



## The Impact of Human Development Variables on Agricultural Growth in Iraq for The Period 1990 - 2022

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### Abstract

Despite the importance of agricultural sector in Iraq, the reality indicates the inability of this sector to meet the needs required of it, as the reason for this lies in the fact that it is managed by individuals who do not possess the most basic elements of human development, the study aims to measure and explain the impact of human development variables in raising the agricultural growth rate in Iraq during the period from 1990-2022. In order to apply the quantitative aspect of the study, the agricultural output growth rate was adopted as a dependent variable Y. As for independent variables, they included agricultural capital X1, mechanical technology X2, chemical technology X3, agricultural labor X4 and agricultural education X5, depending on the statically software E-views10 and its tests according to the ordinary least squares method (OLS), the results showed the significance of the variables of capital and chemical technology with a positive effect in agricultural growth rate in short and long terms. The negative significant effect of mechanical technology and labor force appeared only in long term, while agricultural education appeared to have a significant and positive effect in the long term. The most important conclusions were reached was that human resources contribute to the development of agricultural businesses until they are considered the main means of achieving large-scale production. We recommend increasing government spending in the areas of education, training and rehabilitation in rural Iraq, as it enables the population to employ their skills and experience in raising the rate of agricultural growth.

**Key words:** Agriculture, capital, human resources, labor.

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## **Introduction**

Human resources are considered an essential pillar of any country's economy, as they are considered intellectual capital. The progress of countries is not measured by the wealth they possess, but rather by the thinking and creative minds they possess in order to build a sound development economy.

Accordingly, development experiences have confirmed the necessity of making individuals the center of development and participants in it in order to place the human being in his rightful place in the development process. Hence, the concept of human development appeared, [1] who emphasized in their writings that investing in human capital is the main factor in raising the rate of economic growth. This was followed by the United Nations development programs [2], in which several indicators were developed that were adopted to measure the development or slowdown that occurs in the process of development aimed at serving humanity, which should include a large amount of human content, and in light of this, attention was paid to human or intellectual capital, which has become one of the most important economic development strategies, especially after the collapse of world oil prices [2], because the knowledge and technical construction of work leads to raising the rate of agricultural growth, despite the importance of human resources in developing countries in general and Iraq in particular, they have not given sufficient importance in terms of their development, education, training and qualification compared to what developed countries have achieved, in addition to Iraq's suffering from many different economic and social problems, which means its need for more effective development efforts to enter the path of progress and thus raising its agricultural growth rate, as the contribution of agriculture to the gross domestic product in some developing countries reaches more than 45% [3].

Despite this, these countries, including Iraq, are still net importers of agricultural products, especially the main grain crops. The reason for this is the low efficiency of individuals working in agriculture. Hence, it was necessary to study the role of human

development variables in raising the growth rate of agricultural output in Iraq.

## **Research problem**

The agricultural sector takes an important place in the economies of developing and developed countries alike. Despite this importance, the agricultural reality in Iraq indicates the inability of this sector to meet the nutritional needs of its population. The reason for this is that Iraqi agriculture is managed by individuals who lack the most basic components of human development, as these people are characterized by their low scientific, artistic and technical level, in addition to other factors, reflected in their inability to develop the level of productive art in agriculture. This is accompanied by the subjection of Iraqi agriculture to conditions of risk and uncertainty to a large degree. Thus, the aforementioned factors contributed to the low rate of agricultural growth and the country became in a critical situation represented by the deepening of its food security problem and its dependence on external sources to feed its population and provide basic needs, most notably food, to the point that it has become a net importer of food. This has weighed heavily on the Iraqi balance of payments because the values of imported food bills have reached very high numerical levels.

## **Research importance**

Human resources are considered a fundamental element and an important pillar in agricultural development. They are the target and beneficiary of its positive effects. On the other hand, they are the main resource for the production process, so the human resource is the real wealth of poor countries. The role of human development is focused on qualifying and developing the workforce according to modern standards to become more efficient in production.

## **Research objectives**

The research aims to measure and explain the impact of a number of human development variables in raising the agricultural growth rate in Iraq during the period 1990 to 2022.

### **Research hypothesis**

Developing human capabilities is one of the means of increasing growth, developing the capabilities of individuals, activating the labor force, regulating the size of employment, and reducing poverty rates in Iraq. Therefore, the research is based on the hypothesis that human development variables (capital, mechanical technology, chemical technology, labor force, and education) have a major role in raising the agricultural growth rate in Iraq.

### **Research Methodology**

In its approach, the research relied on a theoretical method that relies on the concepts of economic theory and previous studies that dealt with this topic, as well as adopting a quantitative method in measuring and interpreting the impact of human development variables on agricultural growth in Iraq, using multiple regression analysis, the statistical software E-views 10, and the ordinary least squares method (OLS), because it gives the best unbiased linear estimates in analyzing the aforementioned relationship.

### **Theoretical framework of the impact of human development variables on agricultural growth**

**Definition of human development:** Human development is defined as a means that aims to search for a human force with talents and abilities that are closely linked to the level of technical progress that characterizes modern life, which is related to increasing skills and experience and a high level of technology that leads to raising growth rates and achieving economic progress [4].

**The concept of human development:** What is meant by the concept of human development is the process that results in an increase in the knowledge and capabilities of members of society. That is, it can be described as the process of accumulating human capital in an optimal manner and investing it in developing the economic system. In this regard, individuals are

### **The economic importance of human resources development**

The economic importance of human resources appears through the role of

considered the makers of human development and its goal. Therefore, human thought has paid attention to individuals, who are a means and goal of human and economic development. Paul Streeton considered them a means of improving human conditions, distributing people's choices, and looking at individuals as an end, in addition to being a means of production [5].

It is clear from the above that human development has great importance in the economies of developed countries, but it is of exceptional importance in the economies of developing countries because it reflects two dimensions, the first is material, related to meeting the requirements of individuals represented by income, education, and health, and the second is qualitative, represented by popular participation in providing economic needs, meaning that human development is a qualitative, planned change that aims to achieve comprehensive growth in the economic, social, cultural and environmental reality in a way that is performed by individuals and with government intervention and in a way that achieves economic progress for the country.

### **Human development indicators**

Human development indicators are as follows:

**First-Income:** Human development is concerned with achieving economic growth through organizing the gross national product, setting policies for distributing production, and directing investments.

**Second - Education:** The level of education is one of the most important indicators of human development, building the capabilities of individuals and providing them with various types of knowledge through various means of education.

**Third - Health:** Health services are among the basic services that contribute an essential role in achieving many human development goals. [7]

individuals in improving and increasing agricultural production, and this matter received the attention of many early and modern economists. Adam Smith pointed out

that the wealth of nations is acquired by work [1], while Ricardo emphasized that the value of a commodity depends on the amount of work expended in its production. It is clear from the above the importance of the labor element in the production process, and this depends on the level of qualitative development of individuals through the process of real human development, because increasing agricultural production occurs through increasing the productivity of its workers [8].

### **Human development goals**

The human development goals are as follows:

- 1- Providing the necessary means to obtain education and employment opportunities.
- 2- Striving to reduce the phenomenon of unemployment and provide the largest possible number of job opportunities.
- 3- Developing health and medical care for children, the needy and the elderly.
- 4- Improving the standard of living of individuals and providing them with the necessary needs.
- 5- Raising the level of individuals' personal and cognitive skills and ensuring their psychological stability [11].

### **The reality of human development in Iraq**

The reality of human development in Iraq is represented by many negatives, as the circumstances that surrounded it, whether economic or social, are only a reflection of the political reality that produced negative effects that affected the general reality of the country and its human development, to the point that it made it suffer from it for long periods of time, as it targeted a large amount of its natural, financial and human resources [9], and Iraq has become suffering from a major deficiency in providing the necessary resources to achieve the aforementioned development, as the poverty rate has risen very significantly, food supplies have been cut off, health conditions have deteriorated significantly, the educational sector has deteriorated, and its requirements have become scarce until they no longer keep pace with the development taking place in the world, which has led to a rise in the dropout and failure rate at various stages was

accompanied by a high rate of ignorance and illiteracy, which constituted basic factors in causing further deterioration in human development in Iraq [12].

### **Literature review and contemporary studies of the impact of human development variables on agricultural growth**

The human element is one of the most important elements of production that contribute to raising the rate of agricultural growth and achieving economic development. In this regard, many economists have focused on it, as Marshall 1961 explained that developing the human element is an investment, while Schultz [5] indicated that investment in human capital is the main reason in raising the rate of agricultural growth in developed countries. Also, Denison emphasized that raising the level of education contributes to increasing productivity and the growth rate [13]. In this regard, we decided to represent the most important studies that dealt with the impact of human development variables on agricultural growth so that they could be used in analyzing and discussing the research problem.

In 2016, Mohan conducted a study on the impact of human resources development on the growth rate of the agricultural sector in India. The study highlighted the importance of the sector in achieving sustainable and comprehensive development. It noted that about 60% of the labor force in India worked in agriculture in 2011, particularly on small holdings. The study emphasized the positive outcomes of human resources development, particularly during the Green Revolution period, where India transformed from an importer to an exporter of strategic crops like rice. The compound annual agricultural growth rate reached about 9% during this period, accompanied by an expansion in the use of improved inputs, modern technology, and advanced irrigation methods. The study also mentioned India's ability to produce various types of livestock and fish products, indicating its impact on increasing the agricultural growth rate. India achieved self-sufficiency in agriculture for its population of over 1.33 billion people. Despite this, the agricultural sector lacks necessary investment allocations

to expand rural infrastructure. The researcher concluded that the development of human resources is crucial in achieving remarkable agricultural achievements such as increasing productivity to international rates. The study recommended the continuous development of agricultural workers' capabilities and the adoption of modern technological means, as well as the utilization of agricultural extension teams to achieve these objectives. [14]

In 2017, Ndour conducted a study on the role of human capital development in productivity. The study focused on agriculture's significance in ensuring food security in Senegal to combat poverty and reduce hunger in Africa, policymakers in Senegal aimed to enhance the capabilities of rural individuals, particularly by increasing agricultural productivity through the use of high-yield inputs, appropriate technology, and agricultural practices. The study demonstrated the positive impact of human capital development on agricultural productivity using a sample of 183 farms divided into three categories. The variables of education and agricultural experience were found to be significant in raising productivity rates. The researcher recommended increasing investment in expanding agricultural education and creating an agricultural database for future research and studies in the field. In conclusion, the study identified the importance of human capital development in enhancing agricultural productivity, which is crucial for achieving sustainable development goals, reducing poverty, and ensuring food security in Senegal. The study underscored the need for targeted investments and the adoption of appropriate policies to further develop human capital in the agricultural sector [15].

In 2018, Abdul Kadir and others published a study on the impact of physical and human capital on agriculture in South Sumatra, in which they explained that the agricultural sector in Indonesia contributed 16.06% of the gross domestic product in 2016 and is in third place after the mining and processing industries and has a major role in exporting various types of plant and animal products to various countries of the world. This was achieved by adopting agricultural education and training methods and raising the level of

skills of the labor force in the countryside, as it ranked first in the export of palm oil, rubber, coffee, sugar cane, corn, and animal products, and in order to study the impact of human capital on raising agricultural growth rates, researchers used the Solow model, which is a development of the Harrod-Domar model, which focuses on the role of human capital and the factors that determine agricultural and economic growth, which are the labor force and the level of technology. It turns out that raising the rate of economic and agricultural growth is achieved through developing the technological system that depends on the capabilities of the agricultural laborers and their ability to achieve optimal use of production factors and modern technology, as well as the role of government spending on means that contribute to developing the cultures of rural individuals and their ability to provide economic, marketing, health and educational services because of their extremely important role in increasing agricultural output. The researchers concluded that spending on human development, represented by health, educational and social variables, contributed to increasing production by a rate ranging between 34.68% - 14.69% during the period 2010 - 2015, which led to achieving a significant increase in agricultural growth in South Sumatra, as the agricultural output witnessed increases exceeding the rates of spending on the variables mentioned above. The researchers recommended the need to increase the values of investment allocations to human development variables as they are the most important factors that contribute to raising the agricultural growth rate in the country under study [16].

The study conducted by Lekhuong Ninh in 2020 focused on the impact of education on agriculture, particularly in the rice cultivation sector in the Mekong River Delta region of Vietnam. The study aimed to investigate the role of education in increasing the rate of economic and agricultural growth. The researcher examined 901 families involved in rice cultivation in ten provinces of the Mekong River Delta, which accounts for more than 50% of the rice production in Vietnam. The study found that families with a higher level of agricultural education achieved greater success

in rice production. These families were able to optimize the use of inputs, such as fertilizers and pesticides, and adopt modern technology in the production process. To prove the research hypothesis, the Cobb-Douglas function was used, where the amount of rice output was the dependent variable, and the size of the farm and the level of education were the independent variables. The practical results indicated the significance of education and its positive effect on increasing rice production. Based on the findings, the researcher recommended a focus on spreading agricultural education and its various means. Education plays an extremely important role in increasing the production of rice, which is a crucial source of income for Vietnam. In summary, the study highlighted the importance of education in agriculture, particularly in the rice cultivation sector. Families with higher agricultural education achieved better results in rice production, emphasizing the need to promote and expand agricultural education to maximize crop output [17].

The study conducted by Wang and others in 2022 focused on labor, human capital, and agricultural productivity in the United States. The researchers found that the US has been the global leader in agricultural production since 1947, largely due to increased investment in machinery, equipment, and agricultural software. Additionally, the country has been spending on developing and training the rural labor force, resulting in the utilization of inputs and the increased employment of agricultural labor. The researchers highlighted that agricultural productivity in the US surpasses that of other countries due to the higher values of financial allocations in human investment and the development of knowledge and skills among agricultural workers. This has been facilitated by state spending on agricultural research and development. Consequently, these factors have become the primary drivers of agricultural productivity growth in the US and have led to higher returns compared to the rest of the world. The researchers also referenced a study by economist Shchultz, which demonstrated that developing human capital contributed to a 20% increase in the gross domestic product of the US between 1948 and 1973. Educational

attainment specifically contributed by 14.6% to the rate of economic and agricultural growth during this period. Following World War II, human development indicators achieved significant rates of economic and agricultural growth. Based on their findings, the researchers recommended increasing spending on human development, particularly in areas such as educational attainment, health services, and programs aimed at developing the capabilities and skills of individuals. These investments play a crucial role in enhancing agricultural productivity [18].

By extrapolating the previously mentioned studies, it becomes clear that most of them focused on the topic of the impact of human development variables on the agricultural growth rate in its descriptive form, with the exception of the Ndour [15] study, which dealt with this topic in its quantitative form. What distinguishes our study is that it dealt with this topic in its descriptive form as well as adopting the quantitative method in which the impact of human development variables on the agricultural growth rate and during the research period will be estimated and interpreted, and this is one of the recent studies that used this method.

### **Statistical estimation and economic interpretation of the impact of human development variables on agricultural growth in Iraq for the period 1990-2022**

1- Description of the standard model used in the estimation: In order to estimate and explain the impact of human development variables in Iraq, and during the research period, a number of standard models were adopted that included the following (\*) variables:

Our study included a time series lasting 33 years from 1990-2022. For the purposes of estimation and analysis, several standard models were used for various cases of multiple linear regression, relying on E-views10 software and the Ordinary Least Squares (OLS) method. Therefore, the mathematical form of the model is as follows:

$$Y = f(x_1, x_2, x_3, x_4, x_5)$$

The standard formula for the above model is as follows:

$$Y_i = B_0 + B_1x_1 + B_2x_2 + B_3x_3 + B_4x_4 + B_5x_5$$

The dollar currency was used for all monetary variable values to avoid using the local currency, which might give misleading results. For the purposes of estimation and analysis, stability tests were used to detect the degree of integration of variables and the unit

root test with the aim of adopting the appropriate standard model according to the results that will be obtained using the E-statistical program E-views 10 and its tests because it gives the best unbiased linear estimates that are often consistent with the concepts of economic theory [19], and the following is an explanation of the variables mentioned above.

Table 1: Description of the model used

Variables	Description
Y	Agricultural output growth rate (%)
X1	Agricultural capital (million dollars)
X2	Mechanical technology (horsepower)
X3	Chemical technology (tons)
X4	Agricultural labor (individual)
X5	Agricultural education (number of learners)

(\*) Data was collected from the following references:

1-League of Arab States, 1990-2022, Arab Organization for Agricultural Development, Annual Statistical Book, Volume 35, 40.

2-FAO on the website ( <https://www.fao.org> )

The World Bank, 1990-2022 on the following website: <https://www.albankaldawili.org/ar/hom>

Table 2: The variables of agricultural human development in Iraq for the period 1990-2022

Year	Agricultural output growth rate Y (%)	Agricultural capital X1 (million dollars)	Mechanical technology X2 (horsepower)	Chemical technology X3 (tons)	Agricultural labor X4 (individual)	Agricultural education X5 (number of learners)
1990	0.08	285	5205	3679	2703	2304
1991	-0.05	332	5438	9968	2646	2356
1992	0.07	361	5596	11690	2572	2378
1993	0.04	381	5639	12000	2544	2398
1994	0.006	399	5740	11763	2497	2406
1995	0.002	410	6088	10783	2409	2412
1996	0.02	410	6379	11566	2365	2356
1997	-0.005	412	6630	12526	2321	2373
1998	-0.006	416	6677	12610	2274	2439
1999	0.018	418	6454	12037	1943	2273
2000	0.09	424	6473	11018	1607	2080
2001	0.007	382	5817	10504	1295	1727
2002	-0.02	350	5867	10022	1288	1184
2003	-0.04	303	5951	9992	1300	1216
2004	0.06	281	6230	10522	1318	542
2005	0.04	259	6327	11011	1321	714
2006	0.009	249	6461	11307	1327	556
2007	-0.006	247	6339	11258	1322	617
2008	0.001	251	6375	11192	1323	692
2009	0.001	249	5491	11252	1324	652
2010	-0.001	249	6461	11258	1327	862
2011	0.0004	123	6424	11635	1467	1096
2012	0.009	194	6338	11680	1504	1330
2013	0.035	188	6543	11698	1443	1427
2014	0.011	168	6685	12011	1471	1422
2015	0.054	183	6788	12238	1472	744
2016	0.04	179	6844	12867	1463	969
2017	0.09	181	6812	13465	1489	1125
2018	0.55	193	6915	13688	1492	989
2019	0.56	189	6991	13840	1489	1082
2020	0.17	192	6998	13989	1512	1126
Lowest	-0.05	123	5205	3679	1288	542
Highest	0.56	424	6998	13989	2703	2439
Moderate	0.0592065	285.742	6289.55	11453.8	1736.39	1478.94

Reference: Prepared by the researcher based on the data from: League of Arab States, FAO, The World Bank.

The results of Table (2) indicate that the lowest growth rate witnessed by the agricultural sector was in 1991, which amounted to -0.05%, as the reason for this was due to the remnants of the Second Gulf War, which had its effects in the destruction of the infrastructure of the Iraqi agricultural sector, while the highest growth rate reached 0.56% in 2019. The reason for this is the tendency of agricultural policy makers towards developing the sector under study through rebuilding its infrastructure and importing modern technology and high-yielding inputs, which led to achieving the aforementioned growth rate, while the agricultural growth rate during the research period 1990-2022 reached 0.05%, which is a growth rate close to the growth

rates of agriculturally developed countries. The value of agricultural capital reached a minimum in 2011 at \$123 million, as the reason for this is due to the state's trend towards foreign imports, which began in 2003 at the expense of reducing the values of investment allocations for the agricultural sector while the highest value of agricultural capital reached 424 million dollars in the year 2000, the reason for this is the state's tendency towards increasing the values of investment allocations to the sector due to the blockade imposed on Iraq and the interruption of foreign imports, while the average value of capital during the research period reached 285.742 million dollars, which is a large value compared to the values of agricultural capital



in many regional and neighboring countries. The reason for this is the low performance efficiency of agricultural plans in employing the above amount.

The results of the aforementioned table showed that the values of mechanization reached the lowest level in 1995 at one million dollars, as the reason for this was the decline in the values of investment allocations for agricultural mechanization due to the scarcity of Iraqi treasury funds following the Second Gulf War. The blockade contributed to that, which prevented the entry of all types of investment goods and agricultural mechanization into Iraq [6]. While the highest value in 2020 was 6998, the reason for this lies in the Iraqi government's move towards revitalizing the agricultural sector through the state's decision to launch the agricultural initiative, which contributed to increasing the imported quantities of agricultural mechanization, while the average values of the aforementioned mechanization during the research period reached 6289.55, which is a percentage that is not equivalent to its counterparts in agriculturally developed countries, as many of Iraq's countryside are still working with primitive agricultural methods [10], while the lowest value for chemical technology was reached in 1990 at 3679 million dollars, as the reason for this is due to the state's reliance on producing this technology locally at low costs. This was accompanied by Iraq's entry into the Second Gulf War, in which it devoted its investment spending towards the military sector, while the highest value of the aforementioned technology was reached in 2020 at \$13,989. This was justified by the trade openness since the year 2003, as Iraq was able to activate the function of imports for various types of agricultural commodities, including chemical technology. The average values of mechanization mentioned during the research period amounted to 11,453.8 million dollars, which is a high percentage compared to

neighboring countries and regional countries, but it is low compared to agriculturally developed countries. The number of workers in agriculture reached a maximum of 2,703 individuals in 1990, and this is considered a natural result of this number working in the agricultural sector because of the dependence on local agriculture, while this number decreased and reached its lowest level in 2002 with 1,288 million individuals, as the reason for this is due to trade openness and the policy of globalization, which spread its effects on Iraqi agriculture, which reflected its effect in leaving large areas of agricultural land and working in other job sectors. The average number of labor force reached 1736.39 million individuals during the study period, which is a high number compared to developed countries due to their reliance on more modern methods in the agricultural sector. The number of agriculturally educated people reached its highest level in 1998 at 2439 million individuals, due to state policies that imposed compulsory education and free education starting from its early and even advanced stages, the state's reliance on local agriculture contributed to this, while the number of educated people in 2004 reached 542 million individuals. The reason for this is attributed to the increasing number of migrants from the countryside to the city after the improvement of the living conditions of the city and the rise in income levels and the employment of these people in non-agricultural fields. While the average number of learners during the research period reached 1478.94 million individuals, which is a low percentage compared to its counterparts in developed countries.

## **2- Results of quantitative analysis of the impact of human development variables on agricultural growth in Iraq during the period 1990-2022:**

The linear formula gave the best results in estimating the impact of human development variables on the agricultural growth rate in Iraq during the research period as follows:

Table 3: Results of the unit root test (ADF) for the impact of human development variables on agricultural growth in Iraq for the period 1990-2022

UNIT ROOT TEST TABLE (ADF)							
At Level							
		Y	X1	X2	X3	X4	X5
With Constant	t-Statistic	-3.4691	-0.6607	-2.3130	-1.1368	-2.0921	-1.2328
	Prob.	0.0164	0.8418	0.1746	0.6867	0.2490	0.6468
		**	n0	n0	n0	n0	n0
With Constant & Trend	t-Statistic	-3.7912	-3.0717	-3.0359	-1.9211	-1.6002	-1.1352
	Prob.	0.0317	0.1310	0.1396	0.6170	0.7680	0.9057
		**	n0	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	-0.2154	-0.9817	1.1002	0.6333	-1.2839	-1.3474
	Prob.	0.5997	0.2845	0.9254	0.8472	0.1790	0.1610
		n0	n0	n0	n0	n0	n0
At First Difference							
		d(Y)	d(X1)	d(X2)	d(X3)	d(X4)	d(X5)
With Constant	t-Statistic	-5.8586	-6.0161	-6.8954	-3.9902	-2.3869	-5.1541
	Prob.	0.0000	0.0000	0.0000	0.0048	0.1540	0.0002
		***	***	***	***	n0	***
With Constant & Trend	t-Statistic	-6.4213	-5.9476	-6.7878	-6.0762	-3.1598	-5.1660
	Prob.	0.0001	0.0002	0.0000	0.0003	0.1135	0.0013
		***	***	***	***	n0	***
Without Constant & Trend	t-Statistic	-5.9324	-5.9904	-6.7245	-1.2237	-2.3032	-5.0949
	Prob.	0.0000	0.0000	0.0000	0.1958	0.0229	0.0000
		***	***	***	n0	**	***

Notes: (\*) Significant at the 10%; (\*\*) Significant at the 5%; (\*\*\*) Significant at the 1%. and (no) Not Significant \*MacKinnon (1996) one-sided p-values.

This Result is The Out-Put of Program Has Developed by:  
 Dr. Imadeddin AlMosabbeh  
 College of Business and Economics  
 Qassim University-KSA

Reference: Prepared by the researcher based on the results of the Statistical Software E-Views 10

The unit root test (ADF), as shown in Table (3), showed that the dependent variable Y stabilized at the first level of the data at the constant and at the constant and Trend, while all the independent variables stabilized at the first difference of the data, which led to the necessary for testing the Autoregressive Distributed Lag (ARDL) model, the best lag period was the second according to the VAR test. The estimation results also showed that

the best model was ARDL (3,1,2,3,2,3). The results of the analysis also showed the presence of cointegration between its variables because the value of the F-statistic = 11.20536, which is higher than the lower and upper values at significant levels, except for 1%, and this result is considered economically acceptable. After conducting a cointegration analysis, it became clear that the variables are free of standard problems, as in Table (4).

Table 4: Results of cointegration analysis

Type of problem	Test type	Value	Probability
Auto-correlation	LM-Test	9.893474	0.1126
Heterogeneity	AREH-Test	0.153989	0.6981
Diagnostic tests	RESET-Test	142764	0.1067

Reference: Prepared by the researcher based on the results of quantitative analysis of the software E-views10

**The impact of human development variables on agricultural growth in Iraq:**  
 The results of the quantitative analysis of the

impact of human development variables on agricultural growth in Iraq during the research period can be clarified as in Table (5).

Table 5: Results of quantitative analysis of the impact of human development variables on agricultural growth

ARDL Bounds Test Sample: 1993 2020 Included observations: 28 Null Hypothesis: No long-run relationships exist				
Test Statistic	Value	k		
F-statistic	11.36497	5		
Critical Value Bounds				
Significance	I0 Bound	I1 Bound		
10%	2.26	3.35		
5%	2.62	3.79		
2.5%	2.96	4.18		
1%	3.41	4.68		
ARDL Cointegrating and Long Run Form Dependent Variable: Y Selected Model: ARDL (3, 2, 3, 2, 1, 3) Sample: 1990 2020 Included observations: 28				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y(-1))	0.051010	0.389331	0.131019	0.8990
D(Y(-2))	-1.019989	0.392287	-2.600105	0.0316
D(X1)	0.004566	0.001286	3.550897	0.0075
D(X1(-1))	0.002497	0.000819	3.050390	0.0158
D(X2)	0.000036	0.000045	0.796321	0.4488
D(X2(-1))	0.000493	0.000141	3.503750	0.0080
D(X2(-2))	0.000500	0.000173	2.898273	0.0199
D(X3)	0.000219	0.000053	4.145031	0.0032
D(X3(-1))	-0.000194	0.000043	-4.474190	0.0021
D(X4)	0.000035	0.000236	0.147196	0.8866
D(X5)	-0.000029	0.000069	-0.413730	0.6899
D(X5(-1))	-0.000080	0.000068	-1.183639	0.2705
D(X5(-2))	0.000059	0.000053	1.119267	0.2955
CointEq(-1)	-1.040092	0.343852	-3.024822	0.0164
Cointeq = Y - (0.0034*X1 -0.0009*X2 + 0.0006*X3 -0.0016*X4 + 0.0002*X5 + 0.8315 )				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	0.003413	0.001234	2.765816	0.0245
X2	-0.000939	0.000372	-2.526703	0.0354
X3	0.000563	0.000204	2.765223	0.0245
X4	-0.001648	0.000634	-2.600454	0.0316
X5	0.000247	0.000117	2.113688	0.0675
C	0.831453	0.651163	1.276875	0.2375
R-squared	0.963785	Mean dependent var	0.061979	
Adjusted R-squared	0.877774	S.D. dependent var	0.145218	
S.E. of regression	0.050769	Akaike info criterion	-2.947241	
Sum squared resid	0.020620	Schwarz criterion	-1.995666	
Log likelihood	61.26137	Hannan-Quinn criter.	-2.656335	
F-statistic	11.20536	Durbin-Watson stat	2.808962	

Reference: Prepared by the researcher based on the results of quantitative analysis of the software E-views10.

The results indicate the impact of human development variables on agricultural growth in Iraq, in the short and long term, and during the research period. The results for both terms were analyzed because they show the direct and indirect effects of the independent variables on the dependent variable and during the research period. The dollar currency was

used for all monetary variable values to avoid using the local currency, which might give misleading results. For the purposes of estimation and analysis the ordinary least squares model (OLS) was relied upon, stability tests were used to detect the degree of integration of variables and the unit root test with the aim of adopting the appropriate

standard model according to the results that will be obtained using the E-statistical program EViews10 and its tests because it gives the best unbiased linear estimates that are often consistent with the concepts of economic theory, and the following is an explanation of the variables mentioned above.

The linear formula gave the best results in estimating the effect of independent variables on the agricultural growth rate. The results of analysis showed that the value of  $R^2$  was 0.877, and from this, it is clear that the explanatory power of the estimated model reached 0.87, while the calculated F value reached 11,205, which is greater than the tabulated F value, which indicates the significance of the assumed linear relationship between the independent variables and the dependent variable, there was no autocorrelation problem between the values of the random variables according to the Durbin-Watson D-W test.

The elasticity (\*) of capital X1 is 0.015, the positive sign of the parameter of this variable is consistent with the concepts of economic theory and the study of Wang *et al.*, 2022. Capital is the main driver for raising the agricultural growth rate, as it is considered one of the most important means of providing the latest equipment, high-yield inputs, and advanced technology. This means that this variable brings closer the differences in the agricultural growth rate in developing and developed countries [18], and this result was identical to the same variable and its effect on the dependent variable in the long term, and the mechanical technology variable X2 did not appear significant in affecting the growth rate of agricultural output in the short term, but in the long run, its elasticity reached 0.042, and its negative sign contradicted the concepts of economic theory, as the reason for this lies in the use of most types of agricultural machinery in non-agricultural fields, in addition to the inability to settle large numbers and types of agricultural mechanization in the countryside of Iraq, in addition to the backwardness and ignorance among most types of farmers that prevents them from using modern agricultural machinery and equipment. The elasticity of the

chemical technology variable X3 was 0.096 and the positive sign for the parameter of this variable means that fertilizers, both chemical and organic, have a very important role in increasing the fertility of the soil and agricultural media by providing them with nutrients and mineral elements that contribute to increasing plant growth, the results of this variable were identical in the long term.

The estimation results showed that the labor force variable X4 did not appear significant in affecting the growth rate of agricultural output in the short term, as for the long term, this variable appeared with a non-positive effect on the dependent variable with an elasticity of 0.043, as the reason for this is attributed to the high rate of population density in rural Iraq, which led to an increase in demand for agricultural land, this was accompanied by the lack of regulation of agricultural holdings and their reliance on old foundations and laws, which led to the emergence of the effects of the law of diminishing returns, especially in small areas cultivated with strategic crops, which reflected negative results in the agricultural growth rate, and this result was consistent with the findings of the study of Barros and others [20]. The agricultural education variable X5 did not appear significant in the effect on the dependent variable, however, this variable appeared with a significant effect in the long term and with an elasticity of 0.056, the positive sign of its parameter agreed with the concepts of economic theory and with the results of the study of Mose and Ouru, [21] in which they explained that agricultural education has a very important role in innovating and adopting modern agricultural production processes and selecting breeds that achieve high profitability rates, so this variable is considered an essential element in stimulating agricultural growth, and this is evident from its role in reviewing the results of recent studies that adopt various types of methods whose impact is reflected in raising the growth rate of agricultural output [21].

(\*) Elasticity in linear functions are calculated

in the following way:  $ep = \beta_i \frac{\bar{X}}{\bar{Y}}$

## Conclusions

- 1- Agricultural education is one of the most important factors affecting agricultural production, and it appeared with little effect due to the low educational level of farmers in rural Iraq.
- 2- Technological change is the most important factor that leads to the development of agriculture and reducing the gap between developing and developed countries.
- 3- Chemical and organic technology represent a great deal of knowledge and skills, as it has achieved great development and balance between human resources and the agricultural biosphere.

The trained agricultural labor force plays an important role in improving agricultural growth rates and achieving sustainable development goals, especially in eliminating hunger .

## Recommendations

- 1- There is a need for an effective combination of factors affecting agricultural production in order to raise its growth rate, such as supporting inputs and equipment used for production purposes in order to adopt modern technology and use fertilizers and nutrients in efficient quantity and quality.
- 2- Providing educational services in rural Iraq, especially primary education, as well as improving its quality and emphasizing practical training in modern agricultural methods, which keeps farmers constantly informed of modern innovations and exchanging experiences.
- 3- Adopting modern agricultural technology in the field of using agricultural machinery and equipment with the aim of improving and increasing agricultural production.
- 4- Expanding the use of organic, chemical and biological fertilizers as they contribute to improving the quality of agricultural output.

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## أثر متغيرات التنمية البشرية في النمو الزراعي في العراق للمدة من 1990 - 2022

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### الملخص

يحثل القطاع الزراعي في العراق مكانه مهمه بعد القطاع النفطي كونه يسهم في توفير الغذاء وفرص العمل لأكثر من 30% من اعداد السكان وعلى الرغم من هذه الأهمية الا ان الواقع يشير الى عدم مقدره هذا القطاع من تلبية الاحتياجات المطلوبة منه اذ يكمن سبب ذلك في كونه يدار من قبل افراد لا يمتلكون ابسط مقومات التنمية البشرية تهدف الدراسة الى قياس وتفسير اثر متغيرات التنمية البشرية في رفع معدل النمو الزراعي في العراق خلال المدة من 1990 - 2022 ومن اجل تطبيق الجانب الكمي من الدراسة تم اعتماد معدل نمو الناتج الزراعي كمتغير معتمد  $Y$  اما المتغيرات المستقلة فشملت رأس المال الزراعي  $X1$  والتقانة الميكانيكية  $X2$  والتقانة الكيميائية  $X3$  والعمل الزراعي  $X4$  والتعليم الزراعي  $X5$  بالاعتماد على البرنامج الاحصائي  $E-views10$  واختباراته وفق طريقه المربعات الصغرى الاعتيادية OLS وقد اوضحت نتائج التقدير معنويه متغيري رأس المال والتقانة الكيميائية وبتأثير ايجابي في معدل النمو الزراعي في الامدين القصير والطويل وظهر التأثير المعنوي غير الايجابي للتقانة الميكانيكية وقوى العمل في الاجل الطويل فقط ، اما التعليم الزراعي فقد ظهر بتأثير معنوي ويجابي في الامد الطويل . وتم التواصل الى عدد من الاستنتاجات كان اهمها ان الموارد البشرية تسهم في تطوير الاعمال الزراعية حتى عدت الوسيلة الرئيسة في تحقيق الانتاج الواسع، ونوصي بزياده قيم الانفاق الحكومي في مجالات التعليم والتدريب والتأهيل في ارياف العراق كونه يمكن السكان من توظيف مهاراتهم وخبراتهم في رفع معدل النمو الزراعي.

**الكلمات المفتاحية:** رأس المال الزراعي، الموارد البشرية، العمل.