agriculture production, which only about 5 million hectares are currently cultivated from about 9.5 million hectares [3] and [4], indicating a significant portion of arable land remains unused, and crop production is the major source of income for most farmers, accounting for about 75% of their income [5]. Agricultural sector faces several significant challenges, including drought, water scarcity, soil salinity, desertification, and finally climate change. Overall, while there is a significant amount of arable land available in Iraq, the actual cultivated area is lower due to various challenges. We found the highest cultivated area in 1991 (figure 2), which may be due to the sanctions period (blockade imposed on Iraq after the first Gulf War), with reduced oil exports. We also note that the lowest cultivated area was for the period from 2015 to 2018, which may be due to the loss of large cultivated land and criminal gangs have taken control, leading to lawlessness and insecurity in these areas, in addition to decreases rainfall. This has further exacerbated the challenges faced by farmers and the broader community. Nowadays, the country is losing large areas of arable land to desertification, which is exacerbated by human activities such as mismanagement of water resources, inefficient farming practices, and urban expansion. The decline in agricultural productivity because of decreasing water in rivers or rainfall, has resulted in a significant decrease in crop yields. The drought has also led to the loss of livestock, as grazing land has become scarce due to the encroachment of deserts. Despite the challenges posed by conflict

and climate change, farming remains a vital sector of Iraq's economy. Efforts are being made to improve farming practices and increase resilience through sustainable agriculture. For example, we recommend that farmers adopt modern techniques to manage water more efficiently and reduce their environmental impact.

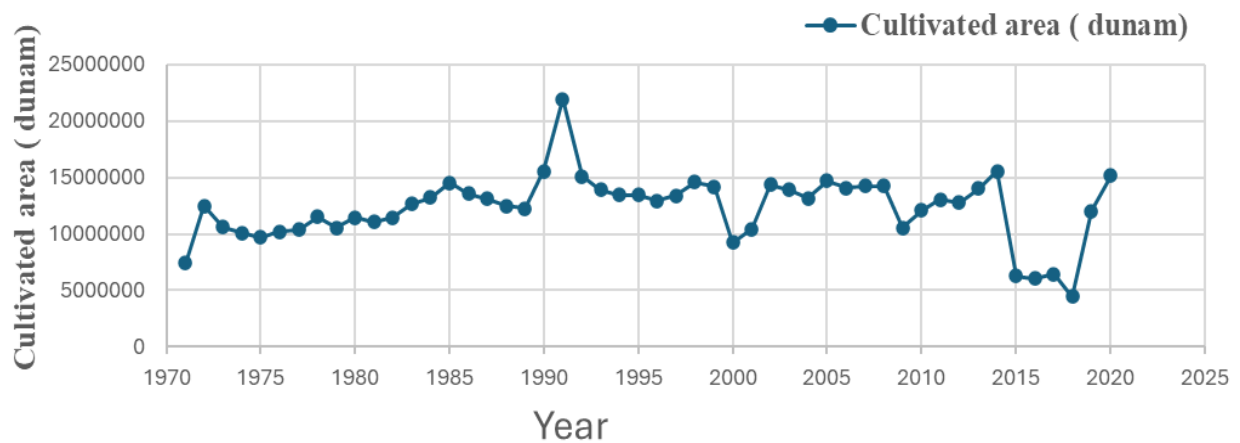


Fig.2. Cultivated area in Iraq from 1970 - 2020 (dunam =2500 m²)

3.3. Cultivated area and total production of different sources of feeds in Iraq

3.3.1. Alfalfa

Cultivated area and total production of alfalfa in Iraq from 1980 to 2020 are explicitly mentioned in (figure 3), with no data recording between 1989 and 2010 of alfalfa production in Iraq. A decline in cultivation and production of alfalfa can be observed after 2014, which may be due to the control of criminal gangs over a large area of land and the wars that ended with the elimination of outlaw gangs and the imposition of law, which was reflected in the increase in alfalfa cultivation and production in 2020.

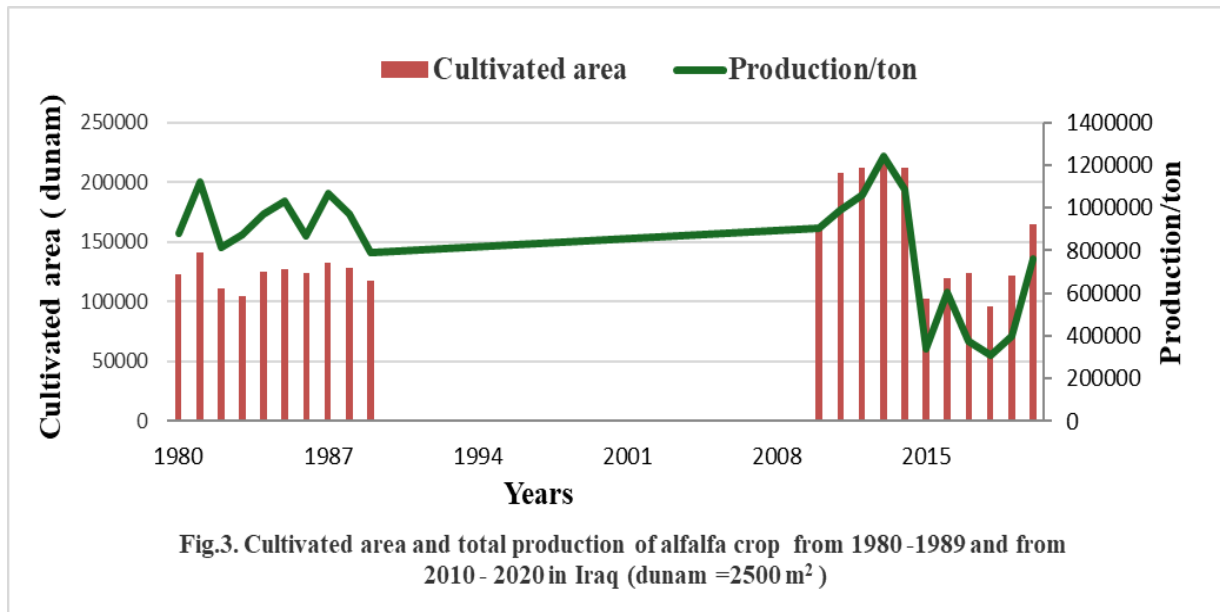


Fig.3. Cultivated area and total production of alfalfa crop from 1980 -1989 and from 2010 - 2020 in Iraq (dunam =2500 m²)

3.3.2. Clover crop

Clover is an important crop in Iraq, playing a vital role in the country's agricultural sector and contributing to the livelihoods of many farming communities. Cultivated area (dunam) of clover and production (ton/ year) presented in figure (4). The production decreased from 2014 up to 2019. Clover, or berseem clover (*Trifolium alexandrinum*), is widely cultivated across Iraq's arable lands, from the plains of Mesopotamia to the mountainous regions of Kurdistan [6]. Farmers have been growing clover to sustain their livestock and improve soil fertility through crop rotation and intercropping practices. Research has shown that incorporating clover into crop rotations and intercropping it with cereals like barley can significantly boost fodder yields and enhance soil nitrogen levels in Iraq's semi-arid areas [7] and [8]. This helps to improve the overall productivity and sustainability of the farming system.

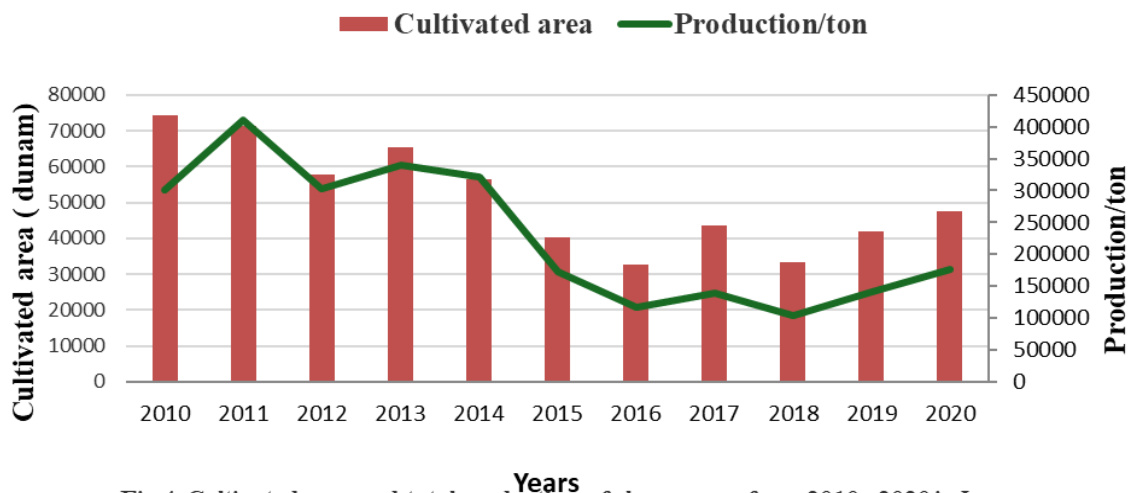


Fig.4. Cultivated area and total production of clover crop from 2010 - 2020 in Iraq (dunam =2500 m²)

To support Iraqi farmers in adapting climate change, the United Nations Development Program (UNDP) is providing training programs and financial grants to enable them to adopt sustainable agriculture practices, including the use of drought-resistant clover varieties and efficient irrigation techniques like drip irrigation. These interventions are helping farmers to increase their crop yield, reduce water consumption, and secure their livelihoods.

3.3.3. Wheat crop

Iraq's wheat crop production and cultivated area have faced significant challenges due to drought, climate change. The country's agricultural sector is heavily dependent on rainfall, which has been declining in recent years. Efforts to address these challenges are crucial to ensuring the long-term viability of the agricultural sector and the overall security of the country. The highest production in 2021, after it decreased due to the difficult conditions that Iraq suffered from between 2014 and 2018 (figure 5) as mentioned above. The production (ton/ dunam) increased with increasing rainfall. USAID program has been actively involved in improving grain production in Iraq stimulating increased production. New varieties of wheat are being introduced, higher caliber seeds are being planted, and new cultivation methods are being demonstrated led to increase wheat production. The government also encourages by purchasing wheat seeds from the farmers at high prices per ton.

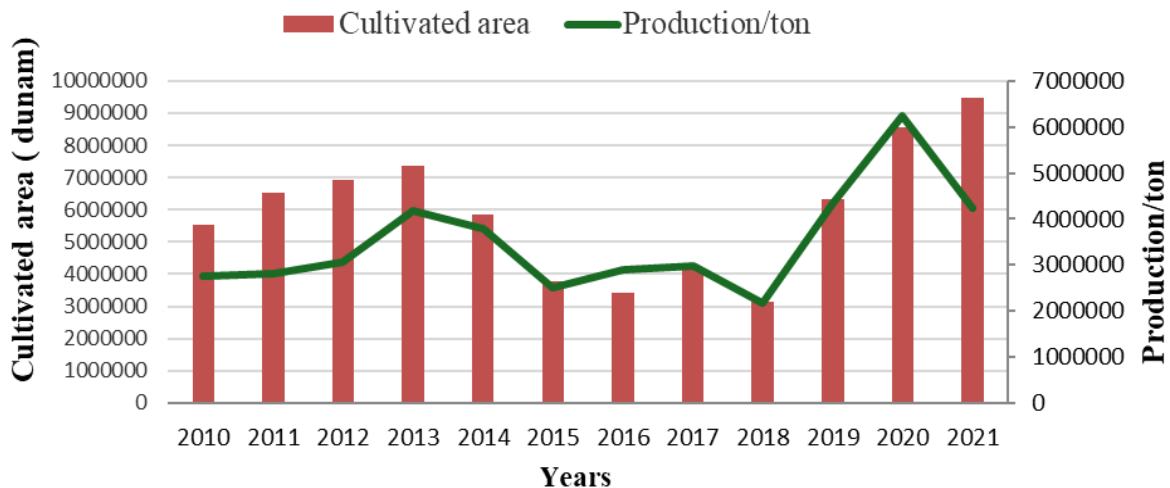


Fig.5. Cultivated area and total production of wheat crop from 2010 - 2021 in Iraq (dunam =2500 m²)

3.3.4. Barley crop

The largest growth in barley production occurred between 2019-2020, and the largest cultivated area between 1989-1990 (figure 6). Barley is primarily used as animal feed in Iraq, especially for ruminant and non-ruminant like horses and camels. Barley production in Iraq

has been significantly affected by climate change, particularly due to reduced rainfall and increased temperatures. These changes have led to challenges in water availability, impacting

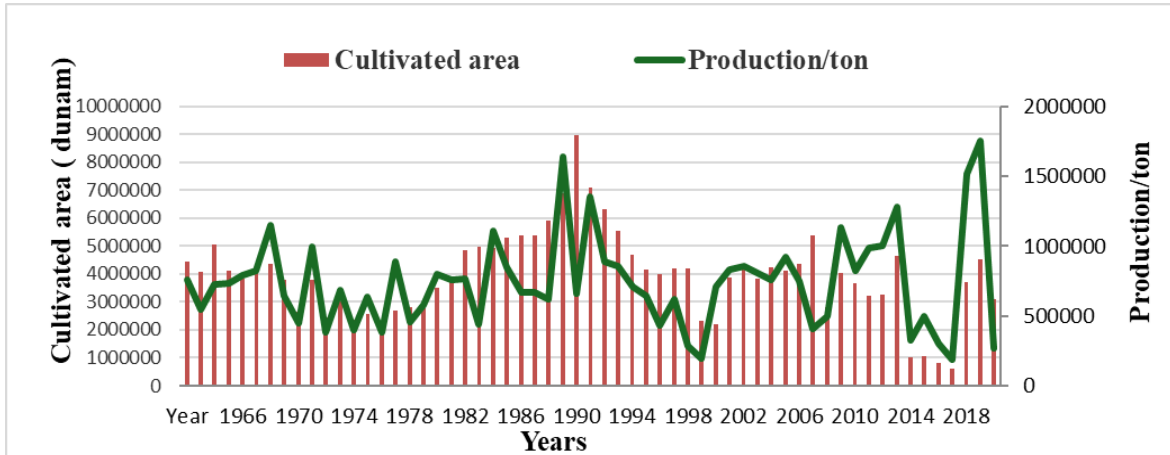


Fig.6. Cultivated area and total production of barley crop from 1963 - 2021 in Iraq

both the quantity and quality of barley yields. Farmers are facing difficulties in maintaining traditional agricultural practices, which are crucial for barley cultivation, as the changing climate alters growing conditions and increases the risk of drought [9]. Using suitable grains for cultivation led to increase the production per cultivated area in recent years.

3.3.5. Maize crop

The largest cultivated area and production of corn occurred between 2012-2013 (figure 7). Corn remains an important crop for human intake, poultry feed production, and needs adequate water supply, so, maize production has been declining due to water availability issues.

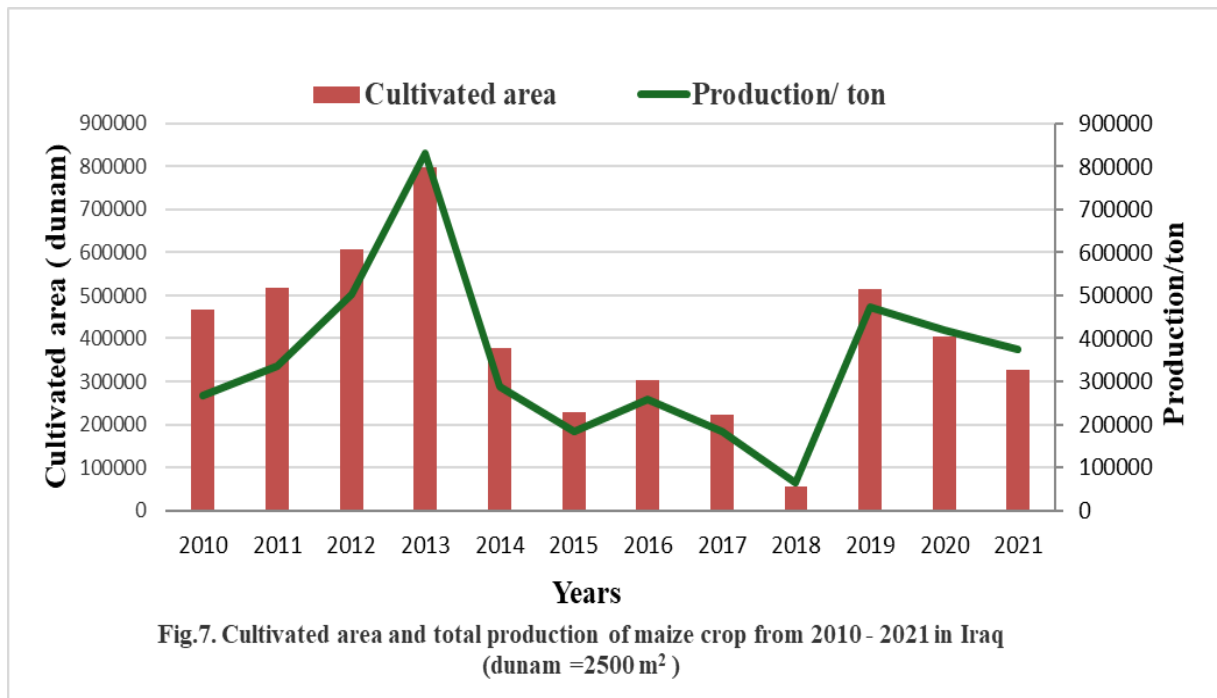
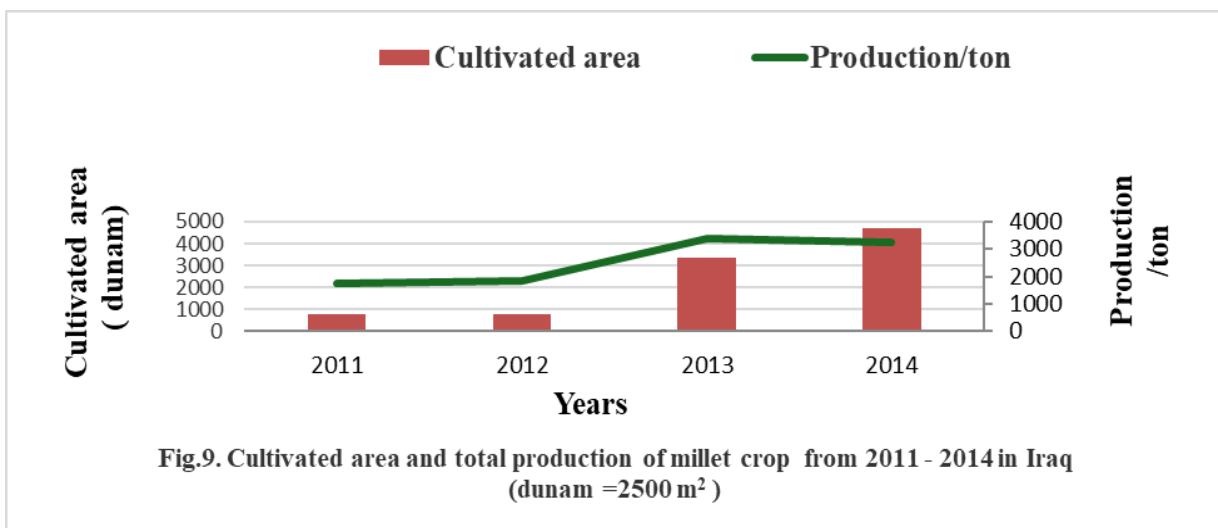
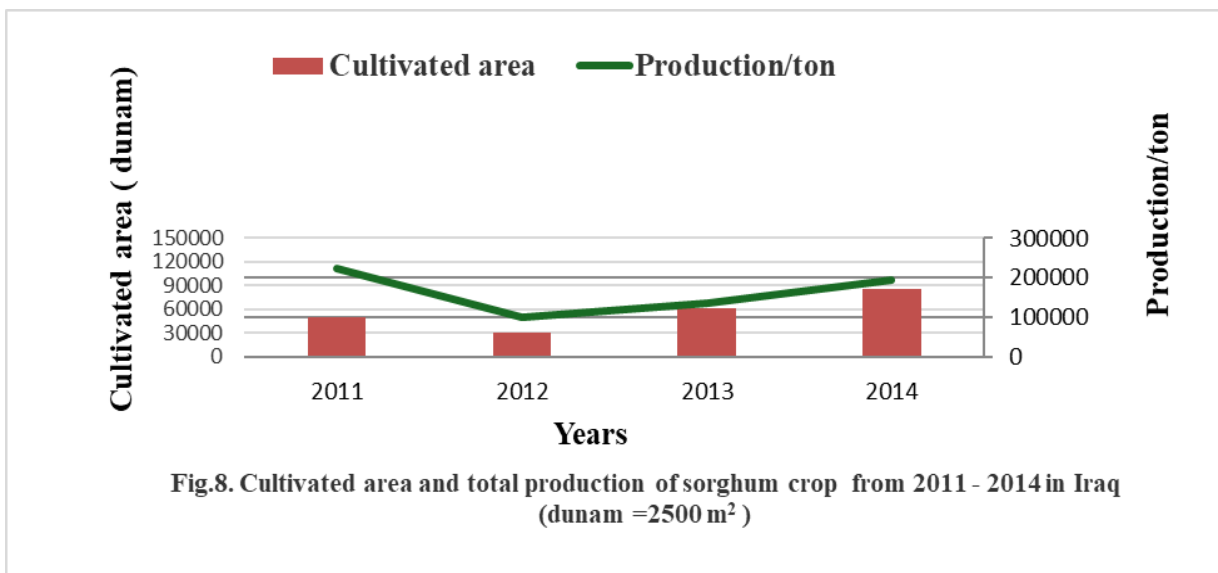


Fig.7. Cultivated area and total production of maize crop from 2010 - 2021 in Iraq (dunam =2500 m²)

3.3.6. Sorghum and millet crops

Sorghum is an important crop in Iraq, with a significant cultivated area and total production (figure 8), along with wheat, barley, rice, and corn. Sorghum, as a highly productive and resilient forage crop, may be suitable for semi-arid conditions in Iraq to support livestock in the face of climate challenges.

Millet production per dunam cultivated area increased (figure 9), because of the high price and uses as fodder.

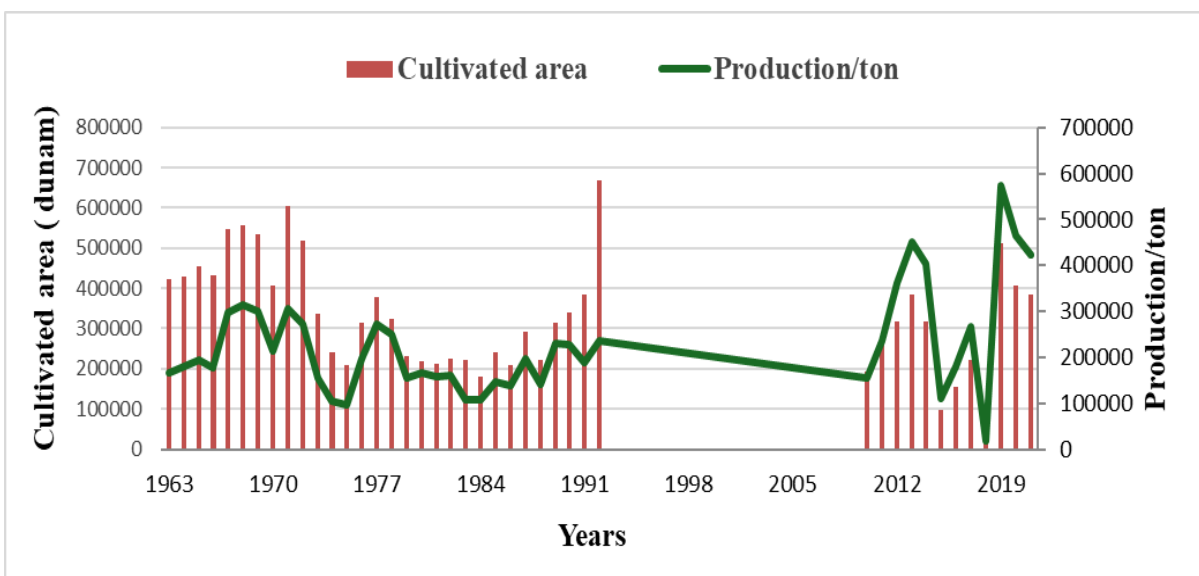
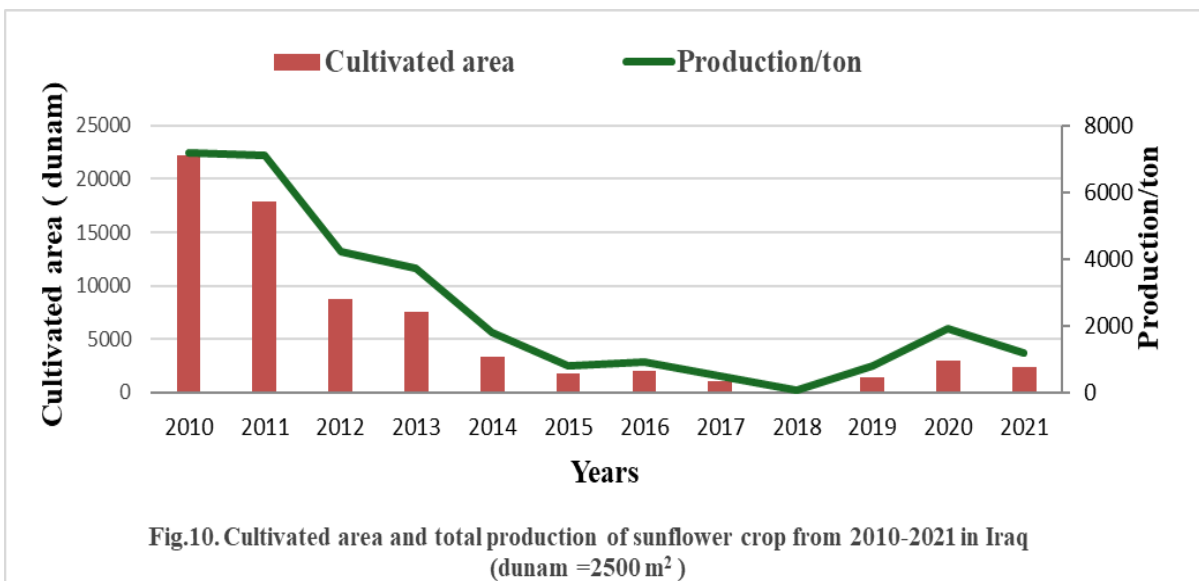


3.3.7. Sunflower crop

Sunflower is one of the most important industrial crops with high oil and protein content. The byproduct of oil production used as animal feed. It is very suitable for cultivation in Iraq. It is cultivated in all Iraq's regions, but the semi-arid conditions and climate challenges led to decrease the rainfall and sunflower cultivated area requires supplementary irrigation, all these conditions led to decrease production of sunflower (figure 10).

3.3.8. Rice crop

Rice cultivation in Iraq was popular and traditional in the twentieth century, especially during the economic blockade in 1991 (figure 11). However, it has declined significantly due to the country's dry climate, declining water resources, increasing desertification, and climate change problems in the twenty-first century. Recently, we have noticed an increase in production per unit area, which may be due to the use of high-quality and highly productive varieties.



3.3.9. Sugarcane crop

Sugarcane is a very important agricultural and industrial crop that operates two important sectors and provides job opportunities. In addition, its agricultural and industrial waste is used for animal feed. In Iraq is not a major crop due to the semi-arid climate and requires substantial water resources. The collected data refers to decline in cultivated sugarcane crops (figure 12). Sugarcane cultivation and production have continued to decline without significant improvement.

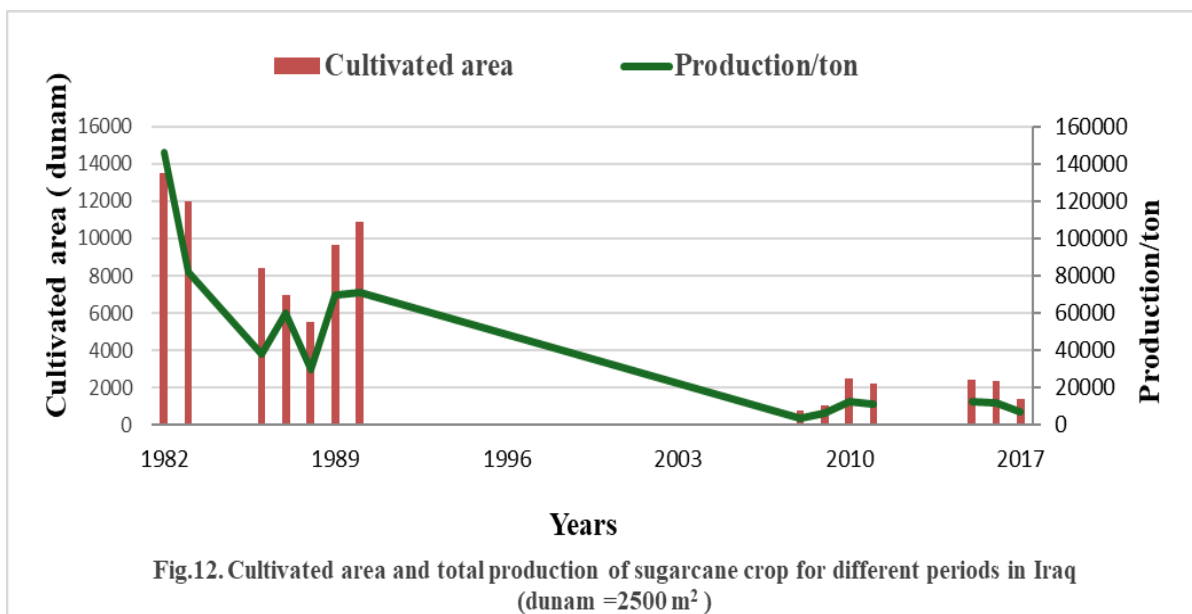


Fig.12. Cultivated area and total production of sugarcane crop for different periods in Iraq (dunam =2500 m²)

4. CONCLUSIONS

Climate change negatively impacts rainfall, increasing desertification, and increasing climate temperature, which leads to a severe decline in pastures and the availability of green fodder, as well as increased imported feed grains. This requires attention to the following:

1. Accurate recording, analysis, and timely comparison of agricultural data.
2. Creating partnerships with international companies for agricultural investment and increasing green spaces.
3. Reliance on modern irrigation systems in agriculture.
4. Implement a program to increase the number of trees, establish artificial forests, and prohibit logging on roads and in public areas without written government approval.

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CONTRIBUTION OF AUTHORS

All the authors read and commented on draft versions, and there are no conflicts of interest.

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