Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1300422

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 6 - Issue 4: 394-401 / July 2023

INVESTIGATION OF AGRICULTURAL SUSTAINABILITY WITH IRRIGATION AND ECONOMIC FACTORS

Sedat KARADAVUT[1]*, Serdar ERDOĞAN[2], Volkan DAYAN[3]

[1]*Trakya University, Havsa Vocational College, Department of Park and Garden Plants, 22500, Edirne, Türkiye*
[2]*Trakya University, Uzunkopru School of Applied Sciences, Department of Accounting and Finance Management, 22300, Edirne, Türkiye*
[3]*Trakya University, Uzunkopru School of Applied Sciences, Department of Banking and Insurance, 22300, Edirne, Türkiye*

Abstract: Agricultural sustainability is becoming more and more important with the increasing world population. Therefore, the dissemination of sustainable agricultural practices; It is extremely important for future generations in terms of protecting the environment and natural resources, ensuring economic stability and increasing sustainable food production. This study investigates the sustainability in agriculture for Türkiye in terms of irrigation and economic factors in crop production change. Using the ARDL error correction model and Granger causality analysis methods for the period between 1995 and 2020, the short and long-term relationship between irrigation and economic factors and crop production value variables were analyzed. The research found that, the relationship between inflation variables irrigation, irrigation and the crop production value was found to be significant. In terms of agricultural sustainability, while the increase in the land opened to irrigation has led to an increase in crop production, the increase in the use of clean water from existing surface and groundwater resources has negatively affected the value of crop production. This has shown how important the water source and economic stability are in the sustainability of agriculture.

Keywords: Sustainable agriculture, Crop production value, Irrigation, Inflation and ARDL

***Corresponding author:** Trakya University, Havsa Vocational College, Department of Park and Garden Plants, 22500, Edirne, Türkiye
E mail: sedatkaradavut@trakya.edu.tr (S. KARADAVUT)
Sedat KARADAVUT https://orcid.org/0000-0001-5070-6747
Serdar ERDOĞAN https://orcid.org/0000-0001-8594-3929
Volkan DAYAN https://orcid.org/0000-0002-4297-4212

Received: May 22, 2023
Accepted: June 13, 2023
Published: July 01, 2023

Cite as: Karadavut S, Erdoğan S, Dayan V. 2023. Investigation of agricultural sustainability with irrigation and economic factors. BSJ Agri, 6(4): 394-401.

1. Introduction

Today, agricultural areas are one of the leading areas where water resources are used intensively. Irrigation is the supply of water to the soil for the development, growth and yield of plants that cannot be met by natural means. One of Türkiye's economic development indicators is the richness of its water resources. Agricultural sustainability of water resources for Türkiye is of great importance in meeting all the economic and social needs of the society (Yuksel, 2015).

Sustainable agriculture is a form of agricultural production carried out by protecting the environment and natural resources for the purpose of obtaining maximum yield with optimum input from the unit area. Without sustainable agricultural practices, it is not possible to increase yield and ensure its continuity in the future. Protecting agricultural soils where agricultural production is carried out and surface and underground water resources used in agricultural irrigation is the main factor in the increase in crop production (Tugay, 2012). Crop production value, which is calculated according to the quantity, quality and sales prices of products grown in a certain area, is affected by soil fertility, water resources, climatic conditions, seed and other input costs. The management and allocation of surface and groundwater resources, which are among the water resources used to supply irrigation water needs that cannot be met by natural means, is an important factor affecting the value of crop production.

In terms of sustainable agriculture, increasing the irrigated areas, providing more fertile land with water, reaching more product amount and variety, meeting the food needs of the increasing world population and the value of plant production that constitutes the earnings of the producer are extremely important.

Studies also support the results of the research. Especially in a country like Türkiye, which has both arid and semi-arid regions, various precautions should be taken, which will suffer more water shortage in the future. Water resources should not be used too much. As a requirement of sustainable agriculture, irrigation engineering studies such as the use of limited irrigation methods, selection of optimum plant pattern according to water availability, use of drip and sprinkler irrigation systems with minimum water loss, reuse of drainage water returning from irrigation, use of wastewater, creation of rain gardens and rain harvesting structures and smart agriculture should be emphasized.

Thus, without depleting our water resources and without damaging the hydrological cycle, the amount of net irrigated area can be increased within environmental sustainability and the value of crop production can be increased.

In this study, agricultural sustainability is discussed in terms of the important economic determinants of agricultural inputs, together with the irrigation factor. While the total water allocation and net irrigation land size for irrigation are included in the study; Inflation rate and market exchange rate took place as economic factors.

In the study, firstly, graphical and explanatory information of the data is given. Afterwards, the stationarity analyses of the variables in question were performed with the Perron 89 unit root test. Subsequently, a multiple regression model was established for regression analysis for the determinants of total crop production value. Then, ARDL error correction model analysis was carried out to determine both the long term and short term relationships. At the same time, the fact that the variables are stationary at different levels is also effective in the use of this model. Finally, the mutual causality relationships of the variables in the study were also evaluated with the Granger causality test.

The aim of this study is to analyze the amount of irrigation water supplied from surface and underground water resources with economic factors in terms of sustainable agriculture and agricultural water management.

Although there are few studies directly related to this topic in the literature, national and international studies that are close to the research were analyzed.

Venkateswarlu (1987), conducted a study on yield in drylands in India. He developed a system for this purpose. He analyzed dryland and rainy regions. He developed solutions for dryland areas.

Karaca and Selenay (2001), in their research compared the economic aspects of furrow and drip irrigation systems in Harran Plain in Türkiye. According to the results of the study, they made recommendations on water resource adequacy and irrigation method.

Bird et al. (2015), in their studies, used a model a special model. Value at risk model was used in the study. With the analysis made, increases and decreases in yield were revealed in all soil types.

Rosa et al. (2017), in their studies, analyzed many variables for agricultural sustainability in Rwanda, such as firewood, soil fertility, water availability, crop yield, etc. They developed a system for this purpose and achieved significant results. In this study, observations were made on productivity in a test field and solutions were developed.

Atzori et al. (2017), according to their studies, examined the effect of seawater salinity on irrigation. They determined what the salinity level affects sea water and what does not. According to the results of the analysis, tolerance values for salty agriculture were determined.

Sertyesilisik (2017), investigated on the political economy of Türkiye's water resources. A literature review was conducted in the study. Türkiye's water policies and possible future impacts of climate change was reported.

Akgis and Karakas (2018), in their studies, examined rural development supports by districts in Türkiye. Irrigation supports are also included in the study. Hot Spot Analysis was made and the spatial distribution profile of the supports was created.

Keskin et al. (2018), in their studies, made an economic analysis between irrigation area and dam height in Amasya province in Türkiye. The relationship between increasing the irrigation area by raising the dam body and project profitability was determined.

Li et al. (2020), according to their studies, propose a unified model for the simultaneous optimisation of irrigation water, crop area, and nitrogen fertiliser under uncertainty, which is applied to an irrigation district in northeast China. According to the results of the study, recommendations that can help to manage agricultural land, water and fertiliser resources sustainably in a changing environment are presented.

Van Hong et al. (2021), in their studies, evaluated the effectiveness of VIETGAP and GLOBAL GAP models, principles and standards applied in Vietnam's agriculture value chain in a specific case study. They focused on improving the irrigation water use efficiency in agricultural production. As a result of the regression analysis made in the study, it was determined that the inflation and exchange rate were lowered in order to increase the GDP.

2. Materials and Methods

2.1. Materials

In this study, firstly, the stationarity analysis of the data will be performed and the regression model will be analyzed. Then, the study will be concluded with ARDL error correction model and causality analysis to reveal the short and long run relationship.

2.1.1. Dataset

In the Table 1, information about the variables used in the study were given.

Table 1. Definition of variables

Period	1995 – 2020	Annual data
Variables	Definition	Source
$LCPV_t$	Crop Production Value	Türkiye Statistical Institute
$LNIA_t$	Net Irrigation Area	General Directorate of State Hydraulic Works
TWA_t	Total Water Allocation	General Directorate of State Hydraulic Works
EXR_t	Exchange Rate	Central Banking Türkiye Republic
INF_t	Inflation Rate	World Bank

Crop production value represents the total value of the agricultural products produced in Türkiye. The exchange rate variable is the nominal value of Turkish Lira against US Dollar and is found to be an important determinant of agricultural exports and imports of intermediate goods especially in agriculture.

The inflation variable is the annual CPI inflation rate and is included in the study as an important indicator of the prices of agricultural products and real purchasing power.

Net irrigation area is the area open to agricultural irrigation in m2 and is included in the study as a factor of wetland size in agriculture. Total water allocation data is included in the study as an irrigation factor, which is an important input in agriculture as the total amount of groundwater and surface water.

After clarifying the variables in the study, the appearance of these series will be presented in the Figure 1. In the graphs, the x-axis represents periods and the y-axis represents values.

The net irrigation area and crop production value variables in the study were logarithmized so that the other variables were converted into close magnitude with each other. The unit root test used to analyse the stationarity of the variables, model types were determined based on the appearance of the series in the Figure 1.

2.1.2. Stationarity analysis

According to the endogenous break stationarity test developed by Perron (1989), the stationarity test is performed by taking into account the break periods of the series. The following Table 2 presents the unit root test results for the stationarity analysis of the variables in the study.

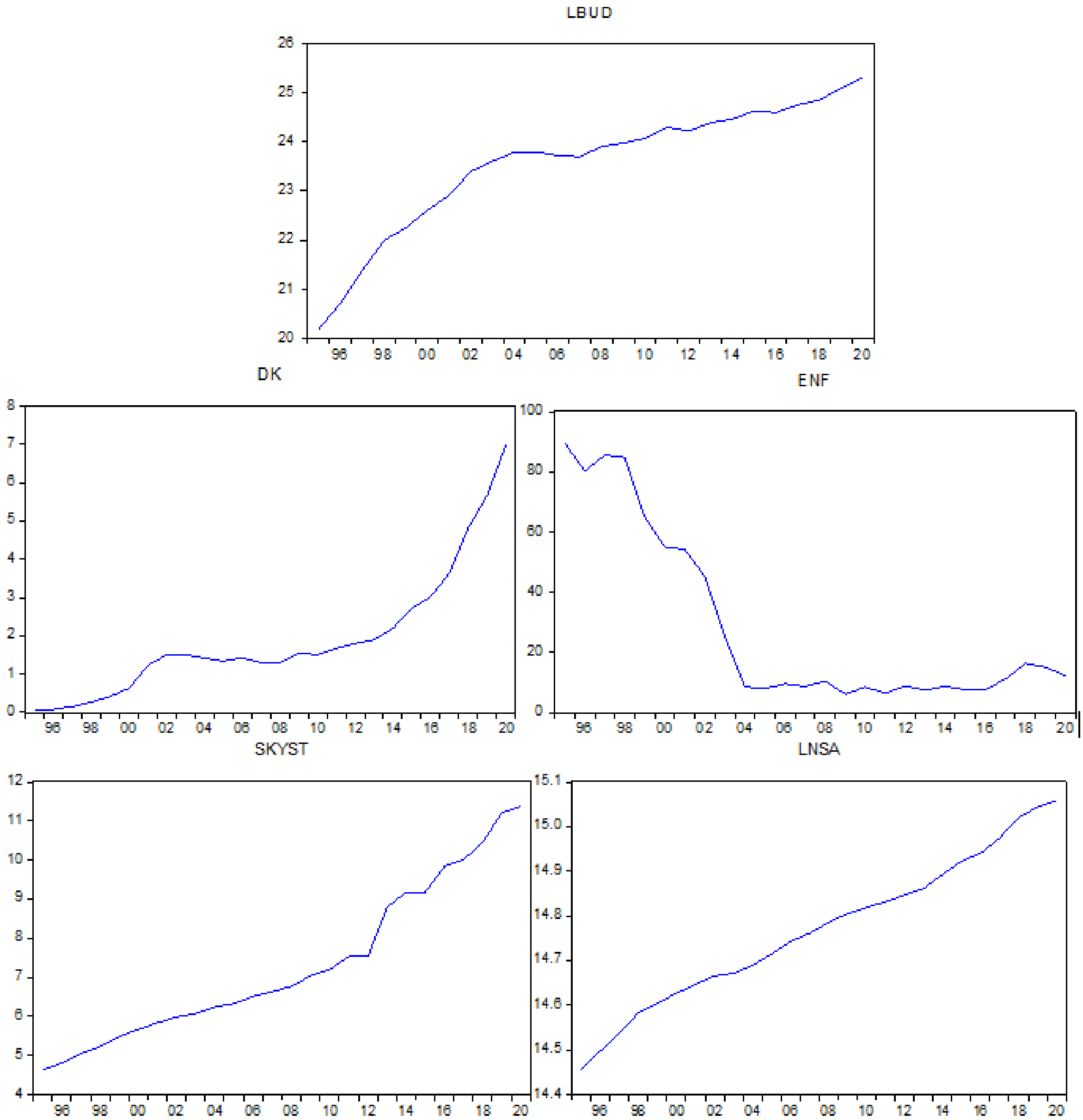

Figure1. Series view.

Table 2. Unit root test

Variables	Phillips Peron Unit Root Test				Phillips Peron 89 Breaking Unit Root Test				
	Constant		Constant and Linear Trend		Breaking Period	Model B		Model C	
	t-Statistic	Prob.	t-Statistic	Prob.		t-Statistic	Prob.	t-Statistic	Prob.
$LCPV_t$			-4.496	0.007	2018			-3.876	0.602
$\Delta LCPV_t$					2007			-5.936	0.000
$LNIA_t$			-2.717	0.238	2008			-4.934	0.089
$\Delta LNIA_t$	-2.813	0.071			2013	-5.529	0.000		
TWA_t			-0.489	0.977	2011			-7.047	0.000
ΔTWA_t	-5.237	0.000							
EXR_t			4.362	0.999	2015			-5.362	0.030
ΔEXR_t	-6.337	0.000							
INF_t			-0.821	0.949	2007			-7.021	0.000
ΔINF_t	-3.213	0.031							

Perron 89 Breaking Unit Root Test Crit. Values after test of unit root; In Model B with Trend without Constant %1:-5.067, %5: -4.524 and %10: -4.261 whereas in Model C with Constant and Trend, %1: -5.719, %5: -5.175, %10: -4.893. Phillips-Perron Unit Root Test Crit. Values; Model with Constant and Trend, %1: -4.374, %5: -3.603, %10: -3.238. Model with Constant, %1: -3.752, %5: -2.998, %10: -2.638.

According to table above, $LCPV_t$, $LNIA_t$variables were found to be stationary as I(1) with the first difference. In addition EXR_t, TWA_t and INF_t The variables are stationary at the I(0) level.. In line with the Phillips Perron unit root test, the variable $LCPV_t$, is stationary at I(0) level, while the other variables are stationary at I(1) level.

2.2. Method

2.2.1. Regression analysis

Multiple regression analysis, which is used to measure the effect of more than one independent variable on the dependent variable, is one of the common statistical methods. (Gemicioglu, 2019). A multiple regression model has been established to be used in this study, and the analysis of the model created with the following Equation 1 was carried out.

$$LCPV_t = \beta_0 + \beta_1 LNIA_t + \beta_2 TWA_t + \beta_3 EXR_t + \beta_4 INF_t \quad (1)$$

The Table 3 shows the results of the analysis of the multiple regression model created with the above equation.

According to the results of the multiple regression analysis obtained in the table above, a 1% increase in net irrigation area leads to a 7.87% increase in crop production value. A 1% increase in groundwater and surface water allocation leads to a 0.33% a fall in the value of the production of crops. A 1% increase in inflation leads to a 0.016% a fall in the value of the production of crops in terms of purchasing power in real terms. Here, the exchange rate variable is statistically insignificant. In this regression model, changes in the independent variables explain 95.9% of the changes in the dependent variable. In addition, the statistical significance of the F test indicates that the coefficients in the model are statistically significant as a whole.

2.2.2. ARDL model analysis

The Error Correction Model has a critical advantage in terms of providing clear and positive results in time series analyses with a small number of observations. (Duasa, 2007). For the ARDL model (Equation 2);

$$X_t = \beta_0 + \beta_1 Y_t + \beta_2 Z_t + u_t \quad (2)$$

in the model with an equation expressed as (Equation 3 and 4);

Table 3. Regression analysis results

Dep.Var.: $LCPV_t$			Method: Least Squ.	
Sample: 1995 – 2020			Inc. obs.: 26	
Var.	Coef.	Std. Error	t-Stat.	Prob.
C	-89.96793	36.15468	-2.488417	0.0213
$LNIA_t$	7.870848	2.518632	3.125048	0.0051
TWA_t	-0.338665	0.179608	-1.885574	0.0733
EXR_t	0.125311	0.095648	1.310136	0.2043
INF_t	-0.016546	0.004807	-3.442287	0.0024
R-squ.	0.959498	F-stat.	124.3747	
Adj. R-squ.	0.951784	Prob(F-stat.)		0.0000

$$\Delta X_t = \beta_0 + \sum_{i=1}^{p} \partial_i \Delta X_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta Z_{t-i} + \mu_1 x_{t-1} + \mu_2 y_{t-1} + \mu_3 z_{t-1} + e_t \quad (3)$$

$$\Delta X_t = \beta_0 + \sum_{i=1}^{p} \partial_i \Delta X_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta Z_{t-i} + e_t \quad (4)$$

The symbols ∂, β, γ, δ and μ in the above equations indicate the parameters of X, Y and Z variables, while u and e indicate the error terms of the model in the equation. In this method developed by Pesaran et al. (2001), it should be decided which is the optimal model among the ARDL models that have been tested. The table below shows the different information criteria that determine the number of lags of the ARDL error correction model.

In the Table 4, it has been revealed that the Akaike information criterion is required in determining the lag values of the ARDL model. In the decision stage for this, the model with the lowest information criterion was selected by establishing a model in the number of $(p+1)^n$, looking at the Akaike information criterion. Here; variable amount: n and delay number: p. ARDL error correction model established as (1-2-0-2-2).

The Table 5 shows that most of the lagged variables are statistically significant according to the ARDL model estimation results.

Table 4. ARDL model selection

	Mod. Sel. Crit. Tab. Sample: 1995 – 2020			Dependent Variable: $LCPV_t$ Inc. obs.: 24		
Model	LogL	AIC*	BIC	HQ	Adj. R-sq	Specification
100	35.430981	-1.952582	-1.363555	-1.796313	0.993774	ARDL(1,2,0,2,2)
91	35.441437	-1.870120	-1.232007	-1.700828	0.993214	ARDL(1,2,1,2,2)
19	35.436370	-1.869697	-1.231585	-1.700406	0.993211	ARDL(2,2,0,2,2)
82	35.680754	-1.806729	-1.119531	-1.624416	0.992683	ARDL(1,2,2,2,2)
10	35.444231	-1.787019	-1.099821	-1.604705	0.992537	ARDL(2,2,1,2,2)

Table 5. ARDL model estimation results

Method: ARDL				Mod. Sel. Meth.: Akaike info criterion (AIC)
Dep. Var.: $LCPV_t$				Sample (adj.):1997 – 2020
Inc. obs.: 24 after adjustments				Max. dep. lags: 2 (Aut. Sel.)
Dyna. Reg. (2 lags, automatic): $LNIA_t, TWA_t, EXR_t, INF_t$				Fixed regressors: C
Num. of mod. Eval.: 162			Sel. Mod.: ARDL (1, 2, 0, 2, 2)	
Var.	Coef.	Std. Er.	t-Stat.	Prob*
$LCPV_{t-1}$	0.374335	0.157317	2.379501	0.0348
$LNIA_t$	4.072010	2.961918	1.374788	0.1943
$LNIA_{t-1}$	-15.98377	4.495479	-3.555521	0.0040
$LNIA_{t-2}$	12.66008	2.870985	4.409664	0.0009
TWA_t	0.049540	0.066358	0.746555	0.4697
EXR_t	0.112353	0.122204	0.919387	0.3760
EXR_{t-1}	0.292198	0.164356	1.777830	0.1008
EXR_{t-2}	-0.373718	0.147431	-2.534876	0.0262
INF_t	-0.014877	0.006698	-2.221155	0.0463
INF_{t-1}	0.014051	0.005137	2.735386	0.0181
INF_{t-2}	-0.008855	0.003660	-2.419496	0.0323
C	3.834420	17.45509	0.219673	0.8298
R-squ.	0.996752	F-stat.		334.7468
Adj. R-squ.	0.993774	Prob(F-stat.)		0.000000
Durbin-Watson stat	2.862513			

The Table 6 shows the long-run coefficients and error correction term coefficient values for the ARDL error correction model.

According to the Table 6, the coefficient is obtained as a negative value in the range of 0-1. Accordingly, the coefficient is statistically significant. The deviations caused by the shock effect of the changes in the independent variables used in the study on the dependent variable in the short term will ensure that it will reach equilibrium (Equation 5) in the long term after 1.60 periods.

Table 6. Error correction model

ARDL Coint. And Long Run Form				
Dep. Var.: $LCPV_t$				Sel. Model: ARDL (1, 2, 0, 2, 2)
Sample: 1995 2020				Inc. Obs.s: 24
		Coint. Form		
Var.	Coef.	Std. Err.	t-Stat.	Prob.
$DLNIA_t$	4.072010	2.961918	1.374788	0.1943
$DLCPV_{t-1}$	-12.660077	2.870985	-4.409664	0.0009
$DTWA_t$	0.049540	0.066358	0.746555	0.4697
$DEXR_t$	0.112353	0.122204	0.919387	0.3760
$DEXR_{t-1}$	0.373718	0.147431	2.534876	0.0262
$DINF_t$	-0.014877	0.006698	-2.221155	0.0463
$DINF_{t-1}$	0.008855	0.003660	2.419496	0.0323
$VECM$	-0.625665	0.157317	-3.977109	0.0018
		Long Run Coef.		
Var.	Coef.	Std. Err.	t-Stat.	Prob.
$LNIA_t$	1.196036	1.937317	0.617367	0.5485
TWA_t	0.079179	0.105915	0.747575	0.4691
EXR_t	0.049280	0.078334	0.629096	0.5411
INF_t	-0.015473	0.005571	-2.777309	0.0167
C	6.128550	28.017556	0.218740	0.8305

$$VECM = LBUD_t - (1{,}196 * LNSA_t + 0{,}049 * DK_t + 0.079 * SKYST_t - 0{,}015ENF_t + 6{,}128) \quad (5)$$

Table 7. ARDL model bounds test

Period: 1997 – 2020			Inc. obs.: 24
Test Stat.	Val.	k	
F-stat.	16.72408	4	
	Crit. Value Bounds		
Sign.	I0	I1	
10%	2.45	3.52	
5%	2.86	4.01	
2.5%	3.25	4.49	
1%	3.74	5.06	
R-squ.	0.911710	F-stat.	11.26511
Adj. R-squ.	0.830778	Prob(F-stat.)	0.000105
Durbin-Watson stat	2.943804		

In ARDL analysis, the bounded and unbounded Error Correction Model equations called the Bounds test are estimated. In the estimation, if the table values prepared by Peseran et al. (2001) are smaller than the F statistic value estimated as a result of the establishment of the hypothesis H0: α1= α2 = α3 = 0, The H0 value will be rejected and the H1 value will be accepted. In this case, the variables x, y, z are assumed to be integrated in the long run and the model has statistical significance. (Shresta, 2006). The Table 7 presents the results of the Bounds test for the ARDL error correction model.

According to the results of the Bounds test, the F value is above the lower and upper limits of the Bounds critical values. Accordingly, it is determined that all variables used in the ARDL model are cointegrated in the short and long run.

The Table 8 presents the descriptive statistics calculated to measure the validity of the ARDL error correction model.

Table 8. ARDL analysis model assumptions test results

Tests	Calculated Value	Prob. Value
Ramsey Reset	0.88	0.397*
LM(1)	3.136	0.104*
LM(2)	2.574	0.125*
WHITE	0.792	0.646*
Jarque Bera	0.895	0.638*

Probability values with (*) sign greater than 5% indicate the significance of these tests.

The tests for the descriptive, autocorrelation, variance and normality assumptions of the ARDL model were found to be significant. This reveals the validity of the ARDL analysis.

2.2.3. Causality analysis

In the literature, causality tests can be used to measure the cause-and-effect relationship between variables. Especially for long time series, these tests developed by Granger are widely used (Granger, 1969).

The Table 9 presents the Granger causality results, which is the last analysis test of the study.

Table 9. Granger causality test

Variables	Direction of Causality	Prob.
Net Irrigation Area - CPV	→	0.002*
CPV - Irrigation Area	-	0.342
Total Water Allocation - CPV	→	0.012*
CPV - Water Allocation	-	0.622
Exchange Rate - CPV	→	0.005*
CPV - Exchange Rate	-	0.243
Inflation - CPV	↔	0.092*
CPV - Inflation		0.037*

According to the results obtained in the causality test table above, it is found that irrigation area, water allocation and exchange rate are unidirectional causes of crop production value (CPV). In addition, it was found that the causality test was significant for inflation and crop production value in a reciprocal manner.

3. Results and Discussion

In this study, the sustainability of agriculture is analysed in terms of the impact of irrigation and economic factors on the value of crop production. Accordingly, total water allocation and net irrigation area are included as irrigation variables. Exchange rate and inflation variables were included as economic variables.

When the results obtained in the study are analysed, it is seen that the effects of water allocation, irrigation area and inflation variables on crop production value are statistically significant and theoretically in the expected direction. In this study, which was carried out using the data of our country by considering irrigation and economic factors of sustainability in agriculture, it is seen that a 1% increase in net irrigation area provides an increase of 7.87% in crop production value. Again in terms of sustainable agriculture; in a region with water shortage, the continuous supply of water from underground and surface sources will cause pollution and destruction of water resources over time and will cause a decrease in the yield and production value of the same region over time. According to this study, it was economically calculated that a 1% increase in groundwater and surface water allocation will cause a 0.33% decrease in crop production value. In the evaluation of the use of irrigation water within the sustainability of agriculture in terms of economic factors; the increase in crop production value is realised by increasing the irrigated areas with effective irrigation management practices without reducing water resources. If the increase in irrigation areas and irrigation amount is provided only from surface and groundwater resources, it reveals that a decrease in the value of crop production will be realised in terms of sustainable agriculture, especially in countries with water shortages such as our country.

4. Conclusion

In addition, the conclusion that the variables in the study are short and long term co-integrated was reached by ARDL method. Here, it is also determined that the short-term deviation effect of the changes in irrigation and economic variables on the value of crop production will reach equilibrium at the end of approximately 1.60 periods. Finally, it is concluded that all variables are the cause of the value of crop production, and in addition, the reciprocal causality relationship of the inflation variable is significant.

The amount of irrigation water supplied from surface and underground water resources has been analyzed with economic factors in terms of sustainable agriculture and agricultural water management. Since the study is original and interdisciplinary, it is thought that it will be beneficial to researchers who will work in this field.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	S.K.	S.E.	V.D.
C	40	40	20
D	40	30	30
S	50	25	25
DCP	30	50	20
DAI	30	50	20
L	30	30	40
W	30	30	40
CR	40	40	20
SR	50	25	25

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

References

Akgis O, Karakas E. 2018. Kirsal kalkinmayi desteklemeye yonelik yapilan makine-ekipman ve sulama desteklerinin ilcelere göre mekansal dagilisi ve belirleyicinin analizi. Türk Cografya Derg, 71: 27-35.

Atzori G, de Vos AC, van Rijsselberghe M, Vignolini P, Rozema J, Mancuso S, van Bodegom PM. 2017. Effects of increased seawater salinity irrigation on growth and quality of the edible halophyte Mesembryanthemum crystallinum L. under field conditions. Agri Water Manag, 187: 37-46.

Bird DN, Benabdallah S, Gouda N, Hummel F, Koeberl J, La Jeunesse I, Woess-Gallasch S. 2016. Modelling climate change impacts on and adaptation strategies for agriculture in Sardinia and Tunisia using Aqua Crop and value-at-risk. Sci Total Environ, 543: 1019-1027.

CBTR, 2022. URL: https://www.tcmb.gov.tr/wps/wcm/connect/TR/TCMB+TR /Main+Menu/ Istatistikler/Doviz+Kurlari/ (accessed date: November 07, 2022).

Duasa J. 2007. Determinants of Malaysian trade balance: An ARDL bound testing approach. J Econ Coop, 28(3): 21-40.

GDSHW. 2022. Official Statistics for 2020 / Water Resources Statistics URL: https://www.dsi.gov.tr/Sayfa/Detay/1498./ (accessed date: November 07, 2022).

Gemicioglu S. 2019. Stata ile regresyon analizi, AUSBF, Aralık, Ankara. 1-18.

Granger CWJ. 1969. Investigating causal relations by econometric models and cross-spectral methods, Econometrica, 37: 424-438.

Karaca G, Selenay MF. 2001. Harran ovasında karik ve damla sulama sistemlerinin ekonomik yönden karsilastirilmasi. J Agri Sci, 7(01): 166-176.

Keskin AÜ, Demir ŞD. 2018. Amasya Degirmendere Barajinda sulama alanı ve baraj yuksekligi arasinda ekonomik analiz. Dokuz Eylul Univ Muh Fak Fen Muh Derg, 20(60): 755-764.

Li M, Fu Q, Singh VP, Liu D, Li T, Li J. 2020. Sustainable management of land, water, and fertilizer for rice production considering footprint family assessment in a random environment. J Cleaner Prod, 258: 120785.

Perron P. 1989. The great crash, the oil price shock, and the unit root hypothesis, Econometrica. 57: 1361-1401.

Pesaran MH, Shin Y, Smith RJ. 2001. Bounds testing approaches to the analysis of level relationship. J Appl Econ, 16: 289-326.

Rosa MF, Bonham CA, Dempewolf J, Arakwiye B. 2017. An integrated approach to monitoring ecosystem services and agriculture: Implications for sustainable agricultural intensification in Rwanda. Environ Monit Asses, 189: 1-35.

Sertyesilisik E. 2017. Türkiye’nin su kaynaklarinin ekonomi politigi üzerine bir inceleme. Türk Bil Derlemeler Derg, 10(1): 28-30.

Shrestha MB. 2006. ARDL Modelling approach to cointegration test. The Central Bank of Nepal. New South Wales: University Of Wollongong, Nepal, India, pp: 1-9.

TSI. 2022. Turkstat, Agricultural Structure (Production, Price, Value) Publication, URL: https://data.tuik.gov.tr/Kategori/GetKategori?p=Tarim-111/ (accessed date: November 07, 2022).

Tugay ME. 2012. Türk tarımında bitkisel üretimi artırma yolları. Tarim Bil Araş Derg, 5(1): 1-8.

Van Hong P, Nguyen NT, Huy DTN, Thuy NT, Huong LTT. 2021. Evaluating several models of quality management and impacts on lychee price applying for Vietnam agriculture products value chain sustainable development. Alinteri J Agri Sci, 36(1): 122-130.

Venkateswarlu J. 1987. Efficient resource management systems for drylands of India. In: Stewart BA, editor. Advances in Soil Science. Advances in Soil Science, Springer, New York, USA, pp:7. DOI: 10.1007/978-1-4612-4790-6_5.

Worldbank. 2022. URL: https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations= TR&view=chart/ (accessed date: November 07, 2022).

Yuksel I. 2015. Water management for sustainable and clean energy in Türkiye. Energy Rep, 1: 129-133.