

Strategies for Addressing Climate Change and Mitigating its Impact on Sustainable Agricultural Development in Iraq

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Abstract

The agricultural sector is one of the important pillars in the national economy of any country in the world. It plays a key role in economic growth through its primary function of contributing to the formation of GDP, food production for different populations, as well as its role in creating abundant job opportunities for various segments of society. Therefore, its development and sustainability is of high importance, and from here attention has turned towards achieving sustainable agricultural development, and identifying everything that affects it and is affected by it. Perhaps among the most important factors affecting it is (climate change), so the research aimed to shed light on the reality and ways to confront climate change and attempts to mitigate its repercussions on sustainable agricultural development in Iraq.

The research has finally found that climate change in Iraq is in a state of serious escalation that has negative repercussions on the overall details of life in it, including economic life. The country faces an upward pattern of rising temperatures that continues to break historical records accompanied by low rainfall. Certainly, such a climatic reality has its effects on the agricultural sector directly, and causes great losses as a result of the dry scorching weather accompanied by water scarcity, which leads to the reduction of vegetation cover, which causes land degradation, and the consequent increase in dust storms and desertification, which costs Iraq a great loss in its agricultural production. In the end, we proposed a set of recommendations at the level of sample countries, the most important of which is to promote environmentally sound agricultural practices and refrain from using chemicals in agriculture to obtain green products. Sustainable production practices can improve agricultural productivity to achieve food security while preserving biodiversity, soil fertility and water use efficiency while reducing pressure to clear the natural environment and reduce desert space. In addition to recommending the need to follow modern technological methods in the agricultural sector capable of repelling or mitigating negative climate changes represented by sweeping the phenomenon of continuous increase in temperatures. In addition to the need to increase financial allocations directed to the development, development and protection of the agricultural sector from external influences, foremost of which is climate change.

Keywords: agriculture, Climate Change, natural environment.

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1. Introduction

Iraq is characterized by its fertile land, fresh water and diverse climate, and thus is the basis for the economic foundation in which the first building blocks of agriculture were formed, and agriculture was the main economic activity in ancient Mesopotamia and modern Iraq. Iraq was self-sufficient in many agricultural food resources and the agricultural sector constituted a high percentage of total domestic production. But during the last decades of the twentieth century and the early twenty-first century, Iraq turned from a source of food to an importer. This transformation is the result of several factors and challenges that the agricultural sector in Iraq has gone through and is still going through, which are represented by population increase, high standard of living, migration of workers from farms to urban places, loss of soil productivity, weak government support and weak interest in research in this field.

There has been a decrease in the level of interest in the agricultural sector in Iraq since the middle of the twentieth century, and this has affected several things, including the difficulty of identifying and confronting the dangerous factors affecting it, foremost of which are climatic fluctuations, and based on that the research problem can be identified through the following question: (Will Iraq succeed in mitigating the negative effects of Climate change in sustainable agricultural development? In light of the challenges and problems faced by the agricultural sector).

The research acquires its importance from the fact that the importance of agriculture in Iraq is not limited to providing food for the population, but is also the cornerstone of many key aspects of life such as: culture, health, livelihoods and prosperity. It represents the second largest contributor to GDP (of course after oil production) and employs more than 25% of the population. Despite the sector's low contribution to the economy, it remains a major source of support for the poor. It is the largest source of employment in rural areas. In addition to feeding and employing the population and contributing to the GDP. Well-managed cultivated land helps prevent desertification, as well as help prevent sandstorms, dust storms and land degradation. However, in order to achieve the desired objectives of the agricultural sector – including reducing food imports, increasing productivity, and building the technical capacity of farmers – coherent and coordinated efforts to improve policies and reprioritize all the negative influences that hinder sustainable agricultural development in the country must be pursued.

The research aims to shed light on the impact of climate change on sustainable agricultural development in Iraq. And ways to confront climate change in it, and attempts to mitigate its repercussions on sustainable agricultural development.

The sustainable agricultural development in Iraq can only be achieved by addressing all the obstacles and problems facing the agricultural sector, and this role is completed by providing adequate support and providing administrative, technological, technical and material capabilities to achieve this goal and promote the agricultural reality in it.

2. The performance of the agricultural sector and climate change in Iraq after 2003

2.1. The Reality and Possibilities

The agricultural sector is one of the main sectors in the Iraqi economy, as its contribution to the formation of GDP is of relative importance compared to other sectors, if the oil sector is excluded from among the total sectors. Agriculture in Iraq employs about 28% of the national workforce. Instead of its development, agriculture has declined a lot in our time to stand unable to meet the growing needs of the population of Iraq, and this decline in the growth of agricultural activity in the country is due to the fact that the

agricultural sector has been floundering for the past decades due to the policies that were applied in it.

that Agriculture in Iraq Depend significantly on the water supply of two major rivers: the Tigris and the Euphrates. Nearly 70% of the country's arable land is located in the central and southeastern region along major rivers, with crop production mainly dependent on irrigation systems. The remaining 30% of the cultivated land is located in the northern region and is cultivated with Baal□ .

Through the table below, it is possible to follow up the reality of the performance of the agricultural sector in Iraq during the period ((2004-2021), and from it we note that the level of the volume of Iraq's gross product is in a state of continuous confusion up and down, and this confusion causes almost the majority of which are known to specialists regarding the Iraqi economy, foremost of which is the link between the developments of the Iraqi GDP and developments in the volume of oil revenues of the country, which are related to the fluctuations of oil prices in the global market first, Secondly, the nature of the political and security situation, which has always cast a shadow on the volume of Iraqi oil exports.

Table (1) Contribution of agricultural sector production to GDP formation in Iraq for the period (2004-2021)

| Year | Gross Domestic Product (GDP) Billion dollars | GDP growth % | Gross Output per Capita | Total Agricultural Product thousand dollars | Agricultural total per capita |
|------|--|--------------|-------------------------|---|-------------------------------|
| 2004 | 36.36 | - | 1214.80 | 1522541.00 | 148.83 |
| 2005 | 49.95 | 1.70 | 1740.70 | 2125913.00 | 155.94 |
| 2006 | 65.14 | 5.60 | 2253.50 | 2230290.00 | 155.32 |
| 2007 | 88.84 | 1.90 | 3099.60 | 2809267.00 | 151.56 |
| 2008 | 131.61 | 8.20 | 4504.50 | 2290104.00 | 134.04 |
| 2009 | 111.66 | 3.40 | 3686.40 | 3271854.00 | 130.12 |
| 2010 | 138.52 | 6.40 | 4430.40 | 4047897.00 | 144.82 |
| 2011 | 185.75 | 7.50 | 5736.90 | 5527377.00 | 151.18 |
| 2012 | 218.00 | 13.90 | 6437.50 | 5950335.00 | 145.98 |
| 2013 | 234.64 | 7.60 | 6612.90 | 7308920.00 | 153.91 |
| 2014 | 228.42 | 0.20 | 6216.00 | 6473564.00 | 140.58 |
| 2015 | 166.77 | 4.70 | 4416.90 | 3135634.00 | 80.48 |
| 2016 | 166.60 | 13.80 | 4305.20 | 3049322.00 | 78.93 |
| 2017 | 187.22 | 1.80 | 4725.20 | 2798908.00 | 74.99 |
| 2018 | 227.37 | 2.60 | 5601.50 | 2774698.00 | 71.87 |
| 2019 | 233.64 | 5.50 | 5621.20 | 5032939.00 | 111.13 |
| 2020 | 180.92 | -12.00 | 4251.30 | 6230570.00 | 130.45 |
| 2021 | 207.69 | 1.60 | 4770.80 | 4103077.00 | 105.95 |

And to give a clear picture of the quantity and quality of agricultural production in Iraq during the study period for some priority crops in agricultural production in Iraq, we use the table below, through which it is clear that the cultivation of cereals acquires the total agricultural production in it, and in the last place comes the cultivation of legumes, and between the two concentrated cultivation of basic vegetables, basic fruits and citrus fruits in order:

Table 2: Production quantities of a group of agricultural products in Iraq during the period (2004-2021) in tons

| Year | Staple grains | Citrus fruit | Staple Fruit | Legumes | Basic vegetables |
|------|---------------|--------------|--------------|----------|------------------|
| 2004 | 3316916.71 | 125756.43 | 1723311.73 | 81338.90 | 2895000.00 |
| 2005 | 3708150.00 | 110166.40 | 1702996.82 | 32808.20 | 3197596.03 |
| 2006 | 3785500.00 | 115300.00 | 1772460.00 | 44125.20 | 3172220.71 |
| 2007 | 3752471.00 | 104992.86 | 1664058.86 | 28551.66 | 3050664.00 |
| 2008 | 2225411.00 | 124600.66 | 1618006.47 | 19406.58 | 2968477.28 |
| 2009 | 2650113.00 | 140518.48 | 1507762.02 | 16463.19 | 2975729.36 |
| 2010 | 4362383.00 | 123272.31 | 1543568.17 | 21791.72 | 3059472.68 |
| 2011 | 4270151.00 | 100763.71 | 1617671.58 | 19490.64 | 3349277.73 |
| 2012 | 4790950.00 | 102759.00 | 1769802.00 | 20211.00 | 2981238.00 |
| 2013 | 6498524.00 | 124503.40 | 1880253.65 | 18865.00 | 3228582.56 |
| 2014 | 7048606.00 | 128075.28 | 1690474.32 | 14854.39 | 2627614.38 |
| 2015 | 3471115.91 | 74652.11 | 1109403.12 | 8906.12 | 1106411.96 |
| 2016 | 4007685.00 | 80903.93 | 1195588.49 | 9142.01 | 833352.65 |
| 2017 | 3735255.00 | 82179.11 | 1251450.62 | 6039.56 | 656303.51 |
| 2018 | 2615277.00 | 80452.38 | 1427181.51 | 6574.16 | 988601.65 |
| 2019 | 6913550.00 | 143078.14 | 1923320.48 | 7712.43 | 1240113.42 |
| 2020 | 8885242.00 | 152811.54 | 2161068.81 | 8869.34 | 1682681.00 |
| 2021 | 5302192.00 | 167879.69 | 2156426.86 | 16846.15 | 1607732.07 |

Source: FAO STAT: <http://www.fao.org/faostat/en>

As for the potential available to the agricultural sector in Iraq, it is concentrated in three main areas, namely (natural resources, human resources, capital resources):

Natural resources: In the field of land resources, the total area of Iraq is estimated at about 43.8 million hectares, and the area of arable land is about (5.000) million hectares, this arable area constitutes 11.6% of the area of Iraq, and as it is clear that it is a very small percentage of the total area, as it has not been exploited in agricultural production. In the field of water resources, Iraq has three types of water resources, which are surface water resources, which are referred to as the Tigris and Euphrates rivers and their tributaries, which are the main source of water resources in the country, and the second type is rainwater, which is the second main source for irrigation purposes in Iraq and the rates of its fall vary, especially the northern region, as rainwater is exploited for agriculture, which is the main feeder for surface runoff of water and storage of quantities of it as a source of groundwater and that falling Snow is largely confined to the northern regions of the country. The third source of water resources is groundwater, which is the appropriate alternative to the lack of surface water in a number of areas in the country and the exploitation of groundwater in Iraq is still limited and below the required level, while natural pastures have a major role in providing food for a large part of livestock, especially camels and sheep, but the productive capacity of pastures is deteriorating as a result of the expansion of demia lands as well as overgrazing. As for forests, they are of great importance in improving the microclimate and protecting the soil from erosion. In addition to making use of its products and wood. It has also been neglected and unregulated cuttings have led to a deterioration in productivity and a failure to meet the country's need for timber. From Table (3), it is possible to show the area of land exploited for agriculture in Iraq, and from it it is clear that there are large areas suitable for agriculture in Iraq, but they have not been optimally exploited, which means that the country still has a natural resource that can be prepared for optimal exploitation in the near future.

Table (3). Area of land used for agriculture in Iraq in units of 1000 hectares for the period 2004-2021

| Year | Area of the country | Agricultural land area | Arable land | Area of land planted with temporary crops | Area of land planted with permanent crops | Forest land area |
|------|---------------------|------------------------|-------------|---|---|------------------|
| 2004 | 43832.00 | 8690.00 | 4500.00 | 2757.50 | 190.00 | 820.80 |
| 2005 | 43832.00 | 9390.00 | 5200.00 | 3186.50 | 190.00 | 821.50 |
| 2006 | 43832.00 | 8990.00 | 4800.00 | 2941.40 | 190.00 | 822.20 |
| 2007 | 43832.00 | 9140.00 | 4950.00 | 3033.30 | 190.00 | 822.90 |
| 2008 | 43832.00 | 8190.00 | 4000.00 | 2451.10 | 190.00 | 823.60 |
| 2009 | 43524.00 | 7850.00 | 3650.00 | 2236.70 | 200.00 | 824.30 |
| 2010 | 43524.00 | 8220.00 | 4000.00 | 2451.10 | 220.00 | 825.00 |
| 2011 | 43524.00 | 8550.00 | 4300.00 | 2635.00 | 250.00 | 825.00 |
| 2012 | 43524.00 | 8568.50 | 4318.50 | 2646.30 | 250.00 | 825.00 |
| 2013 | 43505.20 | 8863.75 | 4613.75 | 3513.75 | 250.00 | 825.00 |
| 2014 | 43505.20 | 9269.00 | 5019.00 | 3889.75 | 250.00 | 825.00 |
| 2015 | 43505.20 | 9250.00 | 5000.00 | 1563.25 | 250.00 | 825.00 |
| 2016 | 43505.20 | 9250.00 | 5000.00 | 1518.75 | 250.00 | 825.00 |
| 2017 | 43505.20 | 9250.00 | 5000.00 | 1608.00 | 250.00 | 825.00 |
| 2018 | 43505.20 | 9250.00 | 5000.00 | 1109.00 | 250.00 | 825.00 |
| 2019 | 43505.20 | 9250.00 | 5000.00 | 3012.00 | 250.00 | 825.00 |
| 2020 | 43505.20 | 9250.00 | 5000.00 | 3767.00 | 250.00 | 825.00 |

Source: Based on FAO STAT data: <http://www.fao.org/faostat/en/>

Human Resources: Iraqi society is one of the young societies and the population is the main source of its workforce (the labor force is that part of the population between the minimum and maximum age of work who are able to work and who want it), knowing that Iraq is characterized by high growth and fertility rates. In the table below, we note the total population and population distribution in Iraq, as we find that the population in Iraq is 27.85895 million people in 2004, and this number has increased significantly and significantly until it reached 43.53359 million people in 2021, and this increase constituted 64% of the population in 2004, which means that Iraq has great levels of young age and youth.

Capital Resources: Capital resources are of great importance in the development of the agricultural sector through the adoption and use of modern technological methods aimed at developing agricultural production in quantity and quality. .and The reality of the agricultural sector in Iraq indicates the low rates of investment and agricultural capital formation and the relative importance of investments directed to the agricultural sector compared to other sectors, as this importance did not exceed only 12% of the total allocations, which is a low percentage. If compared to the percentage of allocations of other sectors and as a result of this decrease in the formation of gross fixed capital in the agricultural sector, this led to a decrease in the productivity of the agricultural sector, and this requires increasing the allocation of financial resources for agricultural investments, which leads to an increase in the formation of fixed capital for the agricultural sector and the provision of production requirements in it, and this can be achieved through a comprehensive investment plan for the agricultural sector .

2.2. The Challenges

As for the challenges facing the agricultural sector in Iraq, they are of two types, as shown in the following :

1. Internal challenges: The lack of administrative expertise as a result of the suffering of wars, economic sanctions and international sanctions, and the other

challenge related to the state's subsidy policy for the prices of final products of basic commodities (wheat and rice).

2. External challenges: There is a wide range of challenges to the performance of the agricultural sector in Iraq, which prevented its development and hindered its development, including the following : climatic and geological changes, and the lack of sufficient water availability. The deterioration in the productivity of agricultural land, the modest technological level used in the agricultural sector, the weak investment and agricultural financing and Security and political instability, post-harvest challenges, and environmental pollution.

2.3. The Performance of Agricultural Development Indicators

The table below shows the most important indicators of sustainable agricultural development in Iraq, which are (food security, pesticide management, fertilizer management, employment rates in the field of agriculture, and water resources management), and from it it is clear that the indicators of sustainable agricultural development in Iraq, most of which did not record a significant improvement, but on the contrary, they recorded a significant and noticeable decline during the study period, This raises a warning bell that threatens to achieve the requirements of sustainable agricultural development in the coming years.

Table 4: Indicators of Sustainable Agricultural Development in Iraq during the Period (2004-2021)

| Indicator Year | Food Security | | Pesticide Management | Fertilizer Management | | | Employment rates in agriculture | | | Water Resources Management | |
|-------------------|----------------------------------|---|----------------------|--------------------------------|---------------------------|------------------------------|---|--|--|--|-------------------------------------|
| | Prevalence of undernourishment % | Number of undernourished (million people) | Pesticide use Kg/h | Total Nutrient Nitrogen N Kg/h | Total phosphate P2O5 Kg/h | Total Potash Feeder K2O Kg/h | Percentage of employment in agriculture as a percentage of total employment | Proportion of males in agriculture in total employment | Percentage of females in agriculture in total employment | Water use efficiency ratio for agriculture | Water stress level in agriculture % |
| 2004 | 20.20 | 5.20 | 828.62 | 21.90 | 1.48 | 0.32 | 27.20 | 27.00 | 27.90 | 0.09 | 66.84 |
| 2005 | 19.40 | 5.10 | 873.01 | 28.55 | 11.60 | 0.45 | 27.00 | 26.90 | 27.50 | 0.09 | 65.30 |
| 2006 | 17.90 | 4.80 | 824.14 | 33.47 | 11.02 | 0.28 | 26.40 | 26.30 | 27.00 | 0.08 | 63.75 |
| 2007 | 18.00 | 4.90 | 1062.61 | 24.60 | 11.58 | 0.27 | 26.00 | 25.80 | 26.80 | 0.07 | 62.21 |
| 2008 | 17.80 | 5.00 | 956.52 | 39.17 | 15.19 | 0.24 | 25.20 | 25.00 | 26.10 | 0.06 | 60.66 |
| 2009 | 17.00 | 4.80 | 850.42 | 44.64 | 12.04 | 0.39 | 24.60 | 24.50 | 25.30 | 0.09 | 59.12 |
| 2010 | 15.80 | 4.60 | 744.33 | 25.59 | 5.78 | 1.14 | 24.20 | 24.10 | 24.70 | 0.10 | 57.57 |
| 2011 | 15.00 | 4.50 | 638.24 | 30.40 | 5.36 | 1.19 | 23.70 | 23.60 | 24.30 | 0.10 | 56.03 |
| 2012 | 15.90 | 4.90 | 532.15 | 34.73 | 11.36 | 0.61 | 22.70 | 22.70 | 23.20 | 0.10 | 54.47 |
| 2013 | 16.60 | 5.30 | 426.05 | 32.86 | 13.81 | 0.83 | 22.20 | 22.10 | 22.50 | 0.13 | 52.93 |
| 2014 | 16.80 | 5.60 | 396.00 | 15.22 | 2.55 | 0.82 | 22.20 | 22.10 | 22.40 | 0.14 | 51.38 |
| 2015 | 17.30 | 5.90 | 196.75 | 12.05 | 2.21 | 0.48 | 21.60 | 21.60 | 22.00 | 0.14 | 44.85 |
| 2016 | 18.40 | 6.50 | 151.46 | 19.90 | 7.18 | 0.34 | 20.70 | 20.60 | 21.10 | 0.13 | 49.49 |
| 2017 | 19.10 | 7.00 | 214.79 | 34.46 | 12.47 | 1.00 | 20.80 | 20.80 | 20.90 | 0.09 | 53.11 |
| 2018 | 18.80 | 7.00 | 283.99 | 32.95 | 18.27 | 1.00 | 20.60 | 20.60 | 20.70 | 0.11 | 43.12 |
| 2019 | 18.10 | 6.90 | 283.99 | 32.95 | 18.27 | 1.00 | 20.10 | 20.10 | 20.00 | 0.10 | 62.11 |
| 2020 | 17.40 | 6.80 | 283.99 | 32.95 | 18.27 | 1.00 | 20.30 | 20.30 | 20.30 | 0.14 | 62.11 |
| 2021 | 15.90 | 6.40 | - | - | - | - | 19.80 | 19.80 | 20.00 | - | - |

Source: FAO STAT: <http://www.fao.org/faostat/en>

3. The Climate change and its effects on sustainable agricultural development in Iraq

Iraq is a dry country and is considered vulnerable to climate change in the Arab region and the most sensitive to climate variability. The arid and semi-arid climate prevails in it, mainly in the center and south of it, and therefore the temperatures are very extreme and frequent. Iraq is located in Southwest Asia, covering an area of 438,320 square kilometers. Summer and winter are the main seasons in Iraq. Summer begins in June and ends in September, winter begins in November and ends in March. Almost all rainfall occurs in winter (Approximately 90% of annual rainfall occurs between November and April, especially between December and March and the rest of the months, especially those that Temperatures rise such as June, July and August, and rainfall is rare.), and therefore the summer is very dry. The amount of rainfall in Iraq varies in different regions. The southwestern part of Iraq receives less than 100 mm of annual rainfall while the northern part receives more than 1,000 mm per year. Iraq records the lowest temperature between 0 and 5 degrees Celsius in winter in the northeastern mountains, while the daytime temperature in summer is usually 45 degrees Celsius in the south. Most of Iraq suffers from a subtropical desert climate, followed by a subtropical steppe climate and a dry subtropical summer climate .

3.1. The Types of climate change in Iraq

Iraq's weather is heavily influenced by its geography. Iraq has 4 climatic zones. Region I: Mediterranean climate of mountain ranges in the north and northeast and this area covers about 21%. The second zone is represented by: the steppe climate of the undulating zone, which covers the south and west of the first zone and constitutes about 9.6%, and with regard to the third region, it is represented by: the subtropical sub-arid climate in the center and south (Mesopotamian plain) and covers about 30.2%. The fourth region covers the continental desert climate in the west by about 39.2%. Iraq also has four climatic seasons: (1) summer (July - October) hot and dry. (2) autumn (October - November; (3) winter (December - February) cool and humid; finally spring (March - May).

The climate comes at the forefront of natural factors affecting agricultural production, both plant and animal, and these climatic variables, as mentioned above, are (solar radiation and temperature, relative humidity, rainfall, wind), and in Iraq they can be followed in general as follows :

Temperatures: In Iraq, the average temperature in summer ranges from a minimum of 27-31 °C, and a maximum of 41-45 ° C. However, in winter it varies from semi-freezing in the north to 4-5 °C in the center and south. Minimum winter temperatures range from semi-freezing (pre-dawn) in the northern and northeastern hills and Western Desert, to -8 to -1 °C (17.6-30.2 °F), and -5 degrees Celsius (17.6-30.2 degrees Fahrenheit), and -5 degrees Celsius to 2 °C (23 to 35.6 °F), in the western plains of southern Iraq. It rises to a maximum of about 10 °C (50 °F) in the Western Desert, and the northeast, 13 °C (55.4 °F) in the south. In summer, minimum temperatures range from about 22 to 30 °C (71.6–86 °F) and rise to a maximum of roughly 32–36 °C (89.6 and 86.8 °F), with temperatures recorded on some days of 38 °C and more. Nighttime temperatures drop below zero more often than not, with temperatures as low as -22 °C (-7.6 °F) recorded in Rutba in Western Sahara, Governorate Anbar, and Rutba are more likely to have temperatures of more than 40 °C (104 °F) in the summer months .

Relative humidity: In Iraq, the annual average humidity is 0.49%, so that the lack of relative humidity in central and northern Iraq makes a person able to withstand the high summer heat and is annoyed by it when he is in Basra. In general, it can be said that the best description of the climate of Iraq is that it is (continental, subtropical rainfall similar to the Mediterranean climate system, that Iraq's astronomical location and distance from the seas made its climate characterized by continental and is located within the hot tropical zone in its southern half and within the temperate zone. The greenhouse in its

northern half resulted in the sun's rays being vertical or close to vertical during the summer and tilted or close to oblique in winter. According to specialists, the climate of Iraq is affected by land more than water, as it tends to the continental character more than to the marine character, and therefore it is characterized by thermal extremism, especially since the small area of the Arabian Gulf and the surrounding of the land from almost all sides made its impact on the climate of Iraq limited and at certain times of the year when exposed to tropical air masses coming from the Indian Ocean and developed in the direction of air depressions coming from the Mediterranean Sea towards Iraq.

Dust storms: Dust storms are severe weather phenomena, and by virtue of the location of Iraq, most of these dust storms are coming from the Najd desert and the Syrian desert, and part of them are local from the Western Desert and from the soil of the loose sedimentary plain in dry years. The frequency of dust storms increases as we head from north to south in Iraq, the Nasiriyah station recorded the highest frequency of the number of dust storms, where the annual average was 327 storms during the year and in light of this, the dust storms are one of the harsh weather phenomena in Iraq by virtue of the damage they leave on humans affecting his health and activity, as well as other effects on the economic phenomena on agriculture and other means of transportation. It is worth noting that there are several basic factors behind the occurrence of severe dust storms in Iraq, including the lack of rain, lack of water resources from downstream countries and the reduction of the agricultural plan, these storms have increased for several reasons, foremost of which is climate change in Iraq, being among the countries most vulnerable to climate change and desertification due to increasing drought and high temperatures that exceed fifty degrees Celsius in the summer. The lack of rainfall has led to a strong drought that has led to a decrease in vegetation cover, especially for open areas, which extends to countries bordering Iraq, which requires an effort with neighboring countries to combat them to reduce these problems. It may be solved by providing a water source in dust areas for natural plant germination in those areas, as well as developing biological or nanomaterials that stabilize the soil there.

From the above, it is clear that the movements of climatic variables in Iraq during the study period, are moving in a direction that is fully consistent with what has been described above regarding the nature of the general climate prevailing in Iraq, which poses a serious and difficult challenge to the implementation of the requirements of sustainable agricultural development in it.

3.2. The current and future effects of climate change on agriculture in Iraq

Weather was and still is the main factor affecting agricultural production despite technological and scientific progress in the field of agriculture and the quality of natural resources available from fertile soil suitable for agriculture and the availability of fresh water for irrigation. We note that Iraq suffers due to its geographical location from high temperatures, and a relative scarcity of rain (and we have referred to this above), which led to limited water resources sources, and the main dependence on the Tigris and Euphrates rivers, which may be affected by the different rates of annual flooding. The agricultural sector is one of the most water-consuming sectors in Iraq, as the percentage of water consumption in this sector constitutes 85%, and due to the use of open and old irrigation channels, the fragility or weakness of water resources management and dilapidated infrastructure, and the use of old irrigation techniques and traditional farming patterns, the quantities of irrigation water have increased from the specified water quotas, which led over time to high ground water levels in it and waterlogging and salinization of the soil. Continued decreasing water resources significantly affect land use. Many farmers have lost their land, as well as changes in the distribution and spread of crops and animals. It is expected that there will be an increase in the water requirements of agricultural crops due to rising temperatures as a result of climate change, which will mean pressure on the available water resources to meet the water requirements for crop cultivation. Since these resources are already limited, the expected impact in the case of

the use of the same varieties of agricultural crops and the continued use of old agricultural technologies without development will lead to a decrease in cultivated land annually to compensate for the increase in the water requirements of crops or this will lead to the loss of cultivation of some agricultural crops in the areas currently producing them, which will naturally mean a decrease in the food produced and necessary to meet nutritional needs, in addition, climate change will negatively and directly affect the production of Agricultural crops due to high temperatures, and indirectly through the increase in the water needs of plants, as the water needs of crops will increase by 6-16% by 2100, for example, wheat, sunflower and rice crop will be affected by the drought conditions in various regions and high temperatures and drought can also lead to a decrease in crop yields due to their impact on the physiological processes of plants.

In addition to the above, Iraq's water security depends on two declining rivers, the Tigris and the Euphrates. Climate changes such as rising temperatures, reduced rainfall, and increased water scarcity are likely to have serious implications for the state of Iraq for years to come.

4. The Climate Change and Sustainable Agricultural Development in Iraq

4.1. The Ways of confrontation

Agricultural development gains its importance from the importance and vitality of the sector in which it operates, that sector, which is the main field of production and the main source of capital accumulation and the liberalization of the workforce necessary for the development of other economic sectors at the same time, it is the main source of providing national industries with the raw materials they need, as it is considered a large market for the disposal of its products, so agricultural development is the necessary entrance to achieve comprehensive development. As a result, Iraq is working on the preparation of the National Adaptation Plan and funded by the Green Climate Fund in cooperation with the United Nations Environment Program, which will be among the basic plans on which the country will rely in implementing this policy to ensure resilience for all vulnerable priority national sectors during the next three years to reduce potential risks from the climate and find successful means to sustain water sources and address acute water scarcity and degradation of water quality.

Given the synergistic relationship between sectors, the preparation and implementation of an action plan for adaptation actions and the achievement of the required benefits for each of the key sectors affected by climate change is essential, within the framework of national and related sectoral strategies such as the National Water Strategy, the National Agriculture Strategy, the National Biodiversity Strategy and the National Framework for Integrated Drought Risk Management in Iraq, which will lead to To strengthen national capacity to cope with the impacts of climate change on different sectors, especially those sectors that are most sensitive and vulnerable.

Agriculture Sector: The main objective of the agriculture sector is to increase the resilience of the agricultural sector to climate change to protect and enhance the country's food security, reduce soil degradation, increase agricultural revenues to achieve economic diversification, reduce poverty and support rural women through the use of modern technologies and technologies as part of achieving the Sustainable Development Goals. It consists of several axes represented by : Reducing and rehabilitating soil, pasture and vegetation degradation, improving land management practices, and adopting smart and conservation agriculture, especially in the field of agriculture and forestry. In addition to the need to modernize, improve and develop agricultural practices and livestock development in order to achieve the principles of adaptation to face climate change. Not to mention the need to establish greenhouse and plastic farms and laboratories for the histological reproduction of varieties resistant to climate change.

The main objective of mitigation policies is to reduce greenhouse gas emissions by taking actions and plans to prepare a document that balances the requirements of the Framework Convention on Climate Change. And the Paris Agreement attached to it on the one hand, and the diversification of the sources of the economy, the sustainability of exports of fossil fuels and the stability of the global market for this type of fuel on the other hand to ensure the achievement of sustainable development goals until appropriate alternatives are found. Iraq worked from an early date to join the Convention and then sign the Paris Agreement by working on the completion of strategic projects and studies to introduce clean and renewable energies, improve energy efficiency, sound environmental management of carbon and increase the area of green spaces. There are many projects to deal with climate change and resist water scarcity, the most important of which is the wastewater treatment project and its reuse to irrigate green belts, which is implemented in cooperation with the Japanese JICA Organization in Erbil Governorate, not to mention afforestation, increasing forest areas and planting green belts, noting that most of the new cities that are being built in the Kurdistan Region are sustainable cities that depend on smart lighting and reuse sewage for irrigation to increase green spaces and many others. . The agricultural sector is also one of the important economic sectors in the country and is one of the main contributors to greenhouse gas emissions, because most of Iraq's crops are cereals such as wheat, barley, rice and corn, in addition to horticulture crops and palm trees. .

Water Resources Sector: The overarching objective of this sector refers to increasing the resilience of the water resources sector in the country by adopting an integrated approach that faces the growing future need for water demand and reducing the potential deficit through the development of water uses in line with the challenges of climate change and the application of the axes mentioned within the Water and Land Resources Strategy until 2035 by providing financial and technical support and introducing alternative and non-conventional sources. Taking into account the improvement of infrastructure, the efficiency of supplies and the preservation of water sources from pollution as part of the sustainability of these sources.

4.2. The Proposals on a strategy for sustainable agricultural development in Iraq

The most prominent ways to achieve the agricultural development strategy in Iraq and improve the reality of the agricultural sector in Iraq are through the following :

1. **Modern irrigation techniques:** Modern irrigation systems are of great importance because of their role in reducing water waste during the irrigation of agricultural crops, and there are a variety of modern irrigation techniques that will contribute to achieving sustainable agricultural development, which is drip irrigation technology and sprinkler irrigation technology .
2. **Follow agricultural rotations.**The agricultural cycle is defined as the organization of cultivating the land according to certain principles, and its main goal is to obtain the largest production and the best quality at the lowest costs and the least effort. One of the most important benefits of the agricultural rotation is the elimination of viruses whose life cycle is short in the soil. It also contributes to soil treatment and the fight against agricultural diseases and pests. It also contributes to maintaining the balance of fertilizers and nutrients in the soil, and reduces the incidence of viral diseases caused by viruses in the soil.
3. **Fertilization:** It is very necessary to use environmentally friendly and consumer organic fertilizers, bio-fertilizers and green fertilizers as an alternative to chemical fertilizers.
4. **Adoption of modern farming methods:** The adoption of modern methods in agricultural operations contributes to raising the efficiency of the production of various agricultural crops and maintaining the characteristics of the soil and rehabilitation, and

there are a number of modern agricultural methods that can be followed to achieve sustainable agricultural development. The most important of them are (organic agriculture, clean agriculture, agriculture without tillage, agriculture without soil, which is known as hydroponics).

5. Nanotechnology applications in agriculture: Nanotechnology applications are one of the most important mechanisms to achieve modern and clean farming methods, as they are characterized by their low economic cost, ease of use, and environmental friendliness. The beginning of nanotechnology dates back to physicist Richard Feynman in 1957, and nanotechnology is a Greek word meaning dwarf or something infinitesimal. Nanotechnology aims to use technology that is less harmful to the environment and human health as well as radical changes in agriculture through new methods of partial treatment of diseases, rapid detection, and improvement of plants' ability to absorb food. As well as reducing carbon dioxide emissions and getting rid of global warming and climate change, and it has several uses, the most important of which are in the manufacture of agricultural fertilizers and agricultural pesticides.

6. Reliance on renewable energy: Renewable energy is the backbone of sustainability and sustainable agricultural development is development that moves society to the era of clean industries and technologies that use the least amount of energy and resources, achieve the same productivity or increase productivity, reduce emissions of gases and pollutants that lead to pollution of the main environmental elements, namely land, air, water and living organisms, and raise the temperature on the surface of the earth. Energy has important consequences for sustainable agricultural development, It has created technology to rationalize energy consumption and reduce the use of fossil fuels, and accelerates the development of renewable energy resources, including working to develop the biofuel industry that depends on agricultural waste and replacing it with fossil fuels, and that it is an environmentally friendly fuel that does not produce gases or waste harmful to the environment. On the other hand, it works to benefit from or recycle agricultural waste and surplus or damaged products from animal and human consumption.

In our opinion, the appropriate strategy for sustainable agricultural development in Iraq should include the application of the following:

- 1) Rehabilitation of new projects for irrigation , drainage and soil maintenance.
- 2) Strive to reduce desertification, and eliminate it completely.
- 3) Give special importance to natural pastures and forests.
- 4) Providing advances, investment loans and soft credit facilities.
- 5) Encouraging national investments allocated to the agricultural sector .
- 6) Activating the role of foreign investment in the agricultural sector.
- 7) Rehabilitation of agricultural infrastructure.
- 8) Encouraging scientific research in the field of agricultural production by increasing expenditure allocations on research and development in this field.
- 9) Developing the skills of workers in the agricultural sector and developing their agricultural capabilities.
- 10) Increase the volume of loans provided by agricultural banks.
- 11) Ensure the proper application of river-related laws with neighboring countries.
- 12) Development of agricultural products industries .
- 13) Encouraging the role of the private sector to enter the field of agricultural production.

5. Conclusions

Iraq is characterized by a rich and integrated base of resources and ingredients that make its economy one of the strongest economies in the Arab and global countries as well, as it has the second largest oil reserves in the world in addition to the diversity of land and fertile and arable soil, as well as the availability of water resources and the availability of human resources that are represented in the high proportions of the population. On the other hand that Climate change in Iraq is in a state of severe crisis as the country faces an upward pattern of rising temperatures that continues to break historical records accompanied by low rainfall. The agricultural sector is directly affected and suffers significant losses due to this scorching dry weather accompanied by water scarcity, which leads to the reduction of vegetation cover, causing land degradation, and the consequent increase in dust storms and desertification, which costs Iraq a great loss. Which requires following a number of important procedures that must be taken into consideration, which That would improve the reality of the agricultural sector It protects it from external influences, including climate change, and maintains its sustainability.

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