FORECASTING THE FOOD GAP AND PRODUCTION OF WHEAT CROP IN IRAQ FOR THE PERIOD (2016-2025)

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ABSTRACT

Wheat is an important economic crop, various development projects adopted by the government to improve the level of production of all crops Despite the efforts to increase the production of grain crops, especially the wheat, the total production is still insufficient to meet the growing consumption needs, which led to widening of the food gap in addition to the increase in population and the increasing demand for food.The aim of this research is to Forecasting food gap and production of wheat in Iraq, Box-Jenkins one of forecasting method used to forecast production and food gap of wheat. Statistical programs Minitab and SPSS used to analyses data. The best method for Forecasting wheat production for the period 2025-2016 is ARIMA (4,1,3) based on significance of its parameters, as well as for having the lowest value of MSE which reached and owning the lowest value for(AIC). About food gap, the ARIMA model (1.0.1) was the best model for the same period in terms of having the lowest value (MSE) and the lowest value of AIC. The research reached a set of conclusions, There is an increase in the production of wheat in Iraq during the coming years (2025-2016) while offset by a semi-constant in the food gap for the same period and this indicates that the self-sufficiency of wheat in the short run can't occur. Food gap for wheat is continuous and semi-fixed, indicating the expectation that self-sufficiency can't be achieved in the short term, and the difficulty of covering consumption through the local production of wheat and having to fill the deficit by importing semi-fixed quantities during the subsequent period.

Key words: Box-Jenkins Methodology, Food Gap, Minitab, Forecasting
Part of M.Sc. thesis of the first author

مجلة العلوم الزراعية العراقية -2018 :49(4):560-568 **مصطاف وجبارة**

التنبؤ بالانتاج والفجوة الغذائية لمحصول القمح في العراق للمدة (2016 – 2025)

ايمان خالد مصطاف **اسامة كاظم جبارة**
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المستخلص:

يعد القمح من المحاصيل الاقتصادية المهمة . وقد اعتمدت الحكومة مشاريع تنموية مختلفة لتحسين مستوى الانتاج لجميع المحاصيل ، وعلى الرغم من الجهود المبذولة لزيادة إنتاج محاصيل الحبوب وخاصة القمح إلا أن الإنتاج الكلي لا يزال غير كاف لتلبية احتياجات الاستهلاك المتزايدة نتيجة زيادة عدد السكان وزيادة الطلب على الغذاء، مما أدى إلى اتساع الفجوة الغذائية. يهدف هذا البحث الى التنبؤ بالإنتاج والفجوة الغذائية لمحصول القمح في العراق، وقد تم استخدام احد اساليب التنبؤ وهي منهجية بوكس- جينكنز للتنبؤ بالفجوة الغذائية وانتاج محصول القمح وباستخدام البرامج الاحصائية SPSS وMINITAB, وتم اجراء اختبارات عديدة لنماذج ARIMA, وتبين ان افضل انموذج للتنبؤ بإنتاج القمح للفترة 2016-2025هو انموذج ARIMA(4,1,3) لمعنوية معلماته وكذلك امتلاكه اقل قيمة MSE ،واقل قيمة لمعامل (AIC) , اما بالنسبة للفجوة الغذائية فكان انموذج ARIMA(1,0,1) هو الافضل للتنبؤ لنفس الفترة السابقة من حيث امتلاكه لأقل قيمة (MSE) واقل قيمة (AIC). وقد توصل البحث إلى مجموعة من الاستنتاجات: هناك زيادة في إنتاج القمح في العراق خلال السنوات القادمة (2016-2025)، في حين يقابله شبه ثبات في الفجوة الغذائية لنفس الفترة، وعدم امكانية الوصول الى الاكتفاء الذاتي من القمح على المدى القصير. والفجوة الغذائية للقمح مستمرة وشبه ثابتة، مما يشير إلى توقع عدم تحقيق الاكتفاء الذاتي على المدى القصير، وصعوبة تغطية الاستهلاك من خلال الإنتاج المحلي من القمح، وتضطر الدولة إلى سد العجز عن طريق استيراد القمح، وبكميات ثابتة خلال الفترة اللاحقة.

الكلمات مفتاحية: منهجية بوكس –جينكنز, الفجوة الغذائية, منيتاب, التنبؤ.
البحث جزء من رسالة ماجستير للباحث الاول

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INTRODUCTION

Wheat is an important economic crop. It is ranked first, followed by rice, maize and barley in terms of importance. Agriculture plays an important role in improving the standard of living of the rural population in particular and the macro economy in general (1). Wheat is easier to cultivate and has low planting costs. Many of the developing and developed countries have adopted economic policies which aimed to reach the self-sufficiency, as one of the developing countries. Long-term development of wheat farming through direct government support on the one hand and through credit and tax facilities on the other Wheat production of Iraq was 3.2 Million ton in 2012-2013, which covers 70% of the national needs. The percentage of production achieved as a result of the various development projects adopted by the government to improve the level of production of all crops Despite the efforts to increase the production of grain crops, especially the wheat, the total production is still insufficient to meet the growing consumption needs, which led to widening of the food gap in addition to the increase in population and the increasing demand for food. This study aims to forecast production of wheat and the food gap for the period (2016 -2025). The importance of this research is comes from the nutritional importance of the wheat, which is the main source of human food. It also contributes to many food industries as well as the economic importance of the crop as an important strategic crop and source of agricultural income. using of approved varieties have great importance in increasing the productivity, and wheat is one of the most important grain crops by production or consumption side, with the reference to most of the wheat consumed source of the ration card system (imported from wheat) of wheat represents one-third of the supply of this crop during the year, and played agricultural production in Iraq an important role in achieving food security before the implementation of the oil-for-food program, but the agricultural sector is far from providing sufficient quantities of food for the population of Iraq and depends on food supply and the importation is very large and it must be emphasized that the weight of food supplies and other support systems play an important role in the lives of the poor or the non-food-insecure population and keep the specter of famine away from them. Most families rely heavily on the public distribution system (ration card) food market, and is supposed to look into Iraq's direction towards self-sufficiency wheat crop, and the low quantities imported from it. On the other hand, the pre-forecasting methods included some bias and lack of clarity in estimating quantities predicted due to their dealing with time series and non-processing of time series variations such as secular trend, seasonal variation and cyclical variation, which sometimes gives illogical or exaggerated forecasts, therefore, the study assumes that the use of such methods will contribute to determining the actual values of the food gap for wheat crop. The research is based on the secondary sources represented by the Ministry of Planning data for the period (1980-2015).

MATERIALS AND METHODS

The time series is defined as a set of values for a particular variable that occurs over a period of time in a given pattern. The most common patterns of chains are: general trend increasing or decreasing, periodic, seasonal, irregular, and before beginning to study any economic phenomenon from the first confirmation of a trend in the time series and according to the nature of chain growth we can distinguish between stationary time series and Stationary Time Series .The fact that the series carries this or that property is directly related to the choice of the appropriate forecast technique, and there are even those who classify forecast techniques on this basis (stable or unstable). The stable time series is one that changes in time, without changing the average, within a relatively long period of time, the series has no trend towards either the increase or the decrease. The unstable time series, the average level is constantly changing, either towards Increase or decrease, this is a graphical representation of a non-independent time series. We say on a time series that is stable at a very low level, if its expectation, variance, and common variations are constant over time .(4)

1 - Oscillated around a fixed arithmetic mean over time: E $E(Y_t) = E(Y_{t+k}) = \mu$........(1)

2 - Stability of variation over time:

Var (Y_t) = E $[Y_t - E(Y_t)]^2$ = Var(Y_{t+k}) = E $[Y_{t+k} - E(Y_{t+k})]^2 = \gamma(0) = \sigma^2 < \infty, \forall_t$.........(2)

3 - The common variation between any two values for the same variable is based on the time gap between the two values, and not on the actual value of the time calculated at the variance, on the difference between two periods.

$cov(Y_t, Y_{t+k}) = E[(Y_t - \mu)(Y_{t+k} - \mu)] =$
$cov = (Y_{t+k}, Y_{t+k+s}) = \gamma(k)$..........(3)

It is sometimes difficult to determine the nature of the time series (stable or unstable) either by simple observation or even by the graph. Here we use statistical measures to test whether or not there is a general trend in the series, and there are tools that are important in the analysis of time series and test stability, and these tools or standards and tests are .(5)

1- Autocorrelation function (ACF):

This method of links between observations for different periods interested in studying the relationship in the elements of the same time series, and the correlation of the self-P of the time gap k is calculated by the following law:

$P_k = \frac{cov(k)}{cov(0)} = \frac{\gamma(k)}{\gamma(0)}$ ....(4)

côv(k)= $\hat{\gamma}(k) = \frac{\sum(yt - \bar{y})(yt+1-\bar{y})}{n-k}$.........*(5)*

côv(0)=$\hat{\gamma}(0) = \frac{\sum(yt-\bar{y})^2}{n}$.........*(6)*

N represents the size of the sample and k represents the length of the time gap. According to this method, the series is stable if the value of PK is zero at any gap greater than > 0 .

The Autocorrelation between -1 $< P_k < 1$ is limited to +1, and the deceleration is determined by dividing the number of observations in the series by 4, k = n / 4

The correlation coefficient of autocorrelation is measured by Barlett statistic Partial Autocorrelation Function: The correlation between successive values of a variable is measured over two consecutive periods with the stability of the other time periods. The coefficients of the partial autocorrelation function of the auto regressive equation of the subject series are obtained through the following relationship:

$\hat{P}\,.\,kk. = \frac{cov[(yt-yt^*)(yt+k-y^*t+1)]}{var((yt-yt^*)}$ ... . (7)

Correlogram3-

This is a graphical representation of the PAC and the autocorrelation function (AC). This graphic representation helps us to:Detecting the existence of a seasonal variations.

b- String stability test.

c- Detecting the existence of internal variables.

d) Define the modes of the model.

For the series to be stable, the random element must satisfy the normal OLS conditions, it follows the white noise series.

White noise series is a sequence of randomized interrelated observations (sometimes assumed to be a sequence of random variables that are independent and have an identical distributed (ID) with an average of 0 and a constant variance σ^2.

4-Unit root test for stability The unit root test of stationarity Dickey-Fuller tests help determine the proper way to make the string stable, so two types of stable models must be distinguished:

Trend Stationary) TS: These models are unstable and indicate deterministic instability. The form $Y_t = f(t) + \varepsilon_t$ where $f(t)$is a function with many time limits (linear or nonlinear), ε_t and white noise, The prototypical models take the form of many first-order borders and are written from the form $Y_t = \alpha_0 + \alpha_1 t + \varepsilon_t$ This model is unstable because medium$\sum(Yt)$ is associated with time, but we make it stable by estimating the parameters 0, ά 1ά in the normal lower squares method, subtracting the Yt on$\hat{\alpha}_0, \hat{\alpha}_1 t; Yt - \hat{\alpha}_0 + \hat{\alpha}_1 t.$

2 - the model of the Differency Stationary (DS): These models are also unstable and stands out Stochastic random instability, and take the form Yt = Yt − 1 + β + ε_t, and we can make it stable using differences:

Yt = β + εt∇ ^ d where β is a real constant, and d is the degree of difference. The first-order differences in these models are often used d = 1, and are written from ΔYt = β + ε_t. These models take two forms

1 - If β = 0: called the model DS Boon derived, and written in this format: Yt = Yt − 1 + εtSince εt white noise, the model is called (Random Walk Model), which is widely used in the study of financial markets

2-If β ≠ 0: DS is called the derivative, and is written in this format:

$Yt = Yt - 1 + \beta + \varepsilon t$......(8)

The Box-Jenkins method, known as the autoregressive integrated moving averages model (ARIMA), was used as a predictive method and was based on the combination of regression models AR and MA. It is one of the most widely used forecast methods in the world. This method has four main stages to follow:

1- Recognition stage (discrimination):

The most difficult stage in constructing linear time series models is the discrimination stage. Several alternatives to the possible models can be obtained and the first prototype chosen at the testing and testing stage can be rejected. If the Yt series shows a strong general trend, the calculation of the first or second class differences will lead to string stability, oftenW_t, and to determine the degree of auto-regression. If the correlation form is within the confidence interval (95%) from the beginning, the ACF is not essentially different from zero. This means that the string is stable and integral of class 0, in which case we perform our analyzes on the original values of variable Yt(95%) in a long period, and the autocorrelation coefficients are significantly different from zero for a relatively large k, the Yt series is unstable, in which case the first-order differences We then perform the same analysis again until we reach a stable sequence (4).

2. Estimation stage: After completion of the stage of identifying the appropriate preliminary model of the data, the parameters of this model should be estimated using one of the methods known in the theory of statistics, the most important of which are the two squares and the larger ones (6). At this stage, The good model is significant and can be compared through OLS as a measure of model quality as well as other measures used to measure the accuracy of the model to compare models (7).

3- Diagnosis stage:== The stage of diagnosis is one of the most important and dangerous stages of analysis. It is the stage that determines the acceptance or replacement of the model by another model. The diagnostic stage includes several tests, the most important is analysis of residues (6).

4. Forecasting stage:

The objective of the forecast is to use the current and estimated model over a given period of time to estimate future values as a time series according to the smallest possible error. Therefore, the forecast for the minimum mean square forecast error (MSE) Predicting a random variable, we minimize its expected value. This forecast is made after estimating the parameters of the ARIMA (p, d, q) model, which has exceeded the various stages of the previous tests and is defined as p, d and q where the forecast value becomes constant equal to the average of the series) after the period q in the mean models The forecast process can be summarized in the following stages

A-Write the estimated model $\boldsymbol{\widehat{Y}_t = f\left(\widehat{\phi}, \widehat{\theta}, Y_t, \hat{\varepsilon}_t\right)}$

B-compensated t + h where *h=1,2,...,*H.===C - Compensate all future values of the variable of the phenomenon studied forecasts, while the forecasting errors are compensated by zeros and past (within the sample).

The data obtained from the Ministry of Planning for the period of study (1980-2015) were based on the statistical analysis of the statistical Package for the Social Sciences program (SPSS), Minitab and the use of the OLS method. The factors affecting the self-sufficiency ratio, the quantity of imports, (ARIMA) in the forecast process.

RESULTS AND DISCUSSION

For the purpose of applying the Box-Jenkins Methodology to the wheat production series data in Iraq for the period 1980-2015, we first plot the trend of the time series, and predict the ARIMA models, we make sure that the time series is stable.

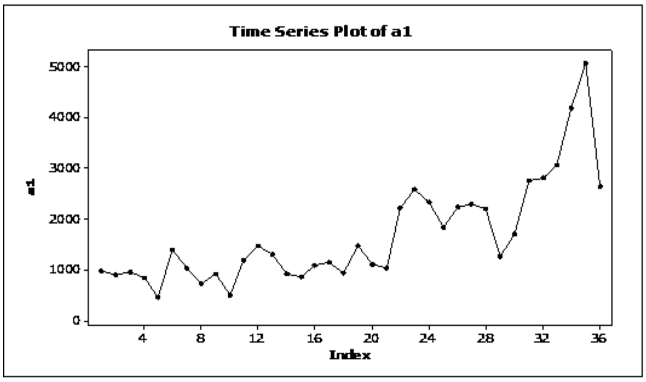

Figure 1. The time trend of wheat production in Iraq for the period (1980-2015)

Source :depending on the results of Minitab 14 program

Source (1) shows that there is a general tendency to increase, the time series is unstable. For the purpose of test the stability of the time series, the autocorrelation Function and partial autocorrelation functions are used as follows:

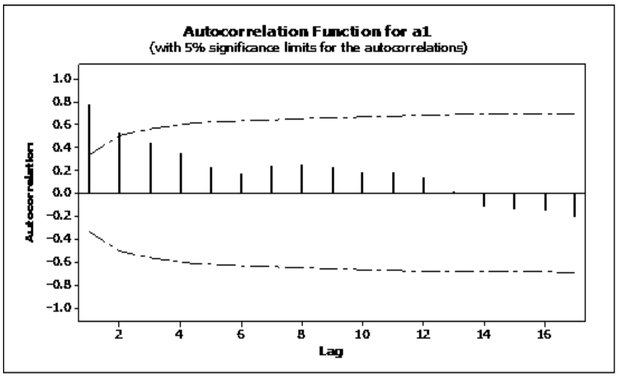

Figure 2. The Autocorrelation function of wheat production data in Iraq

Source :depending on the results of Minitab 14 program

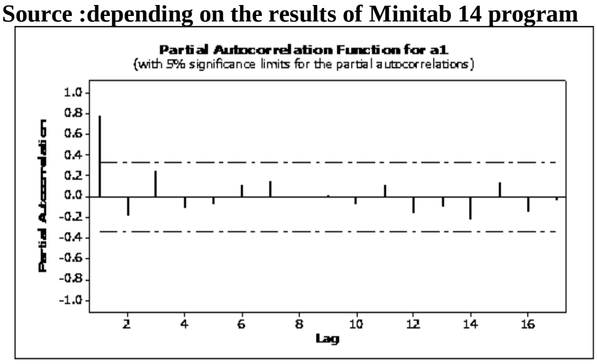

Figure 3. The partial autocorrelation function of wheat production data in Iraq

Source :depending on the results of Minitab 14 program

A review of the auto and partial correlation Sources shows that the time series of wheat production data is unstable, so the series must be adjust to make it stable by taking the first difference.

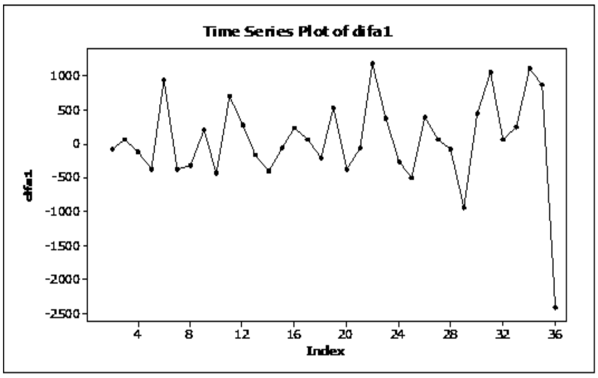

Figure 4. Time series of wheat consumption data after taking the first difference

Source :depending on the results of Minitab 14 program

It is clear from the previous source (4) that the time series has stabilized when the first difference is made. For the purpose of select the model to be used to generate forecasts, the autocorrelation and the partial autocorrelation function of the time series are estimated after taking the first difference and as in the two sources 5 and 6 .

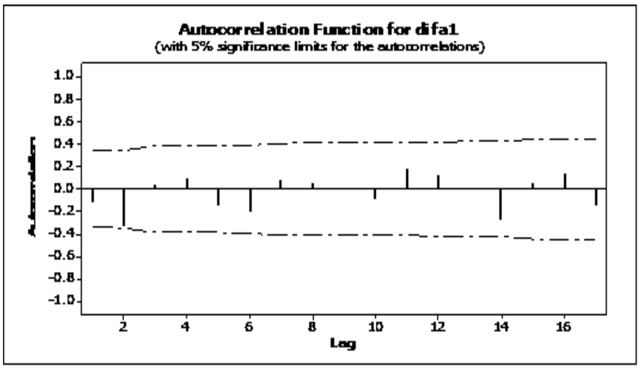

Figure 5. Autocorrelation function after taking the first difference of wheat production

Source :depending on the results of Minitab 14 program

the time series has been stabilized by conducting and testing the first difference based on the partial and autocorrelation functions, the next step is to choose the appropriate model in which a set of forecasting, including the estimated parameters, should be available and pass the statistical tests, Predictive accuracy, the most important of which is the mean square error (MSE) as well as the Automatic Information Criteria (AIC). ARIMA model was tested at several levels and was selected for (4.1.3) because it complied with the above conditions. The values of AR and MA were significant at 1% and 10% is not available in all models estimated, as well as the lowest value for MSE and AIC compared to other models

Table 1. Estimated model parameter values

Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	0.8553	0.2578	3.32	0.003
AR 2	-1.3769	0.2854	-4.82	0.000
AR 3	0.9241	0.2587	3.57	0.001
AR 4	-0.4883	0.2854	-1.71	0.099
MA 1	1.1422	0.2466	4.63	0.000
MA 2	-1.0502	0.2979	-3.53	0.002
MA 3	0.8461	0.2417	3.50	0.002
Constant	74.622	6.382	11.69	0.000

Differencing: 1 regular difference

Number of observations: Original series 36, after differencing 35

Residuals: SS = 7955190 (back forecasts excluded)
MS = 294637 DF = 27

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	4.1	13.0	*	*
DF	4	16	*	*
P-Value	0.392	0.670	*	*

AIC=456.7725

Source: From the work of the researcher using the statistical program MINITAB

and was selected on the basis of several tests, including variation and natural distribution as well as residuals and (Kolmogorov–Smirnov) test as follows:

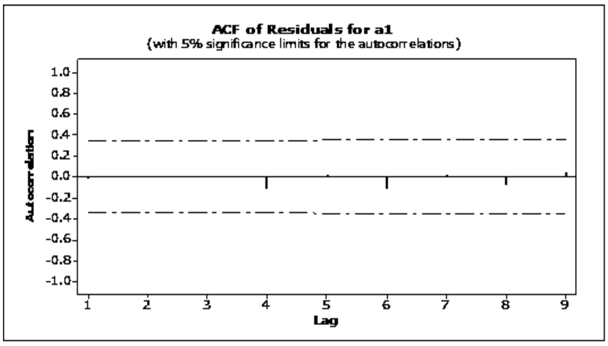

Figure 6. The Autocorrelation function for residuals, ARIMA model (4,1,3)

Source :depending on the results of Minitab 14 program

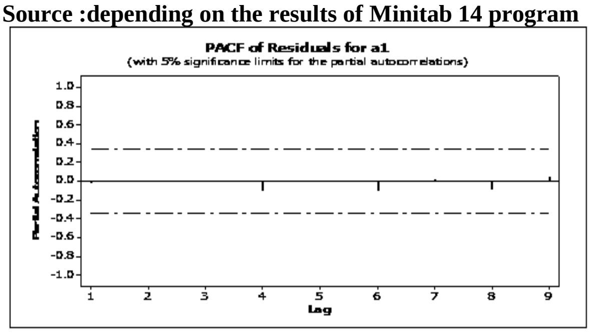

Figure 7. The partial Autocorrelation function for residuals, ARIMA model (4,1,3)

Source :depending on the results of Minitab 14 program.

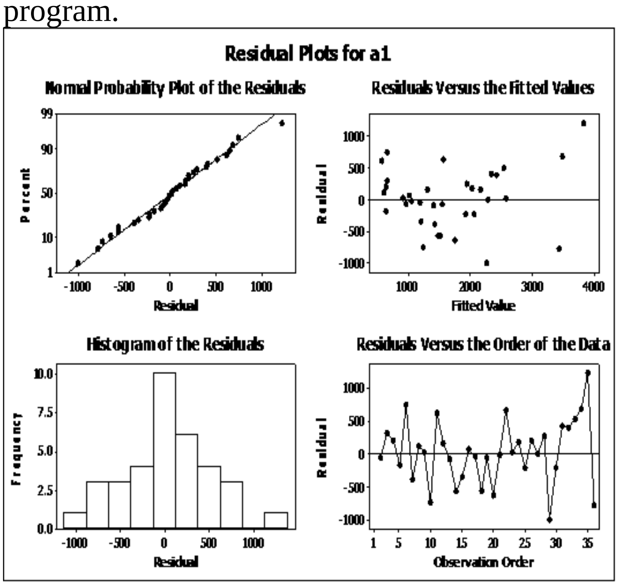

Figure 8. Testing the nature of residues, natural distribution and the spread of residuals of the estimated model

Source :depending on the results of Minitab 14 program

After the diagnosis stage, we reach the last which is to predict wheat production for the period (2025-2016)

Table 2. forecasting values for the production of wheat crop (thousand tons) in Iraq for the period (2016-2025)

Forecasts from period 36 95 Percent Limits				
Period	Forecast	Lower	Upper	Actual
2016	1960.80	896.68	3024.91	
2017	3172.71	1 865.73	4479.70	
2018	3234.02	1918.44	4549.60	
2019	2236.80	914.53	3559.08	
2020	2828.14	1496.86	4159.42	
2021	4246.55	2897.78	5595.33	
2022	3768.62	2390.55	5146.69	
2023	2514.79	1122.23	3907.35	
2024	3197.16	1761.06	4633.26	
2025	4447.60	3010.02	5885.18	

Source: From the work of the researcher using the statistical program MINITAB

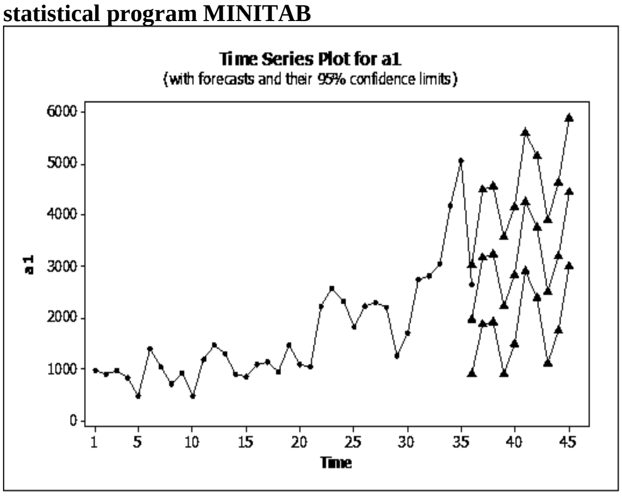

Figure 9. (Time series for forecasting wheat production in Iraq

Source :depending on the results of Minitab 14 program

After forecasting wheat production, we will forecasting the food gap using the ARIMA model. Following the same steps, we confirm the stability of the time series or make it stable in case of instability.

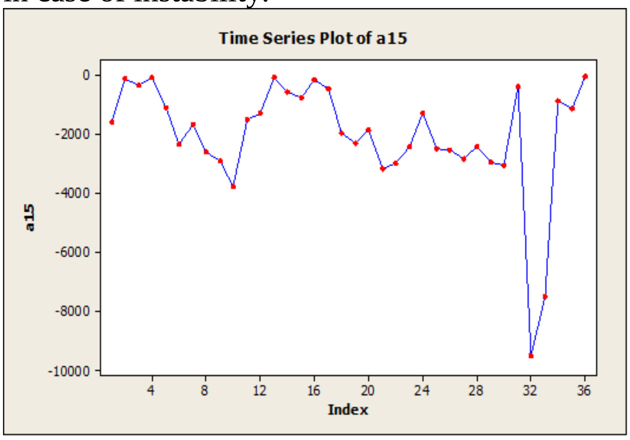

Figure 10. Time series trend of food gap Wheat in Iraq for the period (1980-2015)

Source :depending on the results of Minitab 14 program

Source (10) Shows that there is a general tendency to increase, the time series is unstable. For the purpose of determining the stability of the time series, the Autocorrelation and partial Autocorrelation functions are used as follows:

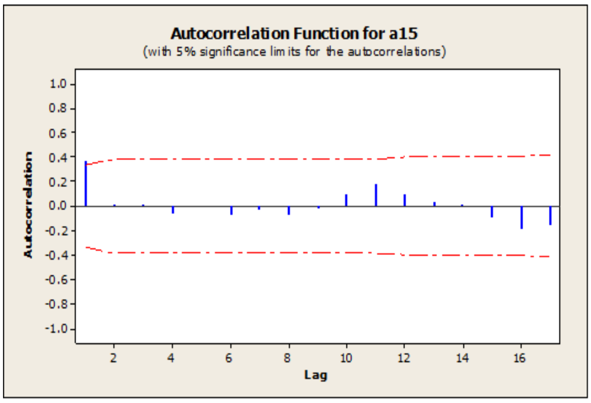

Figure 11. The Autocorrelation function of food gap data wheat in Iraq

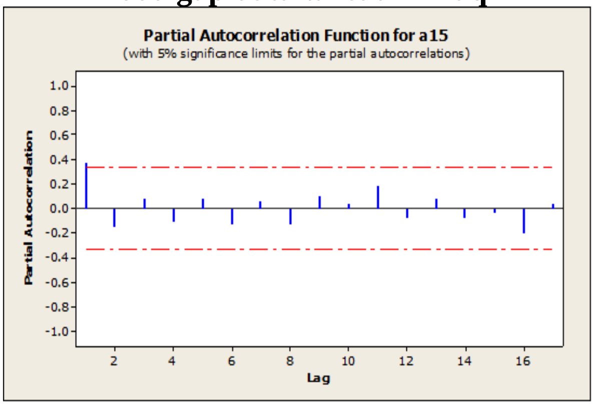

Figure 12. The partial Autocorrelation function of wheat gap data in Iraq

Source :depending on the results of Minitab 14 program

So, by reviewing the partial and autocorrelation function of wheat gap in Iraq, it is clear that the time series of the food gap data from the wheat crop is stable so we will start using the Box-Jenkins method to choose the appropriate model in which there should be a set of features, including the estimated parameters and passing the statistical tests, the lowest value of the predictive accuracy standards, the most important of which are the mean square error (MSE) as well as the (AIC). The ARIMA model was tested at several levels. The sample (1.0.1) was chosen because it complied with the above points. The values of (AR) and (MA) were significant at the level of 1, which was not available in all models estimated, as well as the lowest value for MSE and AIC .

Table 3. Estimated model parameter values

Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	-0.4556	0.2239	-2.03	0.050
MA 1	-0.9207	0.1235	-7.45	0.000
Constant	-2948.9	561.8	-5.25	0.000
Mean	-2025.9	386.0		

Number of observations: 36

Residuals: SS = 102764073 (back forecasts excluded)

MS = 3114063 DF = 33

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	3.5	12.0	*	*
DF	9	21	*	*
P-Value	0.943	0.941	*	*

AIC=546.2518

Source: From the work of the researcher using the statistical program MINITAB

And was selected on the basis of several tests, including variation and natural distribution as well as residuals and (Kolmogorov–Smirnov) test as follows:

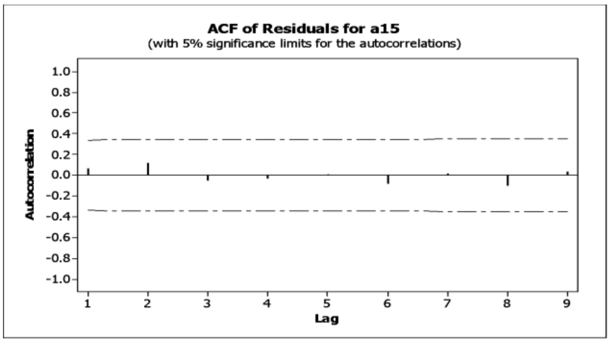

Figure 13. The Autocorrelation function of the estimated ARIMA model (1.0.1)

Source :depending on the results of Minitab 14 program.

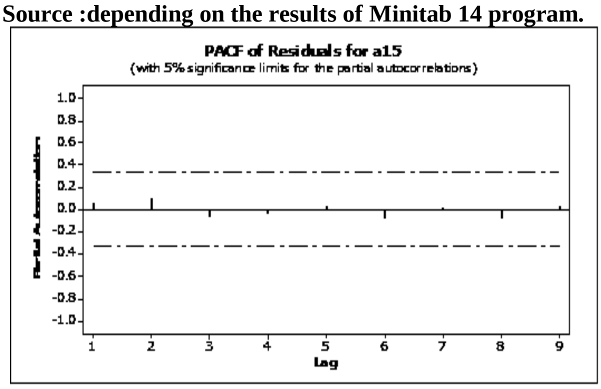

Figure 14. The partial Autocorrelation function of the estimated ARIMA model (1.0.1.)

Source :depending on the results of Minitab 14 program

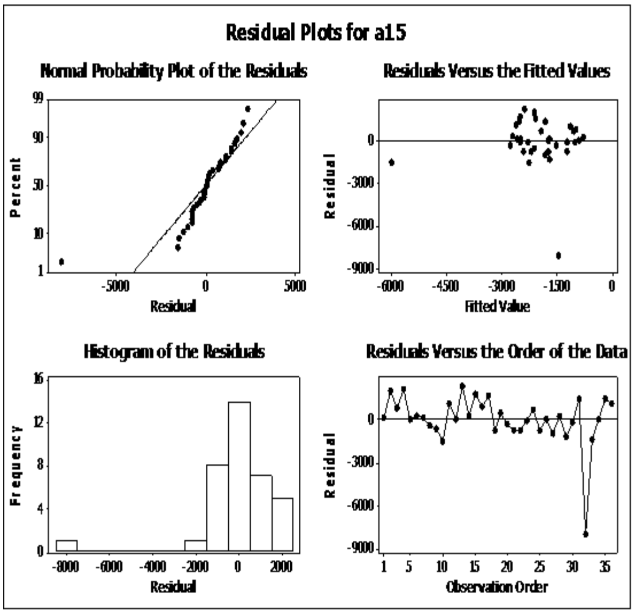

Figure 15. Testing the nature of residues, natural distribution and the spread of the residuals of the estimated model after passing the model for the above tests, the final stage is the forecast of the ARIMA model (1.0.1).

Source :depending on the results of Minitab 14 program

Table 4. Predicted values of the food gap Wheat production (thousand tons) in Iraq for the period (2025-2016)

Forecasts from period 36 95 Percent Limits Period	Forecast	Lower	Upper	Actual
2016	-1920.67	-5380.12	1538.78	
2017	-2073.78	-5889.07	1741.52	
2018	-2004.02	-5889.10	1881.06	
2019	-2035.80	-5935.21	1863.61	
2020	-2021.32	-5923.70	1881.06	
2021	-2027.92	-5930.91	1875.08	
2022	-2024.91	-5928.03	1878.21	
2023	-2026.28	-5929.43	1876.87	
2024	-2025.66	-5928.81	1877.50	
2025	-2025.94	-5929.10	1877.21	

Source: From the work of the researcher using the statistical program MINITAB

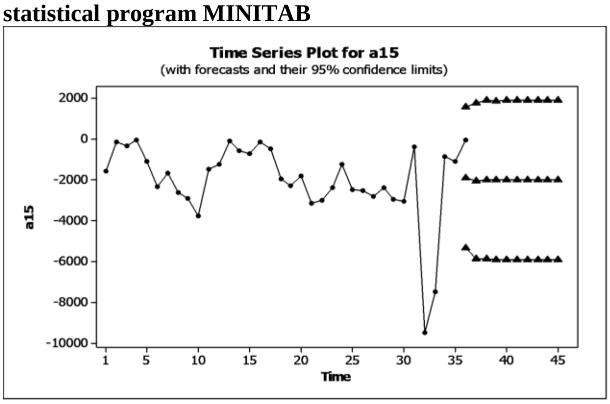

Figure 16.Time series of food gap wheat in Iraq and predicted

Source :depending on the results of Minitab 14 program

It is noted through the predicted values that the food gap for wheat is continuous and semi-fixed, indicating the expectation that self-sufficiency can't be achieved in the short term, and the difficulty of covering consumption through the local production of wheat and having to fill the deficit by importing fixed quantities during the subsequent period. The research reached a set of conclusions,The time series for the production of wheat in Iraq has an increasing general trend which means that it is not static, while the time series of the food gap for the wheat crop was stable. The ARIMA (4,1,3) forecasting model for wheat production has the lowest value (MSE) with 294637 and the lowest value for the AIC (456.7725). The food gap was ARIMA (1.0, 1) is the best in terms of having the lowest value (MSE) 3114063 and the lowest value (AIC) 546.2518 .There is an increase in the production of wheat in Iraq during the coming years (2025-2016) while offset by a semi-constant in the food gap for the same period and this indicates that the self-sufficiency of wheat in the short run can't occur. Food gap for wheat is continuous and semi-fixed, indicating the expectation that self-sufficiency can't be achieved in the short term, and the difficulty of covering consumption through the local production of wheat and having to fill the deficit by importing semi-fixed quantities during the subsequent period.

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