Journal of Agricultural, Environmental and Veterinary Sciences
Volume (5), Issue (1) : 30 Mar 2021
P: 89 - 115

AJSRP
ISSN: 2522-3364

مجلة العلوم الزراعية والبيئية والبيطرية
المجلد (5)، العدد (1) : 30 مارس 2021م
ص: 89 - 115

Forecasting the Cultivated Areas of Qat Crop to 2030 And Its Impact on Food Security in The Republic of Yemen Using ARIMA Model

Adnan Abdulwali Alsanoy
Sana'a University || Yemen
Saif Sallam Alhakimi
University of Bisha || KSA
University of Hodeidah || Yemen

Abstract: This study aimed to forecast and predict the areas planted with Qat tree until the year 2030 in the Republic of Yemen, using the most prominent Autoregressive Integrated Moving Average (ARIMA) models throughout the whole country. This model was adopted in this study for its high accuracy in analysis. This methodology relies on a combination of autoregressive models and integrated moving averages. The results show that ARIMA (1.0.1) is the most appropriate model for forecasting and predicting Qat areas in Yemen until 2030 according to statistical tests of the accuracy of the predictive models. The results indicate an increase in the cultivated areas expected in 2030, which will be 235826 hectares of Qat areas at an annual growth rate higher than the annual growth rate for the time series while the area's annual growth rate reached (30%). This increase is at the expense of the shortage of the significance of cash crops such as coffee and grains, based on the results of the proposed model for the next ten years. This expansion represents economic and social risks to the agricultural sector. Accordingly, the study recommends that decision-makers need to reformulate and draw economic and social policies for the coming periods to limit the spread of this crop, which negatively affects groundwater depletion because Yemen is one of the poorest countries in terms of water storage.

Keywords: Prediction/Forecasting - ARIMA Model - Qat Corp – Area.

التنبؤ بالمساحات المزروعة لمحصول القات حتى عام 2030 وأثرها على الأمن الغذائي في الجمهورية اليمنية باستخدام نموذج ARIMA

عدنان عبد الولي الصنوي
جامعة صنعاء || اليمن
سيف سلاّم الحكيمي
جامعة بيشة || المملكة العربية السعودية
جامعة الحديدة || اليمن

الملخص: هدفت هذه الدراسة إلى التنبؤ بالمناطق المزروعة بأشجار القات حتى عام 2030 في الجمهورية اليمنية، باستخدام أبرز نماذج الانحدار الذاتي المتكامل مع المتوسطات المتحركة. Autoregressive Integrated Moving Average(ARIMA) للتنبؤ على مستوى الجمهورية اليمنية. تم اعتماد هذا النموذج في هذه الدراسة لدقته العالية في التحليل. تعتمد هذه المنهجية على الدمج بين نماذج الانحدار الذاتي والمتوسطات المتحركة. أظهرت النتائج أن نموذج (1.0.1) ARIMAهو أنسب نموذج للتنبؤ بمناطق القات في اليمن حتى

عام 2030 وفقًا للاختبارات الإحصائية لدقة النماذج التنبؤية. وتشير النتائج إلى زيادة المساحات المزروعة المتوقعة في عام 2030 والتي ستكون 235826 هكتاراً من مناطق القات بمعدل نمو سنوي أعلى من معدل النمو السنوي للسلسلة الزمنية بينما بلغ معدل النمو السنوي للمنطقة (30%). وتأتي هذه الزيادة على حساب نقص المحاصيل النقدية مثل البن والحبوب، بناءً على نتائج النموذج المقترح للسنوات العشر القادمة. يمثل هذا التوسع مخاطر اقتصادية واجتماعية للقطاع الزراعي. وعليه، أوصت الدراسة بضرورة قيام متخذي القرار بإعادة صياغة ورسم سياسات اقتصادية واجتماعية للفترات القادمة للحد من انتشار هذا المحصول مما يؤثر سلباً على استنزاف المياه الجوفية لأن اليمن من أفقر الدول من حيث تخزين المياه.

الكلمات المفتاحية: التنبؤ – نموذج -ARIMA- محصول القات - المساحة.

1. Introduction

Yemen is characterized by a unique environmental diversity that helped diversify the large crop of Qat in different regions. Yemen has been known for agriculture since ancient times, which depend on rainwater. The Yemeni farmer developed agricultural techniques unmatched anywhere else, such as mountain terraces, Marib Dam, and irrigation canals. This development is not only for the sake of survival but also for achieving a wide upsurge in development. The American researcher and orientalist D. Varisco (2003) pointed out that "agriculture in Yemen has flourished for more than five thousand years due to the many water harvesting and distribution methods. The irrigation methods used to express Yemeni civilizations' wealth and are also an essential factor for the planning and development of sustainable agriculture in Yemen regardless of scarce resources .

However, the increasing population growth, changes in the consumption pattern of the population, and climate changes, in addition to the trend to meet the needs of the market and the urban development that Yemen has witnessed during the past decades, have greatly affected agriculture and agricultural production, both in the expansion of the cultivation of some crops, especially Qat, fruits, and vegetables, draining the already scarce environmental resources, especially water, or in reducing the cultivation of strategic crops, especially grains. All these and other factors increased the importation of foodstuffs from abroad. Yemenis do import 90% of the food. As a result, people's lives are affected due to domestic challenges, international changes, and climate change. These studies indicate that the Yemeni family spends about 45% of its income on food and 10% on Qat. This percentage increases in coastal areas to 33% of its annual income according to the Ministry of Planning and International Cooperation - Statistics Yearbook, 2012.

Due to the increasing demand for Qat, Qat's agricultural area during the past four decades from 1970 to 2019 has increased by about 21 times. Modern technologies in its cultivation and marketing have increased Qat plant's total production by more than 54 times. Moreover, the number of Qat consumers has increased among the population and extended to many children and women. Furthermore, the periods of Qat consumption, or what is known as Qat chewing or Qat gatherings, increased to more than six hours a day. Some Qat consumers even continued to chewing Qat for two or three periods a day.

Statistics indicate that the number of Qat consumers in Yemen exceeded 72% of men, 33% of women, and 15-20% of children under 12 years.

According to the annual census of the Ministry of Agriculture and Irrigation 2018, Qat cultivation is circulated in most governorates of Yemen. Six governorates make up about three-quarters of Qat's total area, 73%, which are Sana'a, Amran, Dhamar, Ibb, Hajah, and Taiz, respectively. 24% of the area cultivated with Qat is concentrated in Sana'a and 13% in Amran. These two governorates occupy about 37% of the area cultivated with Qat. During the last decade, Qat spread to Qa'a Jahran, Alboone, Qa'a Alsahool, and many other mountainous areas since 2003. Currently, Qat consumes more than a third of the water used for agriculture.

The average area cultivated with Qat was 166,557 hectares of the total cultivated land estimated at 1,172,000,000 hectares. The yield of Qat is estimated at 190 thousand tons annually, according to the Ministry of Agriculture and Irrigation, 2012 statistics.

The crops in Yemen vary according to the region's topographical diversity and the amount of rainfall. The valleys between the mountains, coffee, maize, Qat, and many other sustainable green fruits are spread. In the highlands, grain and vegetables are widely cultivated in addition to Qat. Qat is cultivated in regions at an altitude of 800-2400 meters above the sea level. Its cultivation is more widespread in marginal lands. Qat cultivation depends mainly on rainwater. Its cultivation has flourished in the past decades on irrigated lands. It spread to some major mountain valleys, such as Qa'a Jahran. Many modern technologies were introduced in its cultivation, such as covering it with glass or plastic covers or fabric curtains to protect it from frost and cold, the use of modern irrigation systems for irrigation, in addition to the excessive use of pesticides and fertilizers. Thus, Qat producers were able to adapt its cultivation to obtain the product at any time of the year.

Furthermore, Qat farmers were able to harvest it several times per season. These technologies and careful attention to its production and its marketing network that is unmatched by the marketing of any other crop, and the growing numbers of consumers from different social groups, have made the Qat crop yielding a great deal of income more than other crops .

Ministry statistics also confirm that there has been a great deal of promotion in the Qat trade lately so that Yemenis spend - using it as a stimulant - about $ 12 billion annually.

Research General Framework

Introduction

Predicting the cultivated areas of the Qat tree is considered a necessity as the expansion of Qat cultivation increases annually at the expense of the crop area of grains. This leads to widening the food production gap due to the expansion of cultivated areas. In this regard, Qat is currently the most important crop in Yemen, as it contributes one-third of the total agricultural value, i.e., more than 32% in 2018. Qat is a profitable, drought-tolerant crop that can be harvested continuously throughout the year, providing farmers with cash. Almost all Yemenis chew Qat.

The agricultural sector has shifted its concern to the Qat economy. The high demand for it and the lack of workforce required in its cultivation made it the main profitable crop in the agricultural sector. The downside is that it depletes large amounts of water resources and diverts resources away from strategic crops such as wheat, coffee, and other valuable crops that could provide foreign currency or improve the country's food security situation. The import of Qat is not officially illegal, but in reality, it is not allowed. As a result, this provides local producers with a huge income. Also, the price of Qat in Yemen is much higher than five times the price in Ethiopia, according to a study by the Ministry of Agriculture and Irrigation and the Food and Agriculture Organization (FAO.(

In this study, the researcher sheds light on the steady increase in farmers' demand to expand Qat cultivation at other crops' expense. The latest educational methods will create a perception about the demand for cultivating Qat until 2030 and present it to decision-makers to do proper planning and take decisions and policies to deal with the problem.

Research Significance

Many methods have emerged to predict important variables. The most prominent of these methods is the ARIMA Model. The study concludes a standard model used to predict the cultivated areas of the Qat tree expected to be planted by the year 2030, adapting the Autoregressive Integrated Moving Average Model, ARIMA, using the EVIEWS program and its modern techniques to predict the cultivated areas of the Qat tree for the year 2030 in Yemen for the sake of awakening the political leaders for better planning.

Research Problem

Despite the unstable political, economic, and social conditions in Yemen that do not encourage optimistic planning, it is imperative to predict the cultivated areas and the annual expansion of Qat cultivation. This would guide decision-makers to prepare to limit the spread of Qat based on past data. Given the scarcity of Yemeni outlook studies in general and the weakness of the analytical depth of the few studies that have been conducted, this study aims to fill this deficiency, based on quantitative and qualitatively integrated statistics, and based on the time series analysis method, which has been recently developed through modern statistical package programs to generate predictive estimations of the future with a high degree of confidence.

This study attempts to answer the problem of the following general question:

Forecasting the cultivated areas of the qat tree up to 2030 at the expense of cash crops

How effective is ARIMA models' use to predict cultivated qat areas in Yemen for the year 2030?

Research Objectives

The study aims to test the possibility of applying the modern method in analyzing time series in predicting the areas cultivated by the Qat tree for the year 2030.

The research seeks to achieve the following goals:

1- Learn about the concept of the ARIMA model.
2- Developing a modern standard forecasting model to assist policy-makers in setting future policies for cultivated areas, crop productivity, and consumption.
3- Prediction of qat cultivated areas to the year 2030.

Research limits

The current study determines the areas planted with the Qat tree within the Republic of Yemen

Research Methodology

This study is based on annual data collection

The descriptive-analytical method is used in accomplishing this study by looking at many references, in Arabic and English, that dealt with the Box Jenkins methodology in the analysis of time series. The annual time series of cultivated areas of Qat trees were then gathered from the General Administration of Agricultural Statistics and the Central Bureau of Statistics. The data was analyzed using the EVIEWS Nine (9) Program.

2. Theoretical Framework

The definition of Qat

The scientific name of Qat is Catha Edulis. It could be defined as a narcotic plant that grows in East Africa and Yemen. The Qat plant contains monoamine, an alkaloid called cathinone, similar to a stimulant amphetamine, which causes anorexia and hyperactivity. The World Health Organization has classified Qat as a harmful drug that could cause mild or moderate addiction, less than alcohol and tobacco. Qat is banned in most countries globally, except for Yemen, where it is widely spread and consumed. Qat is a slow-growing tree, with an average length between 1.4 - 3.1 meters, depending on the region and rainfall average. Its leaves are about 5 to 10 cm long, and it is evergreen .

Information of Yemen Country

Yemen is located in the south of the Arabian Peninsula. It was one of the most famous coffee exporting countries. Yamani coffee is considered one of the finest types of coffee. The cultivation of coffee and the agricultural sector in the Republic of Yemen generally have been affected by Qat's cultivation. About 40% of the irrigation water is consumed, especially since its water harvest is already at risk. Each group of Qat plant costs about 500 liters of water. Scientists say that Sanaa City might be the first capital in the world to be completely dried up of water. In addition to Qat's health effects, it poses fatal economic risks for it affects the conduct of business generally.

In 2009, one billion liters of diesel was used to pump water for agricultural purposes. The government itself estimated that it spent about $700 million in depleting its water resources. The problem of water depletion in Yemen is due to the cultivation of Qat. This tree needs more water than the rest of the other plants. Also, the increased demand for Qat drives farmers and traders to double the production. The amount of water consumed is so high that groundwater levels in the Sana'a Basin are decreasing rapidly..

Qat contains nootropic stimulants that increase the state of activity and last for two and a half or three hours. The body soon becomes inactive and leads to consuming more Qat to get the needed energy. It increases blood pressure and myocardial infarction, which is one of its negative effects. Also, chewing Qat for long hours causes sudden heart attacks. The plant's stimulant effect is originally attributed to cathine, which is a phenethylamine-type substance isolated from the plant. However, disputed reports indicate that plant extracts from the fresh leaves of Qat contain another substance that is more behaviorally active than cathine .

The agricultural sector in Yemen

The development of Qat cultivation areas from 1990 to 2019

This sector is essential in determining the reality of food security in Yemen through the most significant agricultural sector indicators. It is noted that the index of useable land to the total is limited; that is, it constitutes only 3.6%, i.e., approximately 1,650 million hectares of the total area estimated at 45,550,246 hectares. As shown, Qat's area is constantly increasing from 58,000 hectares in1990 to 230,000 hectares in 2018. Reports of some international organizations indicating that the area of Qat exceeds this number highly. On the other hand, the quantities of locally produced grain decreased compared to 2012, from 910 thousand tons to 357 thousand tons in 2018. The number of grain and milling products increased from 3,550 million in 2010 to 5,039 million in 2012. The domestic production of wheat from the total, domestic plus imported, decreased by 5.9% in 2012 to 3.2% in 2018. The number of food imports to total exports increased in 2014 from 40.8% to 148% in 2018. The agricultural spending index to the government increased from 0.89% in 2010 to 1.69% in 2016 due to the decline in investment in other sectors and cutting off external financing .

The current situation of agriculture and food in Yemen

The expansion of Qat cultivation increases annually at the expense of the crop area of grains. This leads to an expansion of the food gap, as shown in the attached tables No. (1) and (2). In this regard, Qat is currently the most dominant crop in Yemen. It contributes one-third of the total agricultural value, i.e., more than 32%, according to 2018 statistics. It is also a profitable, drought-tolerant crop that could be harvested repeatedly throughout the year and provides farmers with cash. Almost all Yemenis chew Qat.

The agricultural sector has shifted its concern to the Qat economy. The high demand for it and the lack of labor required in its cultivation made it the main profitable crop in the agricultural sector. However, the downside is that it depletes large amounts of water resources and diverts resources away from strategic crops such as wheat, coffee, and other valuable crops that could provide foreign currency or improve the country's food security situation. The import of Qat is not officially illegal, but in reality, it is not allowed. As a result, this provides local producers with high income. Besides, the cost of Qat in Yemen is much more expensive, five times the cost in Ethiopia, according to a study by the Ministry of Agriculture and Irrigation and the Food and Agriculture Organization, FAO.

The Yemeni government has made general policies related to food security programs and limiting the expansion of Qat cultivation. This crop has become a major problem for food security. The National Food Security Strategy emphasized the limitation of the expansion of Qat cultivation and promoting crops and alternative activities. However, these policies were not implemented until 2018 .

Qat's production consumes about 35% of the agricultural uses of water, which represents a high percentage of the limited amount of groundwater, knowing that Qat cultivation is concentrated in the highland regions, which is one of the areas that suffer from water scarcity. Furthermore, Qat consumption has negative effects on society in general, especially since low-income families spend a very high percentage of their financial resources on Qat consumption in addition to the health effects from its use

The Ministry of Agriculture and Irrigation prepared a national strategy for the agricultural sector as an operational plan from 2012 to 2016. The strategy focused on the issue of Qat. What should be done is to develop a multispectral national strategy that comprehensively addresses the related social, economic, health, and cultural issues of the cultivation, production, trade, and Qat consumption. Since the agricultural sector has the main role in any Qat strategy, measures should be taken. A realistic assessment of the impact of Qat on the rural economy in terms of its returns on farmers compared to alternative crops, and its impact on the broad social segment working in production, cultivation, marketing, transport, and trade of Qat and alternative employment opportunities that could be provided to the rural people. Measures should also be taken to develop a long-term strategy that would move to alternative cultivation and substitute alternative crops that are competitive with Qat; to evaluate and propose alternative crops to farmers and alternative livelihoods for Qat marketers; and to introduce improved agricultural processes and techniques for crop production that would reduce the consumption of groundwater, other resources and the safe and proper use of pesticides.

The current food situation in Yemen has reached a more complex stage based on the emergency assessment of food security and nutrition in 2016 by the Ministry of Agriculture and Irrigation with the

World Food Program's participation and funding, the Food and Agriculture Organization, and UNICEF 2016.

Development of production and major agricultural commodities available for consumption

The development of the food gap's quantitative size for the years from 1990 to 2018 shows an increase in the population and consumption of grains. It also shows a decrease in cultivated areas, especially wheat, for the basic commodities. The consumption of grains increased from about two (2) million tons in 1990 to about 4.4 million tons in 2018. See Table (3).

When Qat leaves dry, the most chemically active ingredient, cathinone, decompose within 48 hours. The resulted ingredient is cathine, which is the most chemically moderating ingredient. Qat is harvested by collecting the leaves and stems in plastic bags or placing them in banana leaves to retain moisture and keep the cathinone in a good state. It is also common for Qat traders to spray Qat with water frequently or use cooling devices during transport.

Forecasting or prediction, its significance, and objectives

Forecasting Concept

The definition of prediction literally is the estimation of the unknown, especially concerning future events, to identify the course of the phenomenon understudy in the future. Prediction can be terminally defined as a rational attempt to estimate possible future variables by examining the negative variables of those apparent (Kazem, 2005).

Forecasting Purpose

The purpose of forecasting emerges in the use of knowledge of future values of time series [Xt + mm = 1,2, ..., n] based on data recorded in the past, Pual & Andrews (2009). Economic forecasting is an important topic. The prediction and interpretation of economic variables and prediction of how they will proceed in the future are among the factors that enable political officials and decision-makers to draw economic and social policies for the time periods. All studies that use time series of all kinds require the study of continuity analysis using statistical methods and tests .

Time Series Stationary Testing

Stability analysis is one of the most important requirements by which the specific model's link is determined. It is possible to identify whether these chains are stable or not utilizing a group of methods, the most important of which are:

Graphic Analysis

The time series of the variable under study is drawn in the form of a graph. The graph could determine whether this series has a general trend or not. Then, it can be determined that this series is stable or not. If it has a general trend, the series is not stable. Therefore, this trend must be eliminated.

Autoregressive Integrated Moving Average, ARIMA Models. It is known as the Box - Jenkins (B J)

Methodology

Statistical Tests

There is a set of statistical tests used to test the stability of time series, the most important of which is the unit root test, and the current study applies several tests :

Augmented Dickey-Fuller (ADF): Kwiatkowski, Phillips Schmidt, Shin (KPSS) (1981), Phillips and Perron (PP), Dickey D. and Fuller W.

Dickey-Fuller extended ADF Test

The ADF test is one of the most important and most common tests used to test the time series's static and stability (Dickey & Fuller). This test is based on the following equation (Durbin & Koopman, 2012):

Prediction using Box-Jenkins ARIMA Methodology

Box-Jenkins methods were developed by Box and his colleague Jenkins (Box and Jenkins, 1976) to analyze Stationary time series. Being stable means that it is Mean and Variance are constant throughout the time of the series. Furthermore, the Covariance between two periods depends only on the distance (or what is called the degree of Lag) between the two periods and not on the time point at which the correlation is calculated. This means that assuming the series is divided into a set of time periods, the averages and variances of the series' values for the different periods are equal. If there is a correlation between the successive series' values, it is the same in all periods, neither increasing nor decreasing according to the different time period. Graphically, considering that the horizontal axis represents time and the vertical axis represents the values of the series, the stable series shows its values centered around a horizontal straight line that passes through its mean, so that they form what looks like a rectangle. This means that the values do not increase in dispersion or converge with time, nor does any pattern appear other than that of a horizontal straight line. However, the assumption that the chain is stable is difficult to achieve in reality. Thus, the methods of Box Jenkins for converting unstable chains into stable chains. Then, the prediction could be conducted..

Series' Values Methodology

Box Jenkins' methods are referred to as "ARIMA Models." Box and Jenkins realized the significance of these methods in predicting the future, especially in economics in the early 1960s. The abbreviated English word ARIMA expresses the three components of the model: receive Integrated Moving Average.

This methodology is used if the time series data under study are static, as it can be described by one of the models that follow the Box - Jenkins methodology. If it is not static, the necessary treatment must be done to become static. The models of Box - Jenkins methodology are as follows:

Autoregressive (AR) Process Model

In this model, the value of a variable in the current period Yt depends on the values of the same variable in the previous periods Yt-1, Yt-2, ... If there is no auto-correlation problem between the values of ut and the value of Y in the current period depends on the values of Yt-1 in the period, then this model is called the First-Order Autoregressive AR (1.(

It can be described with this formula Yt = a1Yt-1 + ut

By estimating the previous formula, the values of Y can be predicted as follows:

$$\hat{Y}_t = (1-\hat{\alpha}_1)\bar{Y} + \hat{\alpha}_1 Y_{t-1}$$

It is noted that among the simplest forms of the Autoregressive AR (1) model of the first order and the common formula in which the autocorrelation coefficient or the serial correlation coefficient is calculated:

If the following model estimated

$$u_t = \rho u_{t-1} + \varepsilon_t$$
$$Y_t = c + bX_t + u_t$$

Suffers from a first-order serial correlation problem, then the method used to solve the problem through EVIEWS Program is to add the formula AR (1) to the equation to be estimated. Then, the program calculates the following formula:

$$Y_t - \rho Y_{t-1} = c + b(X_t - \rho X_{t-1}) + (u_t - \rho u_{t-1})$$

It is equivalent to the following formula:

$$Y_t = c + \rho Y_{t-1} + b(X_t - \rho X_{t-1}) + \varepsilon_t$$

Which excludes serial correlation from the data

For the second-order regression model, AR (2), it takes the following formula:

$$Y_t - \bar{Y}) = a_1 (Y_{t-1} - \bar{Y}) + a_2 (Y_{t-2} - \bar{Y}) + u_t$$

Y's values in the current period depending on its value in the two periods preceding the current period. Y values can be predicted using the following formula:

$$\hat{Y}_t = (1 - \hat{\alpha}_1 - \hat{\alpha}_2)\bar{Y} + \hat{\alpha}_1 Y_{t-1} + \hat{\alpha}_2 Y_{t-2}$$

The autoregressive model can be of any rank (P), AR (P).

Moving Average (MA) Process

This form takes the following formula:

$$Y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1}$$

Here, Yt is equal to the constant μ and a moving average of the random term values in the current period ut and the previous period ut-1. This average is weighted by weights β0 and β1. In this case, it is said that the first-order moving average model is First-Order Moving Average MA (1).

The second-order moving average model is as follows:

$$Y_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2}$$

Thus, the moving average model is of order q if the number of time gaps of the random bound in the model is equal to q. The random bound can be obtained by estimating a predicate regression equation with dependent variable Yt and other explanatory variables.

An Autoregressive Integrated Moving Average (ARIMA) process

If the original time series is nonstationary, it is said that it is not integral. If it is necessary to obtain the difference of the chain a number (d) times until it becomes static, then it is said that the original series is an integral of degree (d). Thus, the Auto-Regressive and Integrated Moving Average model is characterized by three ranks: the autoregressive rank, the integration rank, and the moving average rank. Thus, it could be written as ARIMA (p, d, q). If the model is ARIMA (1,1), then the first differences must be obtained for the original series. An ARIMA estimate could then be done on them because this last estimate is not performed on a static series. Then, the formula of the model is as follows:

$$\Delta Y_t = \lambda \Delta Y_{t-1} + \beta_0 u_t + \beta_1 u_{t-1}$$

In general, it can be said that

ARIMA(P,0,q)=ARMA(P,q)

The original series is static

ARIMA(P,0,0)=AR(P)

ARIMA(0,0,q)=MA(q)

Prediction according to Box-Jenkins method

There are four necessary steps to follow to use the Box-Jenkins method for forecasting:

A- Learn about the Identifications model

B- Estimation

C- Diagnostic checking

D- Forecasting

For the BOX JENKINS method to be applied, the time series must be stationary. Stability, hence, means statistically that the mean and the variance are constant.

Time series stability (Static Tests) using an auto-correlation function based on a correlogram

A simple static test based on what's called the Autocorrelation function (ACF)(

The function $\rho_k = \frac{\gamma_k}{\gamma_0} \frac{Covariance\ at\ lag}{variance}$

When k = 0, then 1= 〖_0〗

Since both the covariance and the variance are measured with the same unit, the auto-correlation is without units, and its value ranges between +1 and -1 as any correlation coefficient. If the graph of the auto-correlation value is drawn, then the auto-correlation of the community has resulted. A sample is obtained for the random process; the sample autocorrelation function $\widehat{\rho}_k$ can be calculated to calculate the autocorrelation function according to the covariance and the variance.

$$\frac{\sum(Y_t - \bar{Y})(Y_{t+k} - \overline{Y})}{n}$$

$$\hat{\gamma}_0 = \frac{\sum\left(Y_t - \hat{Y}\right)^2}{n}$$

Hence, n refers to the sample size, and $\overline{Y}$ refers to the sample mean.

Drawing the function against the lags is called a sample Correlogram. If its value declines slowly, this indicates that the time series is unstable. The k graph can be examined to verify the stability of the function. Likewise, the Q statistic test can be used whether the autocorrelation coefficient ρk is equal to zero, i.e., there is no relationship between the lags.

- **Degree of integration**

The rank of both AR and MA is determined by examining the autocorrelation function and the partial autocorrelation function. If the autocorrelation function does not descend rapidly with an increase in deceleration degrees, then the time series is unstable and needs to differentiate. As for determining the rank of AR and MA, it can be done through the following table:

Test the accuracy of the results

The degree of integration tests whether the time series is stable in levels I (0) or stable in the first variation I (1) or second variation I (2). The degree of integration is determined by performing the Dickey-Fuller test's test on the first difference $\Delta Yt= Yt-Yt-1$ and the second difference $\Delta\Delta Yt= \Delta Yt-\Delta Yt-1$. If the first difference is stable and the function is not stable in the levels, it is said that it is first-degree I (1). Most of the unstable economic time series are integral to the first degree.

The practical application for the ARIMA model

If the following data represent the time series of cultivated areas for qat from 1990 to 2019

Table (1) time series for qat cultivated form 1990 to 2019

Cultivated	year	Cultivated	year
1990	58612	2005	133052
1991	61245	2006	146414
1992	63789	2007	150995
1993	74935	2008	157232
1994	86796	2009	165246
1995	88839	2010	166557
1996	91418	2011	166666
1997	93246	2012	166745
1998	97672	2013	166891
1999	103928	2014	179996
2000	108715	2015	180332
2001	108688	2016	182656
2002	110873	2017	183555
2003	115198	2018	183788
2004	131544	2019	186215

Source: Central Statistical Organization. Collection reports

To perform prediction using the ARIMA model,

First, we make sure of the time series's stability and make it stable in the state of instability, using the autocorrelation function and the partial autocorrelation function. These functions can be extracted by one of the statistical programs, EVIEWS, as shown in the following figures:

A. Graph 1 Show data presented on normal data

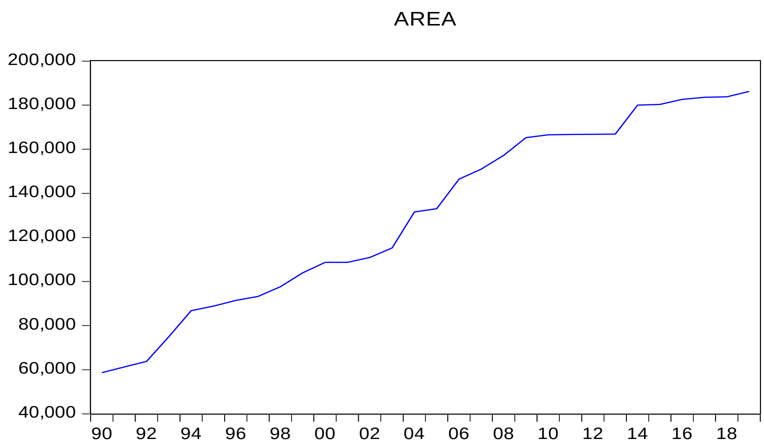

Figure (1) The Data at the normal level

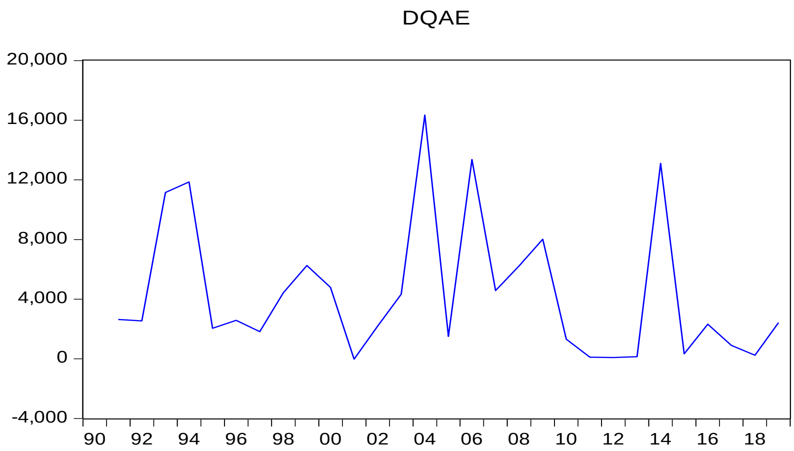

Figure (2) The data after the first difference

Date: 11/24/20 Time: 16:42						
Sample: 1990 2019						
Included observations: 30						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******	. |*******	1	0.909	0.909	27.342	0.000
. |******|	. *| . |	2	0.813	-0.073	50.016	0.000
. |***** |	. *| . |	3	0.710	-0.098	67.928	0.000
. |**** |	. | . |	4	0.614	-0.012	81.864	0.000
. |**** |	. | . |	5	0.530	0.003	92.636	0.000
. |*** |	. *| . |	6	0.437	-0.110	100.27	0.000
. |*** |	. | . |	7	0.353	-0.014	105.46	0.000
. |**. |	. *| . |	8	0.265	-0.079	108.51	0.000
. |* . |	. *| . |	9	0.174	-0.087	109.90	0.000
. |* . |	. | . |	10	0.087	-0.057	110.27	0.000
. | . |	. *| . |	11	-0.004	-0.100	110.27	0.000

.*|.|	.*|.|	12	-0.095	-0.096	110.75	0.000
.*|.|	.*|.|	13	-0.183	-0.077	112.65	0.000
.**|.|	.*|.|	14	-0.267	-0.083	116.91	0.000
.**|.|	.|*.|	15	-0.318	0.075	123.40	0.000
***|.|	.*|.|	16	-0.373	-0.112	132.94	0.000

Figure (3) The kilogram of the variable Y at the first difference of the data

Sample: 1990 2019						
Included observations: 29						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|.|	.|.|	1	-0.010	-0.010	0.0035	0.953
.|.|	.|.|	2	0.061	0.061	0.1290	0.938
.*|.|	.*|.|	3	-0.165	-0.165	1.0742	0.783
.*|.|	.*|.|	4	-0.101	-0.110	1.4418	0.837
.|*.|	.|*.|	5	0.150	0.176	2.2893	0.808
.|.|	.|.|	6	0.022	0.011	2.3080	0.889
.*|.|	.**|.|	7	-0.188	-0.268	3.7507	0.808
.|.|	.|.|	8	-0.049	-0.008	3.8545	0.870
.**|.|	.*|.|	9	-0.259	-0.192	6.8670	0.651
.|**.|	.|**.|	10	0.348	0.299	12.599	0.247
.|.|	.*|.|	11	-0.035	-0.093	12.660	0.316
.*|.|	.*|.|	12	-0.084	-0.203	13.035	0.367

Figure (4) The kilogram of the variable Y at the first difference of the data

From Figure five (5), it's noted that the autocorrelation falls outside the 95% confidence interval over seven (7) time gaps, and the autocorrelation coefficient (AC) decreases to reach its lowest value at the gap ten (10) and returns to increase in the reverse direction. Therefore, the series data are not stationary. When we took the first difference to the data series, the series data has now become stationary. See Fig 4

For further inspection, a Dickey-Fuller test was performed for the dormancy of unit root test for time series on the normal level of data and at the first difference. The results are shown in the following table:

Table (2)

		DICKEY –FULLER TEST			
At the first difference for the data		At the level for the data		Standard	
Trend with	With intercept	Trend with	With		

DICKEY –FULLER TEST					
intercept		intercept	intercept		
5.4020	5.150	1.319662	1.351576	t-Statistic	Augmented Dickey-Fuller test statistic
3.5806	3.574	3.574244	2.967767	Level%5	
0.00008	0.0003	0.862	0.5916	Prob*.	

Source: EVIEWS Results analysis.

The null hypothesis of the Dickey-Fuller test states the unit root's existence and the instability of the chain. The alternative hypothesis states the absence of the unit root and the stability of the series. From the above table results, it's noted that the probability value at the normal level of the data with the carnassial is equal to 97%, which is greater than 5%. Hence, the assumption of the null hypothesis stating the existence of the root of the unit is accepted. Thus, the series is unstable. The probability value of this test with the segment and the vector was less than 0.05, which means rejection of the null hypothesis and acceptance of the alternative hypothesis stating that the series is stable with Secant and vector at the normal data level.

At this level, the Dickey-Fuller test's value is less than the critical value, which means that the time series is unstable. At the first difference, the value of the statistical test is higher than the critical value. The null hypothesis stating that the time series is unstable is rejected and concludes that it is stable at the first difference.

It is obvious from the preview of Figure (5), the previous kilogram of the variable Y, that the auto-correlation AC falls outside the 95% confidence interval until the seventh gap. In comparison, the partial correlation coefficient PACF with the original series falls outside the 95% confidence interval limits at the first gap.

So, we have to experiment with the autoregressive model using the first-order AR (1), the MA (1) moving average model, MA (0,1), and the ARIMA (1,0,1) complex model.

We choose the most appropriate model to describe the data according to standard criteria.

We'll start with the autoregressive model. The formula to be estimated is as follows:

$$Y_t=\alpha + \alpha_1 Y_{t-1}+trend$$

According to the EVIEWS Program, we use the following command:

YC@trendAR(1)

For the moving average model, the formula to be estimated is as follows:

$$Y_t=\alpha +\beta u_t +\beta_1 u_{t-1}+\beta_2 u_{t-2}+\beta_3 u_{t-3}+\beta_4 u_{t-4}+\beta_5 u_{t-5}+\beta_6 u_{t-6}+\beta_7 u_{t-7}+ Trend$$

According to the EVIEWS Program, we use the following command:

Y C @trend MA(1 to 7)

As for the ARIMA complex model, the following formula must be estimated:

$$Y_t=\alpha + \alpha_1 Y_{t-1}+ \beta u_t +\beta_1 u_{t-1}+\beta_2 u_{t-2}+\beta_3 u_{t-3}+\beta_4 u_{t-4}+\beta_5 u_{t-5}+\beta_6 u_{t-6}+\beta_7 u_{t-7}+trend$$

According to the EVIEWS Program, we use the following command:

Y C @trend AR(10) MA(0 1)

Fitting Model Estimation

After estimating the proposed models using EVIEWS, the following results:

Table (3) The result of the auto-regression estimate according to the AR process (1) was as follows:

Date: 10/20/20 Time: 19:09				
Sample: 1990 2019				
Included observations: 30				
Convergence achieved after 11 iterations				
Coefficient covariance computed using an outer product of gradients.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	123005.8	60416.78	2.035954	0.0517
AR(1)	0.994684	0.033903	29.33942	0.0000
SIGMASQ	39797001	8887809.	4.477706	0.0001
R-squared	0.976897	Mean dependent var		130394.6
Adjusted Rsquared	0.975185	S.D. dependent var		42213.28
S.E. of regression	6649.729	Akaike info criterion		20.68873
Sum squared resid	1.19E+09	Schwarz criterion		20.82885
Log-likelihood	-307.3310	Hannan-Quinn criteria.		20.73356
F-statistic	570.8301	Durbin-Watson stat		1.060996
Prob(F-statistic)	0.000000			
Inverted AR Roots	.99			

Source: EVIEWS result analysis

Table (4) The regression estimate for the MA (0 1) process is ARIMA (101).

Dependent Variable: AREA		
Method: ARMA Maximum Likelihood (OPG - BHHH)		
Date: 10/20/20 Time: 18:59		
Sample: 1990 2019		
Included observations: 30		
Convergence achieved after 17 iterations		
Coefficient covariance computed using an outer product of gradients.		

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	130067.1	8645.389	15.04468	0.0000
MA(1)	0.945203	0.167528	5.642051	0.0000
SIGMASQ	5.28E+08	1.82E+08	2.906551	0.0072
R-squared	0.693277	Mean dependent var		130394.6
Adjusted R-squared	0.670557	S.D. dependent var		42213.28
S.E. of regression	24229.21	Akaike info criterion		23.19674
Sum squared resid	1.59E+10	Schwarz criterion		23.33686
Log-likelihood	-344.9511	Hannan-Quinn criteria.		23.24157
F-statistic	30.51367	Durbin-Watson stat		0.395306
Prob(F-statistic)	0.000000			
Inverted MA Roots	-.95			

Source: EVIEWS result analysis

Table (5) The ARIMA (1,0.1) model estimate was as follows:

Dependent Variable: D(AREA)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Date: 10/21/20 Time: 16:34				
Sample: 1991 2019				
Included observations: 29				
Failure to improve objective (singular hessian) after 169 iterations				
Coefficient covariance computed using an outer product of gradients.				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	**4430.372**	**1305.013**	**3.394887**	**0.0023**
AR(1)	**-1.000000**	**2.489772**	**-0.401643**	**0.6914**
MA(1)	**0.999943**	**0.001048**	**953.7239**	**0.0000**
SIGMASQ	**19287571**	**7927794.**	**2.432905**	**0.0225**
R-squared	**0.058397**	**Mean dependent var**		**4400.103**
Adjusted R-squared	**-0.054595**	**S.D. dependent var**		**4606.010**
S.E. of regression	**4730.072**	**Akaike info criterion**		**19.92418**
Sum squared resid	**5.59E+08**	**Schwarz criterion**		**20.11277**
Log-likelihood	**-284.9006**	**Hannan-Quinn criteria.**		**19.98324**
F-statistic	**0.516823**	**Durbin-Watson stat**		**1.896592**
Prob(F-statistic)	**0.674507**			
Inverted AR Roots	**-1.00**			
Inverted MA Roots	**-1.00**			

Source: EVIEWS result analysis

Where the variance is equal to $\Sigma(x - \bar{x})2/(n - 1)$

Diagnostic Checking

The diagnostic checking of the different models after evaluating them to identify the most appropriate model to describe the data under consideration makes it clear that all of the models fall within the 95% confidence interval for the three estimated models. This means that the auto-correlation between the limits of the random limit is not significant. Therefore, the three models are appropriate. However, after the comparisons of the three models, it turns out that the statistically significant model AR (1) P-value = 0. 00236 and MA (0,1) are statistically insignificant, while the ARIMA (1,0,1) model is statistically significant where P value = 0.00142. Hence, we conclude that ARIMA (1,01) is the most appropriate. On the other hand, we find that the ARIMA (1.0.1) model achieved more predictive accuracy than other models according to accuracy tests, which means it can be used in prediction. Table 6 shows the details:

Table (6)

ARMA (1,0,7)	MA(0,1)	AR(1,0)	Test
127.32	105.94	123.93	MSE
9.144	6.832	8.32	MAE
18.001	16.42	17.64	MAPE
-5.941	-5.111	-5.321	MPE

Source: EVIEWS result

Table 7 shows the expected values up to 2030 using the ARIMA model estimation (1.0.1).

Table (7) Area cultivated with Qat trees using ARIMA complex model (1,0,7) from 2020 to 2030.

Expected areas for cultivating Qat trees	Year
191523.	**2020**
195075.	**2021**
200383	**2022**
203936.	**2023**
209244.	**2024**
212797.	**2025**
218105.	**2026**
221657.	**2027**
226966.	**2028**
230518.	**2029**
235826.	**2030**

The above table illustrates the predicted cultivated areas of Qat during the years from 2020 to 2030.

Table (7) It illustrates the study results represented in predicting the cultivated areas of Qat tree from 2020 to 2030 in Yemen's republic. It can be noted from the table that there is a continued increase in the cultivated areas where it will be about 235826 during the year 2030. Another conclusion from this study is that three models are appropriate for cultivated areas prediction using the abovementioned Box Jenkins methodology. However, the most appropriate of these three models and most accurate is ARIMA (1,0,1).

Conclusions and recommendations

The ARMA model is the best predictive model, as the projected area was 235826 hectares.

The government and decision-makers should develop a strategic vision to limit the expansion of the Qat tree, which has harmful effects on the agricultural sector and groundwater depletion.

Encouraging farmers to grow coffee and cash crops, and providing all production requirements process to the marketing stage, to achieve an economic return equivalent to the economic return from the cultivation of Qat tree.

The decision-maker must reformulate plans and strategies for the agricultural sector.

The researcher recommends using the ARIMA method in studying economic and social variables and forecasting the future.

References

1. Nutt D, King LA, Blakemore C (2007). "Development of a rational scale to assess the harm of drugs of potential misuse." Lancet. 369, (9566): 1047–53. doi:10.1016/S0140-6736(07)60464-4. PMID 17382831.
2. CHEVALIER, A. (1949). "Les Cat's d'Arabie, d'Abyssinie et d'Afrique Orientale." Revue de Botanique appliquée 29: 413.
3. Abc: APT Ezekiel Gebissa, Leaf of Allah: Khat & Agricultural Transformation in Harerge, Ethiopia 1875-1991 p.84.
4. Catha Edulis E.notes latest retired DEC 13 2012 Copyright © 14 December 2011 at Wayback Machine website.
5. Yemen's khat habit soaks up water Alex Kirby BBC News Archived October 21, 2017, at the Wayback Machine website.
6. Ezekiel Gebissa, Leaf of Allah: Khat & Agricultural Transformation in Harerge, Ethiopia 1875-1991 p.90
7. Ezekiel Gebissa, Leaf of Allah: Khat & Agricultural Transformation in Harerge, Ethiopia 1875-1991 p.83
8. Yemen." Encyclopædia Britannica. Encyclopædia Britannica Online. Encyclopædia Britannica Inc., 2012. Web. Nov. 25, 2012

9. AB Yemen: Legal High Is 'Fueling Extremism' Sky News last retrieved DEC 13, 2012 Copy reserved March 04, 2016, at the Wayback Machine website.
10. AB: DEXTER FILKINS, Letter from Yemen, The NewYorker last retrieved Dec 2012 Copy reserved October 17, 2013, at the Wayback Machine website.
11. Michael Horton, Yemen's Dangerous Addiction to Qat The Jamestown Foundation last retrieved December 13, 2012, Copy Reserved May 29, 2016, at Wayback Machine website.
12. A documentary on the life of President Ali Abdullah Saleh, accessed December 13, 2012, on the YouTube website.
13. APC Yemen threatens to chew itself to death over a thirst for narcotic Qat plant last retrieved DEC. 13, 2012 Copy reserved April 16, 2013, at the Wayback Machine website.
14. ABC: Khat is the most widespread in Yemen and the Horn of Africa, copy reserved July 03, 2017, on Wayback Machine website.
15. Hassan NAGM, Junaid AA, El Khally FMY, Murray-Lyon IM. The subjective effects of chewing qat leave in human volunteers. p. 34–37
16. Al-Motarreb AL ،Al-Kebsi M, Al-Adhi B, Broadley KJ. Khat chewing and acute myocardial infarction. Heart 2002; 87: 279–280.
17. Junaid AA, Sumairi AA, Shidrawi RG, Al-Hanaki A, Al-Haimi M, Al-Absi S, Al-Huribi MA, Qirbi AA, Al-Awlaki S, El-Guneid AM, Shousha S, Murray-Lyon IM. Oesophageal and gastric carcinoma in the Republic of Yemen. British Journal of Cancer 1995; 71: 409–410
18. Heymann TD, Bhupulan A, Zuriekat NEK, Bomanji J, Drinkwater C, Giles P. Murray-Lyon IM. Khat chewing delays gastric emptying of a semi-solid meal. Aliment Pharmacol Ther 1995; 9: 81–83.
19. Drugs.com (1 January 2007). Complete Khat Info. Archived from the original on March 27, 2019.
20. "[1]", Ministry of Planning & International Cooperation. Poverty Reduction Strategy Paper (PRSP), 2002 Archived March 20, 2012, at the Wayback Machine website.
21. [http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20394806~menuPK:1192714~pagePK:64133150~piPK:64133175~theSitePK:239419~isCURL:Y,00.html] ", The World Bank Group GenderStats database of Gender Statistics Archived April 13, 2010, at the Wayback Machine website.
22. [http://www.al-bab.com/bys/articles/noman95.htmman", the British-Yemeni Society Education of Girls in Yemen, 2002}} [broken link] copy reserved March 8, 2015, at the Wayback Machine website.
23. The World Bank, 2008. "Secondary Education Development And Girls Access Project." Project Appraisal Document.pp1. (PDF). 2008. Archived from the original (PDF) on March 3, 2016.
24. "[The World Bank 2008 EdStats database]"
25. [2], The Republic of Yemen, Ministry of Education Report 2008. The Development of Education in the Republic of Yemen, 2008, copy reserved October 12, 2017, at the Wayback Machine website.

26. The World Bank, 2008. "Secondary Education Development And Girls Access Project." Project Appraisal Document.pp2. (PDF). 2008. Archived from the original (PDF) on March 3, 2016.
27. "[the Republic of Yemen, Ministry of Public Health and Population]," Yemen Multiple Indicator Cluster Survey 2006.pp110, The World Bank Secondary Education Development, And Girls Access Project.
28. Sayyaf R. Kamal H. 2014 (Forecasting the Future of Education in the District of Almadinah: Applying Time Series Analysis).
29. Allen, Geoffery,p. & Fildes, Robert, "Econometric Forecasting," Principles of Forecasting: A Handbook for Researchers and practitioners, Armstrong, J.Scott(ed): Norwell, MA: Kluwer Academic Publishers,2001.
30. Greene, William, Econometric Analysis, New York: Macmillan Publishing Company, Second Edition,1993.
31. Harvey, Andrew, the Econometric Analysis of Time Series, New York: Philip Allan Second Edition,1990.
32. http://www.eviews.com/Learning/index.html
33. Forecasting for Economics and Business: Gloria Gonzalez-Rivera, University of California Riverside, USA Eviews illustrated for Version 9, Richard Startz, University of California, Santa Barbara.

Appendices

Table No. (1) The most important indicators of agricultural production and food situation in Yemen (1990-2018)

2018	2017	2016	2014	2012	2011	2010	2005	2000	1995	1990	Unit	Statement
3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.09	%	Suitable land for planting to the total
1,093	1,173	1,351	1,499	1,501	1,412	1,580	1,201	1,143	1,157	1,194	1hectare	Cultivated land
167,4	166,6	169,4	168,8	167,7	162,6	159,7	123,9	102,9	88,9	76.0	One thousand hectares	Qat cultivated area
357	459	700	864	910	817	1013	496	672	810	767	One thousand hectares	The amount of grain produced locally
4,018	4,095	4,995	4,082	5,039	3,499	3,550	3,280	2,455	1,505	1,234	One thousand hectares	The number of imports of grains and milling products
3.2	4.1	5.5	7.2	5.9	7.9	9	3.7	6.5	11.5	13.1	%	Domestic production of wheat from the total
148	152.3	47.4	38	40.8	28.8	29.4	16.1	19.7	14.8	41.4	%	Food imports to total exports
3.2	4.1	5.5	7.2	5.9	7.9	9	3.7	6.5	11.5	13.1	%	Domestic production of wheat from the total
2,878	2,928	3,300	3,000	4,020	2,700	2,691	2,935	2,031	1,321	1,031	A metric ton	The number of wheat imports
1,93	1,69	1,25	0,94	0,88	0,77	0,89	1,11	1,7	2,6	2,7	%	Agricultural spending to the government

Table No. (19) Area of agricultural land and average per capita share of the land

Average per capita in hectares			Growth Rate	Irrigated		Growth Rate	Rainy		Growth Rate	Total cultivated land	Population	Statement
Of the total cultivated land	Of the Rain	Of the Rain										
Hectares	Hectares	Hectares	%	%	A thousand hectares	%	%	A thousand hectares	%	A thousand hectares	(Thousand people)	
0.10	0.02	0.08		20	236		80	958		1,194	11,970	1990
0.08	0.02	0.06	3.8	24	276	-1.0	76	880	-0.6	1,157	14,410	1995
0.07	0.04	0.03	18.1	55	629	-10.0	45	515	-0.2	1,143	17,461	2000
0.06	0.03	0.03	-2.1	49	593	2.4	51	609	1.0	1,201	20,283	2005
0.07	0.03	0.04	-2.3	44	695	2.0	56	885	5.6	1,580	23,584	2010
0.06	0.03	0.03	20.4	53	748	-16.1	47	664	-10.6	1,412	24,312	2011
0.06	0.03	0.03	-3.8	51	765	4.2	49	735	6.3	1,501	25,066	2012
0.06	0.03	0.03	-2.0	50	750	2.0	50	750	-0.1	1,499	25,843	2013
0.05	0.03	0.02	10.0	55	743	-10.0	45	608	-9.9	1,351	26,644	2014
0.04	0.03	0.02	9.2	60	704	-11.2	40	469	-13.2	1,173	27,470	2015
2.5	0.2	4.6			3.2			7.8		5.6	3.1	2005-2010
-2.1	2.1	-3.9			5.8			-0.4		1.5	3.6	1990-2010
-8.6	-2.7	-14.6			0.3			-11.9		-5.8	3.1	2010-2015

Source: Calculated by the researcher - Based on the statistics of the Central Bureau of Statistics

Table No. (18) Distribution of the Republic of Yemen's lands

Unit: in a million (hectares)

%	Area	Statement	م
45.2	21	Rocky desert land and urban	**1**
48.6	22.6	Pastoral lands	**2**
3.23	1.5	Forests and jungle lands	**3**
3.01	1.4	Invested Lands	**4**
100	46.5	Total	

Source: Agricultural Research Authority

Table No. (17) agricultural lands and their uses

2010-2015	2005-2010	90-2010	2015	2014	2013	2012	2011	2010	2005	2000	1995	1990	Measuring Unit	Statement
3.1	3.1	3.6	27,470	26,644	25,843	25,066	24,312	23,584	20,283	17,461	14,410	11,970	In a thousand	population
-	-	1.0-	45.61	45.61	45.61	45.61	45.61	45.61	45.61	45.61	45.61	55.500	Million hectares	Geographical area
-	-	-	1,630	1,630	1,630	1,630	1,630	1,630	1,630	1,630	1,630	1,630	Thousand hectares	Arable land
-	-	1.0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	2.9	%	Arable land to the total
5.8-	5.6	1.5	1,173	1,351	1,499	1,501	1,412	1,580	1,201	1,143	1,157	1,194	Thousand hectares	Cultivated area
0.3	3.2	5.8	704	743	750	765	748	695	593	629	276	236	Thousand hectares	Irrigated lands
6.4	2.3-	4.3	60	55	50	51	53	44	49.3	55.0	23.9	19.8	%	Irrigated to cultivated lands
11.9-	7.8	0.4-	469	608	750	735	664	885	609	515	880	958	Thousand hectares	Rainy lands
6.5-	2.0	1.9-	40	45	50	49	47	56	50.7	45.0	76.1	80.2	%	Rainy land to cultivated
3.0-	3.0-	4.5-	1.66	1.71	1.76	1.82	1.88	1.93	2.2	2.6	3.2	4.6	Hectare	Per capita geographical area
8.6-	2.5	2.1-	0.043	0.051	0.058	0.060	0.058	0.067	0.06	0.065	0.08	0.10	Hectare	Per capita cultivated area
1.4	4.1	3.3	309	298	298	297	291	288	236	227	191	157	Thousand hectares	Area of sustainable crops
7.4-	6.0	1.2	880	1,054	1,201	1,204	1,121	1,291	966	916	965	1,037	Thousand hectares	Area of seasonal crops

2010-2015	2005-2010	90-2010	2015	2014	2013	2012	2011	2010	2005	2000	1995	1990	Measuring Unit	Statement
1.7-	0.3	0.3-	75.0	78.0	80.1	80.2	79.4	81.7	80.4	80.1	83.5	86.9	%	Area of seasonal crops cultivated
8.3	2.6-	4.6	80	71	62	64	67	54	61.4	69	29	23	%	Irrigated to seasonal lands
55.6	34.9-	10.8-	456.7	278.8	130.6	129.0	218.3	50.1	428.6	486.6	473.4	435.8	Thousand hectares	Abandoned crop area
-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	Million hectares	Forest area
-	-	1.0	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	2.7	%	Forest area to the total
-	0.4-	0.1	22.6	22.6	22.6	22.6	22.6	22.6	23	23	22.8	22.4	Million hectares	Pasture area
-	0.4-	1.1	49.5	49.5	49.5	49.5	49.5	49.5	50.4	50.4	50.1	40.3	%	Pasture area to total area

Source: The Central Bureau of Statistics and the General Administration of Agricultural Statistics

Table No. (12) The food gap in value (thousand riyals)

2010 - 2016	2005 - 2010	2016	2014	2013	2012	2011	2010	2005	2000	1995	1990	البيان
3.8	20.2	281,832,324-	376,262,320-	340,565,470-	390,519,738-	286,080,233-	234,361,749-	93,373,899-	26,868,445-	18,551,800-	1,581,012-	مجموعة الحبوب
3.4	18.2	186,602,676-	226,251,848-	224,670,952-	282,620,434-	206,044,132-	157,569,352-	68,336,837-	12,472,129-	12,351,000-	805,876-	القمح والدقيق
3.8	22.1	26,566,043-	65,344,781-	33,543,629-	32,534,715-	28,909,639-	22,091,493-	8,138,689-	3,453,421-	1,442,900-	103,147-	الذرة الشامية
17.0	29.4	1,332,061-	2,078,587-	1,511,649-	1,194,850-	701,196-	608,733-	167,835-	2,588-	100-	39,923-	الذرة والدخن
4.5	26.5	67,331,544-	82,600,361-	80,858,280-	74,196,270-	50,488,609-	54,119,655-	16,717,171-	10,909,335-	4,747,600-	631,926-	الأرز
		-	13,257	19,040	26,532	63,342	27,484	13,368-	30,972-	10,200-	139-	الشعير
64.7-	41.1	3,929-	298,808	305,265	68,691-	108,599-	720,915-	128,865-	65,986	120,000-	15,312-	البطاطس
30.0	17.9	8,905,281-	5,827,923-	4,688,511-	4,375,925-	2,173,977-	2,396,468-	1,053,545-	1,042,997-	-	-	جملة البقوليات

2010 - 2016	2005 - 2010	2016	2014	2013	2012	2011	2010	2005	2000	1995	1990	البيان
3.8	27.6	5,334,296-	18,751,145-	6,296,860-	4,679,528-	1,861,129-	4,429,946-	1,309,686-	539,531	184,900	141,302	جملة الخضر
37.1-	14.7	313,985	278,823	3,133,796	4,972,970	4,161,406	3,193,608	1,611,157	1,380,689-	1,819,500-	107,128-	جملة الفاكهة
20.5-	18.9	22,699,844-	90,227,437-	78,712,980-	95,654,390-	103,558,456-	71,451,993-	30,049,969-	15,520,905-	8,994,200-	1,272,427-	السكر(مكرر)
7.6-	85.5	45,493,875-	74,046,838-	51,227,635-	51,995,120-	39,256,338-	67,564,591-	3,076,809-	14,032,827-	8,118,000-	450,507-	جملة الزيوت والشحوم
10.7-	12.4	23,190,831-	54,151,198-	52,495,949-	44,428,919-	36,053,470-	40,835,844-	22,719,735-	9,897,229-	3,657,200-	365,859-	جملة اللحوم
15.2-	12.7	595,602-	1,903,197-	1,941,033-	1,367,076-	908,061-	1,361,124-	748,903-	520,447-	811,200-	215,551-	لحوم حمراء
10.6-	12.4	22,595,229-	52,248,001-	50,554,916-	43,061,843-	35,145,409-	39,474,720-	21,970,832-	9,376,782-	2,846,000-	150,308-	لحوم بيضاء
15.3-	16.5	18,852,177	36,835,340	57,292,573	40,778,542	48,767,239	43,300,454	20,174,694	2,955,533	370,202	162,310	الأسماك
		61,317-	232,126-	341,909	299,656-	651,606	300,743	8,903-	657,594-	860,000-	165,467-	البيض
0.6	8.3	49,784,428-	83,010,010-	64,660,767-	61,397,984-	41,849,931-	48,203,101-	32,420,782-	8,252,112-	2,318,700-	463,661-	الألبان ومنتجاتها
0.24-	21	418,139,961-	665,096,025-	537,574,630-	607,668,439-	457,361,881-	423,169,802-	162,356,342-	74,091,747-	43,884,298-	4,117,762-	الف ريال
0.19	18	1,945,833-	3,095,053-	2,501,627-	2,834,936-	2,139,204-	1,927,090-	848,168-	458,120-	438,843-	295,816-	الف دولار

Source: Calculated by the researcher - tables of the main commodity balances based on statistics of the Central Bureau of Statistics