Journal homepage
www.ajas.uoanbar.edu.iq
Anbar Journal of Agricultural Sciences
(University of Anbar – College of Agriculture)

AN ECONOMIC EVALUATION OF THE PERFORMANCE EFFICIENCY OF CONSERVATION AGRICULTURE AND FOOD SECURITY PROJECTS USING LOGISTIC REGRESSION IN IRAQ FOR THE 2022-2023 SEASON

N. S. Noori [1]* B. H. Hameed [2] M. Kh. Mohammed [1]

[1] Ministry of Agriculture
[2] University of Baghdad, College of Agricultural Engineering Sciences

***Correspondence to:** Noor S. Noori, Ministry of Agriculture, Iraq.
Email: noor.sabbah1108@coagri.uobaghdad.edu.iq

Article info

Received: 2024-04-27
Accepted: 2024-05-31
Published: 2024-12-31

DOI-Crossref:
10.32649/ajas.2024.184466

Cite as:
Noori, N. S., Hameed, B. H., and Mohammed, M. Kh. (2024). An economic evaluation of the performance efficiency of conservation agriculture and food security projects using logistic regression in Iraq for the 2022-2023 season. Anbar Journal of Agricultural Sciences, 22(2): 1033-1049.

Abstract

This research involved an economic evaluation of the performance efficiency of conservation agriculture and food security projects using logistic regression in Iraq for the 2022-2023 agricultural season. Using quantitative methodology and the logistics regression method (logit), it analyzed the main factors influencing the adoption of conservation agriculture and food security projects. Data was collected through questionnaires with 74 responses each received from farmers in the food security enhancement project and in traditional agriculture. Also, 45 forms each were received for the conservation and traditional agriculture projects. Regression model coefficients were estimated using the maximum likelihood method, explaining the dependent variable and independent variables. The dependent variable is a binary variable with a value of 1 for farmers adopting the technology and 0 for those who did not. The independent variables included age, experience, educational level, source of household income, productivity, water source, land tenure, field records, and use of agricultural technologies. The study produced several results, the most important of which is the significance of most of the variables for the two projects. The goodness-of-fit coefficient of the model was also shown using the Hosmer and Lemeshow statistic with degrees of

freedom 8 d.f. The P value for the conservation agriculture and enhancing food security projects was greater than 0.05% indicating acceptance of the null hypothesis (H0) which states no difference between the observed and estimated values of the dependent variable and that the model estimates fit the data very well. The study recommended increasing government support for the dissemination of modern technologies to facilitate farmers' access to them and intensifying training programs on the use of these technologies appropriate to the conditions of the region. This also applies to the conservation agriculture and food security projects. There is also a need to transfer the experience of the applied regions to other areas in Iraq.

Keywords: Logit, Hosmer and Lemeshow, Likelihood.

تقييم اقتصادي لكفاءة أداء مشروعي الزراعة الحافظة وتعزيز الامن الغذائي باستخدام الانحدار اللوجستي في العراق للموسم 2022-2023

نور صباح نوري [1]* باسم حازم حميد [2] محمد خالد محمد [1]

[1] وزارة الزراعة

[2] جامعة بغداد، كلية علوم الهندسة الزراعية

***المراسلة الى:** نور صباح نوري، وزارة الزراعة، العراق.

البريد الالكتروني: noor.sabbah1108@coagri.uobaghdad.edu.iq

الخلاصة

تم في هذا البحث اجراء تقييم اقتصادي لكفاءة اداء مشروعي الزراعة الحافظة وتعزيز الامن الغذائي باستخدام الانحدار اللوجستي في العراق للموسم الزراعي 2022–2023. وهدف البحث الى اجراء تحليل اقتصادي لاهم العوامل المؤثرة على تبني مشروعي الزراعة الحافظة وتعزيز الامن الغذائي وذلك عن طريق استخدام اسلوب الانحدار اللوجستي (لوجت). استخدام البحث الاسلوب الكمي. وتم جمع البيانات عن طريق استمارة الاستبانة اذ بلغ عدد الاستمارات التي تم جمعها من المزارعين لمشروع تعزيز الامن الغذائي 74 استمارة ومثلها للزراعة التقليدية. وبلغ عدد الاستمارات لمشروع الزراعة الحافظة 45 استمارة ومثلها للزراعة التقليدية. وتم تقدير معاملات انموذج الانحدار باستعمال طريقة الامكان الاعظم وتوضيح المتغير التابع والمتغيرات المستقلة. وان المتغير التابع متغير ثنائي القيمة 1 المزارعين المتبنين للتقنية، 0 المزارعين غير المتبنين للتقنية. اما المتغيرات المستقلة شملت (العمر، الخبرة، المستوى التعليمي، مصدر دخل الاسر، الانتاجية، مصدر المياه، حيازة الارض، السجلات الحقلية، استخدام التقانات الزراعية). وتوصلت الدراسة عدة نتائج اهمها معنوية اغلب المتغيرات للمشروعين. كما ظهر

معامل جودة توفيق الأنموذج باستعمال احصاءة (Hosmer and Lemeshow statistic) بدرجات حرية 8 d.f. ان قيمة P لمشروعي الزراعة الحافظة وتعزيز الامن الغذائي كانت اكبر من 0.05% وهذا يعني قبول الفرضية الصفرية H0 التي مفادها انه ليس هناك اختلاف بين القيم المشاهدة والقيم المقدرة للمتغير التابع. مما يعني ان تقديرات الأنموذج تناسب البيانات بشكل جيد جداً. واوصت الدراسة بزيادة الدعم الحكومي المتعلق بنشر التقنيات الحديثة لتسهيل حصول المزراعين عليها وتكثيف برامج التدريب على استعمال هذه التقنيات الملائمة لظروف المنطقة. ومنها مشروع الزراعة الحافظة وتعزيز الامن الغذائي. وضرورة نقل تجربة المناطق المطبقة الى المناطق الاخرى في العراق.

كلمات مفتاحية: لوجت، هوسمرو لميشو، الامكان الأعظم.

Introduction

Wheat is one of the most important cereal crops in the world and ranks highest in terms of production, consumption and cultivated area as more than one third of the world's population depends on it (29). In Iraq it is the main crop in terms of cultivated area and in production as well as for agricultural revenue (13 and 19). The crop is moderately sensitive to salinity and the wheat bread varieties are grown in central and southern Iraq where the salinity of the land ranges from medium to high (12). Specialized international organizations have an effective role in transferring and applying modern agricultural technologies in developing countries aimed at raising self-sufficiency rates, achieving food security, and realising significant economic returns by opening agricultural investment horizons to local and foreign investors, as well as strengthening productivity and production (28). This is especially in the main crops and in important aspects that would benefit farmers by enhancing their incomes, strengthening their livelihoods, and improving the agricultural sector in order to raise the contribution rates of agricultural output to the gross domestic product (10). Therefore, it is necessary to pay attention to the work of these organizations and follow up and evaluate the effectiveness of their projects both at the administrative and technical levels.

The process of evaluating the work of those organizations and agencies implementing their projects should involve international standards and indicators for the purpose of keeping pace with rapid global developments in the field of agriculture and investment and to know the extent of the effectiveness of the local executing agencies' performance. The issue of food security in the Arab world and in Iraq is of major interest to specialists and interested parties in various sectors (20). This is because the issue of food for individuals require a scientific and practical strategy capable of meeting those needs through sound means and with government policies based on comprehensive plans and rational management (15). The reality of national food production and how to secure its requirements is based on the standards of interdependence and optimal exploitation of resources (6). One of the elements that makes food security of interest is the daily need for food as it is a basic needs of individuals and is a major source of life. As a food, wheat is important for production

and consumption and has a major impact on trade balances as it is imported in large quantities (8). It extends over time periods and is inherent in the decisions and efforts of the authorities responsible for providing it to individuals within the state, in addition to being one of the aspects of the state's national security (5). The increasing need for food production, the continued deterioration of agricultural lands, the increasing phenomena of desertification and erosion, the recurrence of drought waves, and the fluctuation of rainfall have created uncertainty over the capacity of existing agricultural systems in addressing global food security (11). Therefore, sustainability standards have taken the lead in measuring the success of agricultural projects, and revealing the obstacles to achieving sustainability in agricultural projects has become a priority for research centres and institutes (14).

This interest in sustainability came as a result of the unaccounted results that accompanied the applications of modern agriculture during the second half of the last century due to exaggeration in the rationale. Modern agriculture involves preparing the soil, preparing it for cultivation, and treating it with agricultural chemicals, which caused serious damage to the soil and led to a decrease in productivity and a steady increase in its investment costs (9, 22 and 23). This is in addition to the accumulation of agricultural chemical residues, such as pesticides and fertilizers at levels that affect the environment, and the irrational use of non-renewable natural resources. Global warming also calls for attention to the safety and preservation of the environment to ensure sustainability by preserving the quality and integrity of the soil and energy sources, as well as preserving water resources and increasing their efficiency. Water scarcity is one of the main challenges facing Iraq due to the acute shortage of imports. From the Tigris and Euphrates rivers and the lack of rain and snow, water is considered one of the important and vital issues for achieving economic development and agricultural development. The world has lately been facing scarcity on the one hand and increasing needs and requirements on the other (3), in addition to managing agricultural waste without causing harm to the environment. Based on this, the concept of conservation agriculture has become widespread in agricultural scientific circles, which is based on the inevitability and necessity of managing and maintaining resources and protecting them from deterioration through modern agricultural techniques and integrated agricultural management to achieve food sustainability and increasing human well-being without disturbing the security and needs of future generations. The concept and application of conservation agriculture has become strongly imposed in developing countries, including Iraq, which suffers from aspects that threaten its water and land resources, such as water scarcity, salinization, waterlogging, deterioration, and the unsuitability of the soil for agriculture (7). Several studies have been conducted in this field (14, 15, 16, 18, 21, 24, 25 and 26).

The problem of such research is that conservation agriculture and food security projects have not been conducted based on a comprehensive and integrated economic evaluation by simultaneously measuring strategic administrative and agricultural performances. This includes evaluating the performance of the implementing government agencies, as well as the lack of continued follow-up on the application of modern technologies that have been adopted. The failure to shed light in the form of economic evaluation of the returns of the studied projects (19) by international

organisations is an issue. The other side of the problem is the lack of high food security rates with regard to crops and basic food commodities in Iraq, as well as water and soil resource deterioration. One solution is conservation agriculture (17). This research is based on two hypotheses: (1) that the projects of international organizations specializing in the agricultural sector have an impact on achieving aspects of agricultural growth and development through the introduction and application of modern technologies, and (2) that government agencies responsible for following up on the dissemination and implementation of these technologies suffer from a deficiency in follow-up performance that may be attributed to the inefficiency and lack of follow-up. The research conducted an economic analysis of the most important factors influencing the adoption of conservation agriculture and food security projects by using the logistic regression method (logit).

Materials and Methods

Economic Analysis of The Factors Affecting the Conservation Agriculture Programs and Enhancing The Food Security of The Wheat Crop in Iraq Using Logistic Regression: Regression is generally defined as the analysis that is concerned with studying the dependence of the dependent variable on one or more explanatory variables in order to estimate and predict the average or value of the rate of the dependent variable in the meaning of known values of the illustrative variable when the repetition of the variable or illustrative variables (1). On the basis of that, the logistic regression method is used to reach a mathematical model that illustrates the quantitative relationship between the dependent variable whose value is to be predicted and the variables. Regression analysis came to achieve three basic purposes: describing the form of the relationship between variables. Estimating and predicting the value of the dependent variable at any level of the explanatory variables. Controlling the values of the dependent variable when the remaining explanatory variables are constant (2). Logistic Regression is also a model used to predict the possibility of a particular event by reconciling data in the form of a logistical curve, and is usually used in predicting the values of qualitative or class variables based on a group of mixed independent variables, such as one of which is continuous variables or measurements, while the other section is in the form of intermittent variables (27 and 30).

The use of the binary logistic regression model in analysis instead of the usual micro squares (OLS) method is because when using the (OLS) method in estimating the regression model, which includes qualitative dependent variables, can lead to some values of the dependent variable being smaller than 0 or greater than 1, which are brilliant values for them because the original values of the dependent variable take only the two values 0,1. The first step is to describe the model and determine the nature of the dependent variable and the independent variables as shown below:

First: Application of the Logit logistic regression model to the preservative agriculture project in Iraq for the 2022-2023 season

Prob (event) = Prob (Y: 1: represents it farmer adopted and 0: non adopt..... (1)

As: Prob(event): The probability of the event occurring, Y: 1: Adopting the technique, 0: Do not adopt the technology.

Selection of variables and hypothesis testing: The logistics regression model coefficients of the preservative agriculture project were estimated using the Maximum Liklihood (ML) method using the Eviwes10 program, defined The Maximum Likelihood (ML) method is one of the most efficient methods for estimating binary qualitative models, especially with large samples. This iterative method starts with an initial value for the parameters and then determines the magnitude and direction of the change in the logit parameters. It is one of the methods developed by statisticians for estimating parameters in mathematical models. (ML) is suitable for all models both linear and nonlinear unlike the Least Squares Method, is an iterative method that relies on repeating calculations multiple times until the best parameter estimates are obtained (Kleinbaum and Klein, 2002, p. 40). Due to the extensive and complex calculations required, (ML) was not widely used in the past until statistical software and packages emerged, greatly facilitating the use of this method for parameter estimation (31).

Results and Discussion

And the dependent variable and the independent variables included in the logistics regression model are clarified and can be explained as follows:

First: The dependent variable: (ADPT)Y: When farmers' adoption of any technique is analyzed, it is usually used is a binary variable (adoption or non-adoption). The ADOPT variable is defined as a dual-value variable:

1: The farmers adopting the conservation agriculture project technology numbered 45 farmers.

0: The number of non-adoptive farmers of the conservation agriculture project 48 farmers.

Second: Illustrative variables (independent): There is a set of variables from farmers that affect the conservation agriculture project represented by economic, social, institutional and environmental factors, and the model included 8 illustrative variables represented by the mentioned factors.

(AGE) X1: It is a quantitative variable, which measures the age of the targeted farmers, as young farmers have a greater opportunity to absorb and adopt modern technologies compared to older farmers who will be less acceptable to adopt the conservation agriculture project technology. It has appeared with a negative reference that conforms to the logic, increasing the age by one year leads to a decrease in the probability of farmers adopting the preservative agriculture project by 0.137-, and the test z indicated the morale of this variable at a moral level 5%.

(FEXP) X2: It is a quantitative variable, and this variable measures the experience of the target farmers in growing the wheat crop, and it has appeared with a positive sign that conforms to the logic, increasing the experience by one year leads to increasing the adoption of farmers of the preservative agriculture project by 0.079, while the z test indicated the morale of this variable at a moral level 5%.

(EDU) X3: It is a qualitative variable, this variable measures the educational level of the target farmers, and it has appeared with a positive signal that corresponds to the logic, as farmers with high levels of educational achievement are the most acceptable to adopt the conservation agriculture project than the less educated farmers. Increasing

the educational level by one year leads to increasing the adoption of the project by 1.146, while the Z test indicated the morale of this variable at a moral level 5%.

(INCO) X4: It is a qualitative variable, which measures whether a farmer has income other than agriculture (1: farmer income, 0: non-farm income), and appears with a positive sign that most farmers have no source of income other than agriculture.

(LTEN) X5: It is a qualitative variable, which measures whether the possession of agricultural land is private property or leased (1: king, 0: leased) and it has appeared with a positive signal indicating the positive relationship between private land ownership and the adoption of the conservation agriculture project. Increasing the ownership of the land by one unit leads to increasing the adoption of the conservation agriculture project by 1.337, as the tenant farmer has a fear of losing his land by excluding it from the landowner to the land, giving him this feeling of insecurity, and this discourages them from investing in modern technologies and improving their land, while testing z indicated the morale of this variable at a moral level 5%.

(PROD)X6: It is a quantitative variable that indicates the productivity of the land after the adoption of the conservation agriculture project. It appeared with a positive signal indicating the positive relationship between productivity and the adoption of the conservation agriculture project. Increasing productivity by one unit leads to an increase in the adoption of the project by 0.007, while the z test indicated the morale of this variable at a moral level 1%.

(IRR)X7: It is a qualitative variable, referring to the source of irrigation water (1: river, 0: others) and appeared with a negative indication that the source of irrigation water is not by the river, but by rainwater, as it is in the northern regions that depend on the watering, while the z test indicated the morality of this variable at a moral level 1%.

(TECHNO)X8: It is a qualitative variable, referring to the application of the preservative agriculture technique or the like. It means the similar agriculture (on the skin), that is, the application of farmers to preservative agriculture without their knowledge that it is a technique. A positive signal has appeared indicating the positive relationship between the use of the technology and the adoption of the conservation agriculture project. Increasing the use of the technology by one unit leads to increasing the adoption of the conservation agriculture project by 1.015, while the z test indicated the morale of this variable at a moral level 1%.

R Squared: The coefficient of determination appeared at a value of 0.55, meaning that the independent variables explained the probability of adoption by an amount of 55% of the fluctuations occurring in the binary dependent variable, while the remaining percentage 45% is the variance explained by other external factors that were not included in the model and whose effect was absorbed by the random variable. Thus, we reject the hypothesis. We accept the alternative hypothesis that confirms the existence of a positive and significant relationship to the implementation of a conservation agriculture project.

LR Statistic (Likelihood Ratio): This statistic controls the quality of the logit model, so we compare this value, which amounted to -39.79, which follows the distribution of x2 with the value of the table x2 at the degrees of freedom of df 10, where an LR value

greater than the table x2 appeared. Thus, we reject the hypothesis of nothing and accept the alternative hypothesis, which confirms the positive adoption of farmers for the conservation agriculture project.

Table 1: Estimated Logistics Equation in the Method of the Greatest Potential (ML).

Variable	Coefficient	S.E.	Z-statisics	Pro.
X1	-0.137459	0.054912	-2.503284	0.3217
X2	0.079821	0.052924	2.508219	0.0123
X3	1.146631	1.021220	1.122806	0.0198
X4	0.158253	0.583506	0.271210	0.0526
X5	1.337655	0.703143	1.902394	0.7862
X6	0.007405	0.002434	3.043073	0.0571
X7	-1.008666	0.595445	-1.693972	0.0023
X8	0.134537	0.611288	2.564991	0.0502
Constant				
McFadden R-squared	0.55		Akaike	1.060
LR statistic	47.899		Schwarz	1.307
Prob(LR statistic)	0.0000		Hannan-Quinn	1.160
Log likelihood	39.797-		Avg. Log likelihood	432-0.

Source: From the researcher's preparation based on the Eviwes10 program.

Hosmer and Lemeshow: The quality of the model reconciliation was tested using a statistical (Hosmer and Lemeshow statistic), which is one of the most reliable tests for the reconciliation of the logistic regression model (2), and the results of the matching quality test showed that it is similar to (R2), which is calculated through the distribution of the Chi-Square box with degrees of freedom 8 d.f, that the value of P was 0.645 and indicates that we are because the rejection of the zero hypothesis H0 hypothesis, which is no difference between the viewing values and the estimated values of the dependent variable, which means that the model estimates fit the data very well, since the value of (P) if it is less than 0.05, it indicates twice the compatibility of the model.

Table 2: Hosmer and Lemeshow test for logit model parameters for the adoption of the conservation agriculture project.

	Quantile of Risk				Dep=0	Dep=1	Total	H-L
	Low	High	Actual	Expect	Actual	Expect	Obs	Value
1	0.0015	0.0703	8	8.67016	1	0.32984	9	1.41338
2	0.0713	0.1633	7	7.73993	2	1.26007	9	0.50524
3	0.1681	0.2083	8	7.32903	1	1.67097	9	0.33085
4	0.2150	0.2911	6	6.75689	3	2.24311	9	0.34018
5	0.3022	0.4350	6	6.21406	4	3.78594	10	0.01948
6	0.4466	0.5652	7	4.56120	2	4.43880	9	2.64393
7	0.5736	0.6932	3	3.35165	6	5.64835	9	0.05879
8	0.7010	0.8794	2	1.75560	7	7.24440	9	0.04227
9	0.8974	0.9793	0	0.55901	9	8.44099	9	0.59603
10	0.9868	1.0000	0	0.06247	10	9.93753	10	0.06286
			Total	47	47.0000	45	45.0000	92
	H-L Statistic		6.0130		Prob. Chi-Sq(8)		0.6458	
	Andrews Statistic		28.6286		Prob. Chi-Sq(10)		0.0014	

Source: Prepared by the researcher based on the Eviwes10 program.

Wald Statistic: It is used to test the significance of the explanatory variables of the logit model by testing the null hypothesis, which states that the parameters associated with the explanatory variables xs are equal to zero and as it says:

H0: b1= b2= b3= b4= b5= b6= b7= b8= 0
H1: b1= b2= b3= b4= b5= b6= b7= b8 0

It is clear from Table 3 the test results that follow the normal distribution at the degrees of freedom 10 d.f. The parameters of the logistic regression model (logit) as a whole explained their moral 0.000 and explains that the illustrative changes (farmer's age, experience, educational level, the farmer has an income other than agriculture, land tenure, productivity, irrigation water source, application of preservative agriculture technology or the like) have a moral impact on the adoption of the conservation agriculture project, thus rejecting the zero hypothesis (the non-sup hypothesis) and accepts the alternative hypothesis that the parameters of the explanatory variables of the logit model are not zero.

Table 3: Wald Statistic test for logit model parameters for the adoption of the conservation agriculture project.

Test Statistic	Value	Df	Probability
F-statistic	2.586073	(8, 83)	0.0003
Chi-square	20.68859	8	0.0008
Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0, C(8)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(1)		-2.333720	2.355011
C(2)		-0.137459	0.054912
C(3)		0.079821	0.052924
C(4)		1.146631	1.021220
C(5)		0.158253	0.583506
C(6)		1.337655	0.703143
C(7)		0.007405	0.002434
C(8)		1.008667	0.595445

Source: Prepared by the researcher based on the 10 Eviwes program.

Second: Applying the Logit model to the project of enhancing food security in Iraq for the season 2021-2022.

Prob (event) = Prob (Y: 1: represents it farmer adopted and 0: non adopt..... (1)

Selection of variables and hypothesis testing: The Logistic Regression Model Transactions Were Estimated Using the Maximum Liklihood (ML) Method Using the Eviwes10 Program, and the Subordinate Variable and The Independent Variables in The Logistics Regression Model Are Clarified and Can Be Clarified As:

First: The dependent variable: (ADPT)Y: When farmers' adoption of any technique is analyzed, it is usually used is a binary variable (adoption or non-adoption). The ADOPT variable is defined as a dual-value variable (1: 74 farmers adopting food security enhancement technology and 0: 74 non-technology-adoptive farmers).

Second: Illustrative variables (independent): There is a set of variables from farmers that affect the gasification of food security represented by economic, social,

institutional and environmental factors. The model included 9 illustrative variables represented by the mentioned factors and these variables are:

(GE) X1: It is a quantitative variable, which measures the age of the targeted farmers, as young farmers have a greater opportunity to absorb and adopt modern technologies compared to older farmers who will be less acceptable to adopt the technology to enhance food security. It has appeared with a negative reference that matches the logic. Increasing the age by one year leads to a decrease in the degree of probability that farmers adopting the food security project by 0.10-, while the z test indicated the morale of this variable at a moral level 1%.

(FEXP) X2: It is a quantitative variable, and this variable measures the experience of the target farmers in growing the wheat crop, and it has appeared with a positive signal that corresponds to the logic, increasing the experience by one year leads to increasing the adoption of the project by 0.07, while the z test indicated the morality of this variable at a moral level 5%.

(EDU) X3: It is a qualitative variable, this variable measures the educational level of the target farmers, and it has appeared with a positive signal that corresponds to the logic as farmers with high levels of educational achievement are the most acceptable to adopt the food security enhancement project from less educated farmers. Increasing the educational level by one year leads to increasing the adoption of farmers of the project by 0.38, while the Z test indicated the morale of this variable at a moral level 5%.

(INCO) X4: It is a qualitative variable, which measures whether a farmer has an income other than agriculture (1: agricultural income, 0: non-farm income), and that experimental studies have proven that there is a negative relationship between non-farm income and the adoption of modern agricultural techniques, and it has shown a negative signal confirms that negative relationship, which indicates that farmers whose source of income is only agriculture are the most adopted for the project to enhance food security while the z test indicated the morale of this variable at a moral level 10%.

(LTEN) X5: It is a qualitative variable, which measures whether the possession of agricultural land is private property or leased (1: King, 0: Leased) and has appeared with a positive sign indicating the positive relationship between private land ownership and the adoption of the adoption of the food security project. Increasing the ownership of the land by one unit leads to increasing the adoption of the food security project by 1.36. As the tenant farmer has a fear of losing his land by excluding it from the owner of the land, giving him this feeling of insecurity, and this discourages them from investing in modern technologies and improving their land, while testing z indicated the morale of this variable at a moral level 5%.

(PROD)X6: It is a quantitative variable that indicates the productivity of the land after the adoption of the food security promotion project. It appeared with a positive signal indicating the positive relationship between productivity and the adoption of the food security promotion project. Increasing productivity by one unit leads to an increase in the adoption of the project by 0.009, while the z test indicated the morale of this variable at a moral level 1%.

(RECO)X7: It is a qualitative variable, referring to the use of field records (1: yes, 0: no), and it has appeared with a positive signal that corresponds to the logic, and indicates the positive relationship between the use of field records and the adoption of the food security promotion project. Increasing the use of field records by one unit leads to an increase in farmers' adoption of the project by 0.91, while the z test indicated the morality of this variable at a moral level 10%.

(IRR)X8: It is a qualitative variable, referring to the source of irrigation water (1: river, 0: other) and ppeared with a negative indication that the source of irrigation water is not by the river, but by puncta water and wells, while. The z test indicated the significance of this variable at a significance level of 1%.

(TECHNO)X9: It is a qualitative variable, indicating the use of agricultural technologies (1: yes, 0: NO) and it has appeared with a positive sign indicating the positive relationship between the use of productive agricultural technologies and the adoption of the food security enhancement project. Increasing the use of agricultural technologies by the farmer by one unit leads to increasing the adoption of the food security enhancement project by 1.029. While the z test indicated the morale of this variable at a moral level 10%.

Pseudo R-squared: The coefficient of determination appeared 0.70, meaning that the independent variables explained the probability of adoption by an amount of 70% of the fluctuations occurring in the binary dependent variable, while the remaining percentage 30% is due to other variables that were not included in the model and whose effect was absorbed by the random variable. Thus, we reject the null hypothesis and accept the alternative hypothesis. Which confirms the existence of a positive and moral relationship to the implementation of the project to enhance food security.

LR Statistic (Likelihood Ratio): This statistics controls the quality of the logit model, so we compare this value, which amounted to 47.85-, which follows the distribution of x2 with the table x2 value at the freedom grades of d.f 10, where an LR value greater than the value of the table x2 appeared. Thus, we reject the hypothesis of nothing and accept the alternative hypothesis that confirms the positive adoption of farmers for the project to enhance food security.

Table 4: Estimated Logistics Equation in the Method of the Greatest Potential (ML).

Variable	Coefficient	S.E.	Z-statistics	Pro.
X1	-0.1052	0.032	-3.243	0.001
X2	0.0753	0.036	2.086	0.036
X3	0.3850	0.768	2.081	1030.
X4	-0.9509	0.580	-1.638	0.101
X5	1.3599	0.566	2.401	0.016
X6	0.0092	0.001	5.663	0.000
X7	0.9104	0.567	1.605	0.108
X8	-0.7152	0.570	-1.254	0.209
X9	1.0296	0.568	1.810	0.070
Constant	-5.8465	1.766	-3.309	0.000
McFadden R-squared	0.704		Akaike	0.792
LR statistic	95.7		schwarz	0.996
Prob(LR statistic)	0.0000		Hannan-Quinn	0.875
Log likelihood	-47.858		Avg. Log likelihood	-0.327

Source: Prepared by the researcher based on the Eviwes10 program.

Hosmer and Lemeshow: The quality of the model reconciliation was tested using a statistical (Hosmer and Lemeshow statistic), which is one of the most reliable tests to reconcile the logistical regression model. The results of the reconciliation quality test showed it is similar to (R2), which is calculated through the distribution of the Chi-Square with degrees of freedom 8 d.f. that the value of P amounted to 0.763 and indicates that we are because the rejection of the zero hypothesis H0 (premise of zero hypothesis), which is that there is no difference between the viewing values and the estimated values of the dependent variable, which means that the estimates of the model fit the data very well, as the value of (P) if it is less than 0.05, indicates twice the compatibility of the model.

Table 5: Hosmer and Lemeshow test for logit model parameters for the adoption of the food security enhancement project.

	Quantile of Risk				Dep=0	Dep=1	Total	H-L
	Low	High	Actual	Expect	Actual	Expect	Obs	Value
1	0.0003	0.0141	14	13.9077	0	0.09234	14	0.09296
2	0.0159	0.0631	13	14.4484	2	0.55161	15	3.94836
3	0.0663	0.1401	13	12.6774	1	1.32263	14	0.08691
4	0.1578	0.2845	12	11.5874	3	3.41262	15	0.06458
5	0.3147	0.4969	9	8.88035	6	6.11965	15	0.00395
6	0.5178	0.6493	7	6.03997	7	7.96003	14	0.26838
7	0.6757	0.8564	3	2.90549	12	12.0945	15	0.00381
8	0.8729	0.9572	1	1.09552	13	12.9045	14	0.00904
9	0.9615	0.9802	0	0.41284	15	14.5872	15	0.42453
10	0.9803	1.0000	0	0.04501	15	14.9550	15	0.04515
		Total	72	72.0000	74	74.0000	146	4.94767
		H-L Statistic	4.9477			Prob. Chi-Sq(8)	0.7632	
		Andrews Statistic	29.3057			Prob. Chi-Sq(10)	0.0011	

Source: Prepared by the researcher based on the Eviwes10 program.

Wald Statistic: It is used to test the significance of the explanatory variables of the logit model by testing the null hypothesis, which states that the parameters associated with the explanatory variables xs are equal to zero and as it says:

H0: b1= b2= b3= b4= b5= b6= b7= b8= b9 =0
H1: b1= b2= b3= b4= b5= b6= b7= b8= b9 0

Table 5 shows the test results that follow the normal distribution at the degrees of freedom 10 d.f. The parameters of the logistic regression model (logit) as a whole explained their moral 0.000 and this explains that the illustrative changes (the age of the farmer, experience, the educational level, the farmer's income other than agriculture, land acquisition, productivity, the use of field records, the source of irrigation water, and the use of agricultural technologies) have a moral impact on the adoption of the project of promoting food security, thus rejecting the zero hypothesis (the non-non-premise) and accepts the alternative hypothesis that the parameters of the explanatory variables of the logit model are not equal to zero.

Table 6: Wald Statistic test of logit model parameters for the adoption of the food security enhancement project.

Test Statistic	Value	Df	Probability
F-statistic	3.923097	(9, 136)	0.0002
Chi-square	35.30788	9	0.0001
Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0, C(8)=0, C(9)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(1)		-5.846523	1.766662
C(2)		-0.105242	0.032446
C(3)		0.075358	0.036120
C(4)		0.385055	0.768515
C(5)		-0.950968	0.580216
C(6)		1.359958	0.566184
C(7)		0.009257	0.001634
C(8)		0.910422	0.567208
C(9)		-0.715250	0.570043

Source: Prepared by the researcher based on the 10 EViews program.

Conclusions

The results showed that the coefficient of determination for the conservation agriculture project value of 0.55, meaning that the independent variables explained the probability of adoption by an amount of 55% of the fluctuations occurring in the binary dependent variable, while the remaining percentage 45% is the variance explained by other external factors that were not included in the model and whose effect was absorbed by the random variable. Thus, we reject the hypothesis. We accept the alternative hypothesis that confirms the existence of a positive and significant relationship to the implementation of a conservation agriculture project.

The coefficient of determination for the food security enhancement project appeared 0.70, meaning that the independent variables explained the probability of adoption by an amount of 70% of the fluctuations occurring in the binary dependent variable, while the remaining percentage 30% is due to other variables that were not included in the model and whose effect was absorbed by the random variable. Thus, we reject the hypothesis. We accept the alternative hypothesis, which confirms the existence of a positive and significant relationship to the implementation of the project to enhance food security. The results of the logistic regression analysis showed the morality variable of the age variable of the farmer for the preservative agriculture project by 0.137-, and indicated the morality of this variable at a moral level 5%. It appeared with a negative signal that conforms the logic, and the results of the logistic regression analysis showed the moral age variable of the farmer of the food security enhancement project by (When the z test indicated the morality of this variable at a moral level 1% and showed a negative signal identical to the logic, increasing the age by one year leads to a decrease in the probability of farmers adopting. The results of the logistical decline analysis showed that the experience of the target farmers in growing the wheat crop for the two conservation agriculture projects and promoting food security was shown with a positive signal that corresponds to the logic, increasing the experience by one year

leads to increasing the adoption of the project by farmers, while the z test indicated the morale of this variable at a moral level 5%. The results of the logistical decline analysis showed that the educational level of farmers targeted for the projects of conservation agriculture and enhancing food security, and it showed a positive signal that corresponds to the logic, as farmers with high levels of scientific achievement are the most acceptable to adopt the food security promotion project from less educated farmers. Increasing the educational level by one year leads to increasing the adoption of the project by farmers, while the Z test indicated the morale of this variable at a moral level 5%. The results of the analysis of the logistical decline of the two projects of conservation agriculture and the enhancement of food security to land productivity after the adoption of the two conservation agriculture projects and the enhancement of food security showed a positive sign indicating the positive relationship between productivity and the adoption of the two projects, while the z test indicated the morale of this variable at a moral level 1%. The study recommended increasing government support related to the dissemination of modern technologies to facilitate farmers' access to them, by providing these modern technologies at state-supported prices, encouraging the cultivation of the wheat crop and supporting it in the governorates covered by the study, intensifying training programs on the use of these technologies appropriate to the conditions of the region, including the conservation agriculture project and enhancing food security, and the need to transfer the experience of the applied areas to other areas in Iraq. Encouraging the private sector, represented by private agricultural offices and companies, to continue its current role, as it plays a major role in guiding and following up farmers and providing production supplies and modern technologies in a timely manner.

Supplementary Materials:

No Supplementary Materials.

Author Contributions:

Author N. S. Noori; methodology, writing—original draft preparation, B. H. Hameed and M. Kh. Mohammed writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding:

This research received no external funding.

Institutional Review Board Statement:

The study was conducted following the protocol authorized by the Head of the Ethics Committee, University of Baghdad, Iraq Republic.

Informed Consent Statement:

No Informed Consent Statement.

Data Availability Statement:

No Data Availability Statement.

Conflicts of Interest:

The authors declare no conflict of interest.

Acknowledgments:

The authors are thankful for the help of the Animal Resources Field Manager, The College

Dean, and the Head of the Soil and Water Dept. The College of Agriculture, University of Anbar, Iraq. We would also like to thank the undergraduate students for their valuable help and technical assistance in conducting this research.

References

1. Abbas, A. K. (2012). Using the logistic regression model in predicting functions with qualitative dependent economic variables. Kirkuk University Journal of Administrative and Economic Sciences, 2(2).
2. Abd, M. N. (2023). An economic study of the determinants of rural women's contribution to farm work and its impact on improving the level of farm income (Baghdad Governorate as a model). doctoral thesis, College of Agricultural Engineering Sciences, Baghdad University, Department of Agricultural Economics.
3. Al-Badri, B. H., Mohammad, M. K., and Khalid, J. O. (2023). The Water Footprint and Virtual Water and Their Effect on Food Security in Iraq. In IOP Conference Series: Earth and Environmental Science, 1222(1): p. 012023. DOI: 10.1088/1755-1315/1222/1/012023.
4. Al-Bahloul, R. (2021). The Impact of Agriculture and Viewpoints on Specific Production and Some Soil Fertility Indicators. Al-Baath University Journal, 43(20).
5. Al-Dulaimi, A. J. (2022). Conservation agriculture and its applications for growing wheat and barley crops in a number of Arab countries. Journal of Geographical Research, (25).
6. Al-Ghannam, A. (2020). The varying effects of some demographic, social, economic, and agricultural factors on enhancing Arab food security in light of the Corona pandemic. Journal of Agricultural Economics and Science Social Studies, 11(12): 1027-1037. https://dx.doi.org/10.21608/jaess.2020.161880.
7. Al-Hadithi, B. N. (2013). Economic analysis of conservation agriculture for wheat in Nineveh Governorate for the agricultural season (2010-2011), Master's thesis, College of Agricultural Engineering Sciences, Baghdad University, Department of Agricultural Economics.
8. Al-Jumaili, A. A (2020). An economic study of the reality of food security in Iraq for the period (1980-2017), Master's thesis, Agricultural Economics and Extension - Agricultural Economics, College of Agriculture, Tikrit University.
9. ACSAD, Arab Center for Studies on Dry Zones and Dry Lands. (2012). Conservation Agriculture, System for Encouraging Sustainable Agricultural Adaptation for Agricultural Production.
10. Al-Moola, A. H. (2020), Forecasting of wheat production in iraq using box-jenkins model for period 2020-2024, Anbar Journal of Agricultural Sciences, 18(1): 109-118. https://doi.org/10.32649/ajas.2020.170516.

11. Al-Obaidi, A. R. (2021). Economic analysis of the impact of modern technologies on wheat production for farms operating within the program to enhance food security in Iraq for the agricultural season, Master's thesis, College of Agricultural Engineering Sciences, Baghdad University, Department of Agricultural Economics.
12. Alsaho, N. A., A. D. Kassar, and M. K. Mohammed. (2022). The impact of some agricultural legislation and wheat farmers' commitment to it in wasit governorate. Anbar Journal of Agricultural Sciences, 20(1): 90-103. https://doi.org/10.32649/ajas.2022.175490.
13. Azeez, R. A., and khalaf, M. A. (2017). Effect of Agricultural Policy on Marketing Wheat Crop in Wasit province. Anbar Journal of Agricultural Sciences, 15(2): 625-635.
14. Babtain, A. A. (2008). Logistic regression and how to use it in building prediction models for data with two-valued dependent variables, doctoral thesis, Umm Al-Qura University - College of Education, Kingdom of Saudi Arabia.
15. Dallal, G. E. (2001). Logistic Regression.
16. Ghanem, A., and Al-Jaouni, F. (2011). Using the binary-response logistic regression technique in studying the most important economic and social determinants of family income adequacy, An applied study on a random sample of families in Damascus Governorate. Damascus University Journal of Economic and Legal Sciences, (27)1.
17. Hamdi, M., N., & F. Ahmed, A. (2024). An Economic Analysis Of The Impact Of Government Lending Agricultural And The Agricultural Initiative On The Agricultural Domestic Product In Iraq For The Period (1990-2020). Anbar Journal Of Agricultural Sciences, 22(1), 665–679. https://doi.org/10.32649/ajas.2024.183785.
18. Ismail, M. A. (2001). Linear Regression Analysis. Institute of Public Administration, Kingdom of Saudi Arabia - Riyadh.
19. Jasim, S. A., and Al-Snbll, I. A. (2017). Measurement of technical and economic efficiency and determine the economic size of wheat farms in Erbil using the data envelope analysis method (DEA) in agricultural season 2014-2015. Anbar Journal of Agricultural Sciences, 15(1) :244-256.
20. Kadhim, R., Z., T. Abd Al-majeed, A., & T. Jassam, Q. (2024). Estimation Of Marketing Efficiency And Production Quantity At The Break-Even Point For Cotton Farmers In Iraq (Baghdad Province: A Case Study). Anbar Journal Of Agricultural Sciences, 22(1), 1–15. https://doi.org/10.32649/ajas.2024.183691.
21. Lea, S. (1997). Multivariate Analysis II: Manifest variables analysis. Topic 4: Logistic Regression and Discriminant Analysis. University of EXETER, Department of Psychology.
22. Mahboub, A. A. G. (1998). Principles of econometrics: Theory and application. Al-Mansour University College.
23. Mahyoub, E. J. (2018). The effect of the conservation agriculture system on some hydro physical soil properties and the productivity of some forage crops in the Salmiya Research Center area, Master's thesis, College of Agriculture, Soil Sciences Department, University of Damascus.

24. Namek, F. N. (2015). Using the logistic regression technique and the multiple linear regression technique to diagnose the factors affecting the rise in fee rates in higher education. Journal of the Baghdad College of Economic Sciences, (43).
25. Newsom, I. (2015). Data analysis II: logistic regression.
26. Pampel, F. C. (2020). Logistic regression: A primer (No. 132). Sage publications.
27. Porter, S. R. (1999). Viewing One-Year Retention as a Continuum: The Use of Dichotomous Logistic Regression, Ordered Logit and Multinomial Logit.
28. Qamra, S., Jamila, A., and Hassan, G. H. (2020). Measuring the impact of losses on agricultural economic resources and food security for the most important grain crops in Egypt. Agricultural Economics Research Institute, Research Center, pp. 181-193.
29. Saleh, M. M., and Jbara, O. K. (2022). Measuring economic efficiency of wheat crop producers in desert areas who adopt pivot irrigation technology and who do not adopt for the season 2020-2021. Anbar Journal of Agricultural Sciences, 20(1): 120-137. https://doi.org/10.32649/ajas.2022.175493.
30. Woldbeck, T. (1998). A Primer on Logistic Regression.
31. Wolfe, R. A. (2002). Logistic Regression, Unpublished Classic Lectures in Statistics.