The Influence of Price and Non-Price Factors on Maize Supply in Iraq: An Econometrical Analysis

Najlaa Salah Madlul, Rosni Bakar & Zulkarnain Lubis

1 School of Business Innovation & Technopreneurship University Malaysia Perlis, Malaysia.
2 Agricultural Economy, College of Agriculture, Tikrit University, Salah Alden, Iraq.
3 Universitas Medan Area, JalanKolam No.1, Medan Indonesia.

Abstract: Maize is one of the most important crops in Iraq, being both the major feed grain for livestock and the primary staple food crop for the majority of the Iraq population. Furthermore, the maize industry contributes substantially to employment, manufacturing, foreign exchange and food security. The importance of maize in contributing to national growth is critical; this makes it meaningful to investigate the nature of maize farmers’ production decisions. This study quantifies the supply response of maize farmers to price and non-price factors in Iraq using econometric techniques. The non-price factors considered in this study are land usage, technology, rainfall, production lagged one year and siege. A modified Nerlovian partial adjustment model was applied on historical time series data spanning from 1986-2015 to estimate the supply response of maize in Iraq. To deal with the expected problems associated with time series data the study adopted several diagnostic tests. Results indicate a short-run supply elasticity and a long-run supply elasticity are inelastic, signifying that maize farmers are less sensitive to price changes. The results confirm that price factors seem to have more effect on maize supply in Iraq. These findings coincide with those obtained in supply response studies for field crops conducted in other developing Iraq countries. The study also showed that non-price factors such as, rainfall, production lagged one year, technology and land usage have a positive impact on maize production. Given the findings, the study recommends policies that focus more on non-price factors as a means of stabilising maize production. The study also recommends that Industry stakeholders and policymakers should find means to integrate the significant relationships between non-price factors and production output into future decisions and marketing policies to safeguard a healthy, growing and sustainable maize industry in Iraq.

Keywords: Maize, price factors, non-price factors, Nerlovian, Supply.

1. Introduction

The economic of Iraq depends heavily on agriculture which provides the main source of food income and employment especially to the rural population. In Iraq, agriculture plays an important role in the economy as it employs about 60-70% of the population and contributes to about 30% of the Gross Domestic Product (GDP) (Iraqi central Statistical Organization, 2015). Therefore, achieving higher growth in the agricultural sector is of utmost concern especially in the face of rising incomes and increasing population growth. Furthermore, formulating agricultural policies targeted at increasing production is critical to meet this rising demand. However, agricultural growth in the recent past has been declining. It is therefore important to understand farmers’ production decisions in order to inform policy.

According to Mamingi (1997) agricultural supply mainly in the form of area expansion is determined by agricultural price and non-price factors. Price is very important in determining farmers planting decisions as it provides incentives for them to increase production. Hence in order to meet the rising demand and bring about sustained and balanced economic growth, it is paramount to understand the effect of prices on production supply. Also, non-price factors such as good weather conditions and improving technological and institutional frame leads to shifts in the supply function. This is particularly so, for developing countries where various studies (Patel and Singh, 1994, Dixit, et al., 1998) have shown that farmers response behaviour are influenced more by non-price factors. Among the staples grown in Iraq, maize has been identified as one of the most important within
the grains and cereals family. It is cultivated on more than, 378,061 hectares and across all agro ecological regions in Iraq (Central Statistical Organization, 2015).

As for Iraq, maize is regarded as one of few major economical crops of the country, rating fourth next to wheat, barley and rice. The acreage exploited for growing this crop fluctuates up and down from one year to the next. In 2013, a total of 798,099 acres were exploited, producing around 831,299 tons of maize crop, but this figure soon dropped down in 2014 to 378,061 acres while the production size jumped to 289,288 tons (FAO, 2014). Out of all Iraqi provinces, Babylon comes first as per the acreage used for growing corn crop (Mahdi, 2009).

Iraq is one of the developing countries that import maize in gross amounts to cover the local needs of this crop although its global prices are high. It is worth noting that the areas used to grow this crop had been seeing a lot of changes due to price factors and non-price factors fluctuation (Abbas and Al ukeili, 2015).

Statistics have been reflecting that the areas of plantation of this product increase in some year’s and decrease in others (Iraqi central Statistical Organization, 2015), this is clearly depicted in Fig 4.1. Another observation is that the siege imposed on Iraq from 1990 till 2003 has led to a downfall in the self-sufficiency of this crop. Most of the discourse on Iraq tended to focus on the comprehensive economic siege which the United Nations Security Council (UNSC) had imposed on Iraq in 1990. The siege had effectively shut off 90 percent of Iraq's imports and 97 percent of its exports and produced serious disruptions to the economy and hardships to the people (The New York Times 6 December 1990).

The siege had immediate impact on food availability in Iraq since the country's imported food dependency was 70-80 percent of total caloric intake. The siege -caused food shortages resulted in sharp increases in food prices ranging from 200 to 1800 percent by between August and November 1990 (Provost 1992). This concern with the embargo should not be surprising given its catastrophic effects on the people of Iraq and the economy and its contribution to the rise and persistence of humanitarian emergency in Iraq (Vayrynen, 1998).

2. Background of the Study
A considerable number of studies have focused on agricultural supply response to price and non-price factors with wide range of crops over the years. More importantly, expanding cultivated area is a viable option for increasing production (Molua, 2010).

Understanding how producers make decisions to allot acreage among crops and how decisions about land use are affected by changes in prices and their volatility is fundamental for predicting the supply of staple crops and, hence, assessing the global food supply situation (Haile et al. 2013). The production decisions of farmers are dependent on various policies of the government. Price policy, among the others, is the most important one. That is, farmers would allocate their limited land resources to that crop enterprise towards which the relative price movements tend to be favourable. This is however, quite logical and rational as the allocation of land to a better- priced crop would fetch more revenue to farmers. Responsiveness of farmers to economic incentives such as price could influence contribution of agriculture to economy (Mushtaq & Dawson, 2002). One of the most important issues in agricultural economics is acreage response. Since the responsiveness of farmers to economic incentives largely determines agriculture’s contribution to the economy. The gap between planting and harvest guarantees that agricultural producers do not know in advance what price they will receive for their product and the random nature of production ensures that producers do not know in advance what their output (yield) will be. The knowledge on the extent to which agricultural sector responds is not only important in understanding the dynamics of production, but also for planning public programmes, mindful of the producer behavior and response to prices (Mckay et al. 1999). The crucial factors responsible for farmers’ area allocation behavior are expected price (based on previous years price), price of competing crop, yield, weather climatic conditions, area, technology etc. The pioneering work of Nerlove (1958) on supply response enables one to determine short run and long run elasticities; also it gives the flexibility to introduce non-price shift variables along with price. Very little analytic research as per the knowledge of this researcher has been carried out on acreage response of maize growers in Iraq (Mushtaq & Dawson, 2002; Nosheen & Iqbal, 2008). Thus there is an intense need to study production response of maize growers to price and non- price factors in Iraq to give an insight to policy makers for allocation of land and production of maize in Iraq. Production response to price and non-price incentives is of considerable importance for devising suitable policy and planning development programmes for the agricultural sector of an economy. Moreover, reliable estimates of production response of maize growers are of greater importance for predicting accurately the farmers’ responsiveness towards the price and non-price factors and for formulating programmes consistent with national requirement of food and fodder. This study is...
important because it will assist policy analysts in managing area allocation to maize in this province.

The objectives of the study are:
- To quantify Iraq maize supply response to changes in the price factors.
- To estimate the maize supply response to changes in the non-price factors.
- To determine the short and long-run price elasticity’s of maize supply in Iraq.

The remainder of this paper is organized into three sections. Section 2 is devoted to data and methodology. Section 3 presents, results and discussion. Section 4 concludes this study with some recommendations.

3. Descriptive statistics

Table 4.2 shows the statistical properties of the data used in the maize supply function. The mean, standard deviation, maximum and minimum of the variables of the model are presented in the specified time frame. On average, 294556.03 tonnes of maize are produced yearly with an average standard deviation of 173010.78 tonnes. The average real producer price of maize is 268.41 dinars/kg with a standard deviation of 244.74 dinars/kg. The average maize acreage is 470761.97 dunum with a standard deviation of 203971.12 dunum. The average annual rainfall is 2884.33 mm with a standard deviation of 932.98 mm per year. Table 4.2 shows the original statistical properties of the variables of the maize supply model. The transformation of data into logarithmic form ensures that the errors are normally distributed.

### Table 1: Statistical properties of the original data

<table>
<thead>
<tr>
<th></th>
<th>Total Land (Dunum)</th>
<th>Production (tons)</th>
<th>Productivity (kg)</th>
<th>Price (dinars/kg)</th>
<th>Rainfall (Mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mean</strong></td>
<td>470761.97</td>
<td>294556.03</td>
<td>594.49</td>
<td>268.41</td>
<td>2884.33</td>
</tr>
<tr>
<td><strong>standard deviation</strong></td>
<td>203971.12</td>
<td>173010.78</td>
<td>145.74</td>
<td>244.74</td>
<td>932.98</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>885242</td>
<td>831299</td>
<td>1041.6</td>
<td>700</td>
<td>5029.5</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>123300</td>
<td>53100</td>
<td>145.74</td>
<td>0.3</td>
<td>1467.4</td>
</tr>
</tbody>
</table>

4. Total Land

Table 1 illustrates that total area of maize crop during the study period rated to an average of 470761.96 dunum, with a maximum fluctuation in area of 885242 dunum in 1998, the minimal area being 123300 dunum in 1986. The increase in cultivated areas for this crop can be attributed to state legislations aiming at increasing production while the downfall of areas noticed in 1986 is attributed to the state declining receipt of maize crop from the farmers or perhaps to prices weakly responding to production, which marks production being very susceptible to technical and climatic factors, and high competition with other grains crops being more predominant than prices and their consequences on production. This is clearly depicted in Fig.1.

The figure shows that the acreage exploited for growing this crop fluctuates from one year to the next. In 2013, a total of 798,099 acres were exploited. There was a slight increase during 1986-2015 i.e., about 2.7% due to expanding measures because of technological advances such as the adoption of new varieties, greater application of fertilizers and irrigation. However, this figure soon dropped in 2014 to 378,061 acres. This has been linked to various factors such as reduced...

5. The Production

Table (1) shows that maize crop production in Iraq during the study period averaged to 294556.03 tons. There was a slight increase during 1986-2015 due to expanding measures. Maximum production was in 2013 reaching 831299 tons in contrast with the lowest production level in 1986 being 53100 tons. This can be noticed from this figure:

![Figure 2: Iraqi production of Maize crop in Iraq During (1986-2015).](image)

The figure shows that maize production has been showing a fluctuation trend, an increase in some years and decrease in other. There was a slight increase during 1986-2015 about 4.6%. Maximum production was in 2013 reaching 831,299 tons due to expanding of land usage. Soon, however, the level of production declined during 2014 to reach 289,288 tons, this has been linked to various factors such as reduced productivity, government policies such as ESAP, unstable macroeconomic environment, the wars in Iraq in 1995, 2003, 2014, 2015 and the pricing policy that all led to Iraqi farmers feeling reluctant to grow maize, eventually leading to decreasing the acreage of this product and therefore, decrease maize production.

6. Rainfall variability

Rainfall is a key determinant of maize supply in developing countries. In Iraq rainfall varies from season to season fluctuating above and below average. Below is a graphical presentation of the standardised rainfall series from 1986 to 2015.

![Figure 3: Standardised rainfall series from (1986 - 2015).](image)

7. Maize Prices

Figure 4 shows a rising maize price trend over time. However, the price of maize was almost stagnant at a very low price from 1986-1995. From there onward, the price of maize showed an increasing trend. Farmers respond in different ways to increasing and unstable maize prices as well as other non-price factors such as weather. This is because higher maize price variability and inconsistencies in of non-price factors all pose a risk to producer’s investment. The use of high priced agricultural inputs such as inorganic fertilizer and hybrid seed is intensified with better crop prices as the farmers perceive profits. This, therefore, entails that low market prices may contribute to low use of these agricultural inputs.

The degree of responsiveness to both market and non-market factors requires empirical research in order to substantiate existing theoretical frameworks that have been developed and adopted to explain the dynamics of supply response in agriculture (Albayak, 1998). In Iraq, this is the case in that there is the assumption that price and non-price factors influence maize donum response but there is the lack of robust empirical evidence to support the assumption. This study, therefore, aimed to understand how maize farmers respond to prices and non-price factors using empirical evidence.
Measures the speed of adjustment and due to economic and non-economic factors like


Figure 4. Standard Figures for maize crop prices in Iraq during (1986 -2015).

7. Research Method

This study was conducted in Iraq. Data for the identified variables were collected from various published sources. Data regarding maize yield, maize land, and maize price were obtained from Agriculture Statistics of Iraq for the years 1986 to 2015. Data on rainfall were collected from Iraq metrological department. The following techniques from simple means to the use of econometric modeling applied for data analysis. The Durbin h statistic, augmented dickey fuller test and ordinary least square regression (OLS) were performed (Stata). Nerlove (1958) introduced the idea of partial adjustment suggesting that since it takes a while for equilibrium to occur, therefore only a partial adjustment takes place within a unit time period. The delay occurring in the equilibrium could be due to many reasons including consumer preferences, which takes a while to change; production already took place and needs to be disposed off.

8. The Nerlovian model

Of all the econometric models used to estimate agricultural supply response, the Nerlovian model is considered one of the most prominent and effective, judged by the large number of studies which utilise this approach (Leaver, 2003). The pioneering work of Nerlove (1958) on supply response enables one to determine short run and long run elasticities; also it gives the flexibility to introduce non-price shift variables in the model. The partial adjustment lagged model is considered appropriate for crop producers and is widely used by researchers like Rao (1989), Belete (1995), Leaver (2003), Wasim (2005), Mythili (2008), to measure the producers behaviour. The basic form of the Nerlovian model for an annual crop consists of the following three equations.

\[ Y_t^* = b_0 + b_1 P_{t-1}^* + b_2 X_{t-1} + V_t \]

\[ P_t^* = P_{t-1}^* + \beta (P_{t-1} - P_{t-1}^*) \]

\[ Y_t - Y_{t-1} = \lambda (Y_{t}^* - Y_{t-1}) \]

Where:

- \( Y_t \) = actual Production of maize in time t.
- \( Y_t^* \) = desired Production of maize at time t
- \( P_t \) = actual price at time t,
- \( P_t^* \) = expected price at time t,
- \( X \) = other observed, non-economic factors affecting supply at time and are labelled the expectation and adjustment coefficients respectively.
- \( V_t \) = disturbance term

Nerlove (1958) adjustment model postulates that the desired Production is a function of ‘expected normal price,’ while the actual area adjusts to the desired Production with some lag. Equation 1 is a behavioural relationship, stating that the desired output of maize depends upon the relative prices in the preceding year. According to Seay et al (2004), equation 3 states that the current maize Production \( Y_t \) will move only partially from the previous position to the target level \( Y_t^* \). The amount of the adjustment of maize farmers to various factors between time \( t \) and \( t-1 \) is equal \( \lambda \left( Y_t^* - Y_{t-1} \right) \).

\( \lambda \) Measures the speed of adjustment and assumes values from 0 to 1. It is interpreted as the coefficient of adjustment which characterises the fact that there are limitations to the rate of adjustment of \( Y_t \) due to economic and non-economic factors like technological constrains, weather variability, prices and various inflexibilities. Relations with Equation 1 and Equation 3 give the reduced form which eliminates the unobserved variable by an observed variable \( Y_t^* \). By eliminating these variables, the estimating or the reduced form Nerlovian equation is achieved.

The reduced form equation is given by:

\[ Y_t = b_0 + b_1 P_{t-1} + b_2 Y_{t-1} + b_3 X_t + V_t \]

Where:

\[ b_0 = \lambda \beta_0, b_1 = \lambda \beta_1, b_2 = 1 - \lambda, b_3 = \lambda \beta_3, V_t = \lambda V_t \]

The model used for this study is based on economic theory and previous work done in the field of supply response for field crops. However, it is not always possible to estimate a model suggested by theory, because it is not always possible to include all the variables initiated by theory due to the non-availability of data and quantification problems. The supply model used in this particular study is based on supply models for field crops used by Belete (1995), Leaver (2003) and Mythili (2008). The models used by these research studies were used as a framework for constructing a maize supply model for this study. Ordinary Least Squares (OLS) technique was used to estimate the parameters of the models. The estimation of the Nerlovian model may result in residuals that violate the assumption of normality of the error terms (Leaver, 2003). To ensure normality of the residuals, the estimating equations used in this study were expressed in logarithmic form. The transformation is acceptable because it ensures that the errors are both homoscedastic and normally distributed (Maddala, 2001). An additional benefit of using the logarithmic form is that the coefficient of the price variable can be directly deduced as the short-run supply elasticity.

To estimate the impact of price and non-price factors on changes in maize output this study uses production response functions. The simplified production response function is computed as follows:

\[
\ln Y_{mt} = \alpha + b_1 \ln P_m + b_2 \ln P_{m(t-1)} + b_3 \ln Y_{m(t-1)} + b_4 \ln A_{m(t-1)} + b_5 \ln \hat{p} + b_6 \ln R + b_7 D + b_8 T
\]

Where:
- \( Y_{mt} \) = Production of maize in time \( t \) (dunum).
- \( P_m \) = Maize price (Dinar/kg).
- \( P_{m(t-1)} \) = One year lag price of maize (Dinar/kg).
- \( Y_{m(t-1)} \) = Yield of maize with one year lag (Ton/Dunum).
- \( R \) = Average rainfall in mm with one year.
- \( A_{m(t-1)} \) = Area under maize with one year lag (Dunum).
- \( \hat{p} \) = Price risk.
- \( D \) = Dummy variable (the siege).
- \( T \) = Technology
- \( \ln \) = Natural log.

10. Estimation of Short Run and Long Run Elasticities

The coefficients of log model give short run elasticities of the corresponding variables. The long run elasticity can be derived as follows:

\[
EL = \frac{ES}{\lambda}
\]

Where:
- \( EL \) = Long run elasticity
- \( ES \) = Short run elasticity
- \( \lambda = 1 – \) coefficient of lagged dependent variable
- \( \lambda = \) Adjustment coefficient and \( 0 \leq \lambda \leq 1 \), is the speed of adjustment

11. Detection of Autocorrelation

Usual Durbin-Watson test for serial correlation is inappropriate for models including a lagged dependent variable as an explanatory variable, there is always a greater likelihood of autocorrelation in autoregressive models than the d-statistic test would suggest. The combination of autocorrelation and lagged dependent variable results in biased parameter estimates because the error term is correlated with a regressor. For such models, called autoregressive models, Durbin has developed the so-called h statistic to test the first order autocorrelation which is defined as follows (Gujarati & Porter, 2009).

\[
h = p \sqrt{\frac{1}{1-n} \left[ \text{var}(a) \right]}\]

\[
p = 1 - \frac{1}{2} d
\]

\[
d = \text{Durbin Watson value (DW)}
\]

\[
\text{var}(a) = (se)^2
\]

-1.96 ≤ h ≤ 1.96

Where \( n \) is total number of sample, \( a \) is the variance of the coefficient of the lagged dependent variable, \( se \) is the standard error and estimate the first order autocorrelation. If the value of Durbin statistic is in between -1.96 and 1.96 then there will be no autocorrelation.

12. Detection of Stationarity/ non-stationary

By stationarity we mean that the variance of data is constant i.e. there is homoscedasticity in the data. If a non-stationary time series is regressed on another non-stationary time series it may create a spurious regression. To avoid this problem, the data...
has to be transformed from non-stationary to stationary. There are two methods to make the data stationary; 1) if a time series has a unit root problem, take the first difference of such time series to make it stationary. This is called difference stationary process and 2) to regress such a non-stationary time series on time and it will become stationary. This process is called trend stationary process. The terms unit root, nonstationarity, random walk and stochastic trend can be treated as synonymously. For the detection of stationarity, ADF test was applied (Gujarati & Porter, 2009).

### 13. Results and Discussion

The logarithmic form of the Nerlovian model was estimated in E-views 9 using ordinary least squares. Although this approach does not require the pre-testing for unit roots, we follow the general times series procedure and test the variables for unit roots. The data series on maize production, the real price of maize, maize price lagged one year, rainfall, price risk, production of maize lagged one year and the land usage were tested for unit root for the study period 1986-2015. The Augmented Dickey-Fuller test was used for this test with the optimal lag length chosen on the basis of the Schwarz Bayesian Criterion. The unit root test results are presented in table 3.

#### Table 2: The results of trend equations of the total land, production, productivity, prices and rainfall in Iraq during (1986-2015).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Equation</th>
<th>T</th>
<th>R²</th>
<th>F</th>
<th>growth rate%</th>
<th>Test of Normality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Land</td>
<td>Ŷ = 321446.5 + 9332.2x</td>
<td>2.46*</td>
<td>0.63</td>
<td>6.06*</td>
<td>2.7*</td>
<td>0.365</td>
</tr>
<tr>
<td>Production</td>
<td>Ŷ = 136243.8 + 9894.5x</td>
<td>3.3**</td>
<td>0.72</td>
<td>10.7**</td>
<td>4.6**</td>
<td>0.425</td>
</tr>
<tr>
<td>Productivity</td>
<td>Ŷ = 423.2 + 10.7x</td>
<td>4.8**</td>
<td>0.75</td>
<td>23.3**</td>
<td>1.8**</td>
<td>0.326</td>
</tr>
<tr>
<td>Prices</td>
<td>Ŷ = 124.5 + 24.6x</td>
<td>12.**</td>
<td>0.83</td>
<td>144**</td>
<td>26.8**</td>
<td>0.725</td>
</tr>
<tr>
<td>Rainfall</td>
<td>Ŷ = 2310.6 + 23.9x</td>
<td>3.01*</td>
<td>0.69</td>
<td>9.02*</td>
<td>1.4*</td>
<td>0.236</td>
</tr>
</tbody>
</table>

**Significant at the 1% level *significant at the 5% level.

#### Table 3: Results of unit root tests at levels

<table>
<thead>
<tr>
<th>Series</th>
<th>ADF test statistic</th>
<th>Critical value</th>
<th>Lag length</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ly&lt;sub&gt;m&lt;/sub&gt;</td>
<td>6.241052</td>
<td>4.323979</td>
<td>0</td>
<td>0.0001</td>
</tr>
<tr>
<td>Lm</td>
<td>5.013602</td>
<td>4.323979</td>
<td>0</td>
<td>0.0026</td>
</tr>
<tr>
<td>Lp</td>
<td>5.241367</td>
<td>4.323979</td>
<td>0</td>
<td>0.0012</td>
</tr>
<tr>
<td>LR</td>
<td>7.542542</td>
<td>4.323979</td>
<td>0</td>
<td>0.0000</td>
</tr>
<tr>
<td>LP&lt;sub&gt;m-1&lt;/sub&gt;</td>
<td>5.310667</td>
<td>4.323979</td>
<td>0</td>
<td>0.0010</td>
</tr>
<tr>
<td>Lp</td>
<td>4.402973</td>
<td>4.323979</td>
<td>0</td>
<td>0.0083</td>
</tr>
<tr>
<td>Ly&lt;sub&gt;m-1&lt;/sub&gt;</td>
<td>6.071328</td>
<td>4.323979</td>
<td>0</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Critical value at 1%
All variables are in log form. The ADF method test the hypothesis that Ho: X~ 1(1), that is, has unit root (non-stationary) against H0: X~1(0), that is, no unit root (stationary). The critical values for the rejection of the null hypothesis of unit root are all significant at 1%. $L_y^m$ denotes log of yield, $L_A$ denotes log of area planted, $L_p^m$ denotes log of maize price, $LR$ denotes log of rainfall, $L_{p_{m-1}}$ denotes log of maize price lagged one year, $L_{\hat{p}}$ denotes log of price risk and $L_{y_{m-1}}$ denotes log of maize yield lagged one year. The results of the unit root tests showed that all variables are stationary at levels as after first differencing, shown in table 4.4. The results indicate rejection of the null hypothesis. Consequently, co-integration test is necessary to establish a long run relationship between the supply of maize and the other variables in the model.

16. Co-integration analysis

Co-integration was done to test for the long run relationship between two or more variables. The method that was used to test for co-integration is called the Engle and Granger Method which is based on OLS and tests for the long-run relationship between two time-series variables. If there is co-integration the residuals should be stationary. To test the residues for stationarity Dickey-Fuller method was used and the errors were found to be stationary. This would imply that there was a long run relationship among variables. This is shown clearly in table 4 below where the t statistic value 4.97 is more than the Mackinnon table values 3.96. A one on one co-integration analysis can be done to see if each variable is co-integrated to the other. However, the long run model was run and the residuals were tested for stationarity and found to be stationary implying the presence of co-integration among the variables. The results of the co-integration analysis are shown in table 4.

### Table 4: co-integration results

<table>
<thead>
<tr>
<th>Delay Optimization Level</th>
<th>t Statistic</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.45</td>
<td>4.97**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.79</td>
</tr>
</tbody>
</table>

** Significant at the 1% level. The Mackinnon table values 3.96.

The maize series was tested for co-integration to examine whether existence of a long-run relationship between the variables on maize supply. The results of the co-integration test evidently confirm that existence of a long-run relationship between the variables on maize supply as the t statistic value of 2.97 is significant at 1% level thus, rejects the null hypothesis. So the estimated parameters do not contain any unit roots.

17. Variance Inflation Factor Test

The Variance Inflation factor Test was conducted in order to test the model for Multicollinearity problems and the results were showed no sign of Multicollinearity problem. The results were realized as the VIF- value less than 100.

18. Autocorrelation Test

The value of Durbin $h$ statistic is 1.20 found within the given range that is $-1.96 \leq 1.20 \leq 1.96$ which ensured that the data is not plagued with the problem of serial-autocorrelation.

19. Spearman’s Rank Correlation Test

In the present study, the significance of linear bivariate relationship between the independent variables of maize price, maize price lagged one year, land usage lagged one year, maize production lagged one year, price risk, rainfall, the siege and technology and the dependent variable of maize production was measured with the help of Spearman’s correlation analysis. Tables 4 display the results of the analysis. The correlation analysis was primarily conducted to determine the relationship strength between each independent variable and the dependent variable.
Table 4.6: Spearman’s Rank Correlation Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>A</th>
<th>( p_m )</th>
<th>( p_{m-1} )</th>
<th>( R )</th>
<th>( y_{m-1} )</th>
<th>( \hat{\sigma}p )</th>
<th>( T )</th>
<th>( Y_m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( p_m )</td>
<td>*0.22</td>
<td>1</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( p_{m-1} )</td>
<td>*0.18</td>
<td>*0.08</td>
<td>1</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( R )</td>
<td>*0.09</td>
<td>*0.16</td>
<td>*0.07</td>
<td>1</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( y_{m-1} )</td>
<td>*0.16</td>
<td>*0.19</td>
<td>*0.15</td>
<td>*0.13</td>
<td>1</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( \hat{\sigma}p )</td>
<td>*0.11</td>
<td>*0.25</td>
<td>*0.16</td>
<td>*0.26</td>
<td>*0.13</td>
<td>1</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>( T )</td>
<td>*0.14</td>
<td>*0.23</td>
<td>*0.08</td>
<td>*0.12</td>
<td>*0.14</td>
<td>*0.07</td>
<td>1</td>
<td>---</td>
</tr>
<tr>
<td>( Y_m )</td>
<td>*0.17</td>
<td>*0.24</td>
<td>*0.16</td>
<td>*0.21</td>
<td>*0.28</td>
<td>*0.22</td>
<td>*0.29</td>
<td>1</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level

** Significant at the 1% level. Durbin-\( h \) statistic = 1.20

Note: All variables except technology and siege are in logarithmic form.

### 20. Maize supply response

Two common output variables can be used in estimating the maize supply response. These are yield and area planted. The logarithmic form of the yield response function was estimated in spss using ordinary least squares method. Table 6 provide the estimates of the yield response function.

Table 6: Regression results for supply response of maize in Iraq

(Independent Variable = Log production)

<table>
<thead>
<tr>
<th>Dependent variable: L production</th>
<th>Coefficient</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations = 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanatory variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>23.9</td>
<td>4.59**</td>
</tr>
<tr>
<td>( LnP )</td>
<td>0.45</td>
<td>5.36**</td>
</tr>
<tr>
<td>( LnP_{m-1} )</td>
<td>0.34</td>
<td>5.96**</td>
</tr>
<tr>
<td>( LnA_{m-1} )</td>
<td>0.84</td>
<td>4.69**</td>
</tr>
<tr>
<td>( Lny_{m-1} )</td>
<td>0.08</td>
<td>4.86**</td>
</tr>
<tr>
<td>( Ln\hat{\sigma}p )</td>
<td>0.11</td>
<td>3.86**</td>
</tr>
<tr>
<td>( D )</td>
<td>-0.06</td>
<td>-5.38**</td>
</tr>
<tr>
<td>( T )</td>
<td>0.06</td>
<td>4.56**</td>
</tr>
<tr>
<td>( LnR )</td>
<td>0.87</td>
<td>5.69**</td>
</tr>
</tbody>
</table>

Adjusted \( R^2 = 0.89 \)

Durbin -Watson = 2.19

\( F = 76.69 \)

### 21. Findings

The yield response function was used as the basis of our maize supply response analysis. With this in mind, we assume that maize farmers in Iraq respond to price changes to some degree by intensive application of inputs besides extending the area. The model estimated contains production of maize as depended variable with maize price, price lagged one year, maize production lagged one year, rainfall, land usage lagged one year, price risk, technology, and the siege as explanatory variables (see table 6).

The size of the adjusted coefficient of determination (adjusted \( R^2 \)) and the \( F \)-value is highly statistically significant at 1 percent significant level; the F-statistic shows the supply model’s goodness of fit. Based on the volume of the adjusted coefficient of determination, the explanatory variables explain 86 percent of the variation in the dependent variable. The result showed that all hypotheses are accepted in this study.

#### 21.1 Effect of price on the maize supply.

The effect of price was tested against maize supply; the coefficient of the price variable has a positive sign with the value of 0.45 and is significant
at the 1 percent level signifying that a price increase will be followed by an increase in production of maize in the following period. There is a significant response of yields to prices. Thus, if price is good, farmers will continue to grow the crop. Result is similar to that of Bailey and Womack (1985), Bhowmick and Ahmed (1993), Mesfin (2000), El-Batran (2003), Alemu et al. (2003), Rao (2003), Alemu et al (2003), Leaver (2004), Mahmood et al. (2007), Muchapondwa (2009), Ogazi (2009), Molua (2010), Bakr (2010), Bhatti et al. (2011), AL Ubaidi (2013) and Shoko (2014) who observed that the price factor is a significant variable explaining production changes. However, it opposes the finding of Gulati and Kelley (1999).

21.2 Effect of price lagged one year on the maize supply

The effect of Price lagged one year was tested against maize supply; the results indicate a positive relationship between the two variables. The estimate maize price lagged one year the positive coefficient of maize price lagged one year 0.34 in the production equation bears significant relationship with maize production, This behaviour can be assigned to the fact that producers’ are assumed to include past production experiences when forming production expectations. This result agree the observation of Mahmood (2010), Bakar (2010), AL Ubaidi (2013).

21.3 Effect of One Year Lagged production on the maize supply

Production lagged once is suggesting that an increase in production in one period will be followed by an increase in production in the next period. This tends to confirm the hypothesis of Nerlove's partial adjustment model; farmers do not adjust their yield instantaneously to changes in prices and technology. Rather, they adjust to the optimum yield level over time. These results agree with findings obtained by Alemu et al (2003) and Ogazi (2009) whose studies that have been conducted in this field. The coefficient of lagged yield is 0.29 which is significant at 1 percent level.

21.4 Effect of Price Risk on the maize supply.

The effect of price risk was tested against maize production, the coefficient of the price risk is positive and significant at 1 percent level, and the results showed that the farmers have the ability to bear the risk of price. The low price risk coefficient value indicates that maize producers may be trepidation, to government policy fluctuation in Iraq which results in the change on prices. These results agree with findings obtained by AL Ubaidi (2013).

21.5 Effect of Land Usage lagged one year on the maize supply.

The effect of land usage lagged one year was tested against maize production; the results indicate a positive relationship between the two variables, the coefficient of the land usage 0.84 is statistically significant at 1% level with positive sign. This implies that if land usage is increased by 1 cent it will lead, on average, to an increase of about 0.84 cent in maize production, This behavior can be assigned to the fact that producers’ are assumed to include past production experiences when forming production expectations. This result agree the observation of Mahmood (2010), Bakar (2010), AL Ubaidi (2013).

21.6 Effect of dummy variable on the maize supply.

The dummy variable represents the siege in 1990-2003. The coefficient is negative with a value of -0.06 and significant at 1 percent level. The
negative influence of siege on maize production might be due to changes in price policies that lead producers to plantation another more important crop as wheat, rice and barley also non-availability of inputs and other services, non-peace condition. The negative effect of the siege on maize production in Iraq can be briefed in light of the fact that most farmers opted to quit their profession and indulge in military service since the siege era witnessed a lot of military activities. This led to decreasing the cultivated areas allocated for maize crop, leading eventually to decreasing the maize output in general.

21.7 Effect of the technology on the maize supply

The coefficient of the technology variable indicates that technological change is causing a shift in the maize supply function of 0.06 percent per year. The coefficient is positive and significant at 1 percent level. The positive relationship between this variable and production of maize suggest that maize production in the Iraq increased over time as a result of adaptation of new technologies. The low technology coefficient value indicates that maize producers in Iraq may be averse to technological changes which result in low production response.

21.8 Effect of the rainfall on the maize supply.

The coefficient of rainfall was observed to be positive with the value of 0.87 and is significant at 1 percent level. This value indicates that an increase in rainfall will be followed by an increase in maize supply in the subsequent period. If we look at the magnitude of the rainfall coefficient it seems that rainfall is a key determinant of agricultural supply both in the short and long-run. This result is in conformity with the results of Molua (2010). The result is in contradiction with the findings of Leaver (2004).

22. Determine The Short and Long-Run Price and Non-Price Elasticity's.

Table 4.8 shows short and long run price and non-price elasticities. For maize supply, short run and long run maize price elasticity is worked out as 0.45 and 0.49, respectively; while short run and long run maize price lagged one year elasticity is 0.34 and 0.37, respectively; with significant influence. Short and long run elasticity of significant variable, lag maize yield is 0.08 and 0.09, respectively; In case of siege, response variable (production) is inelastic not with significant influence to the independent variable siege. In the short run, a one per cent increase in siege decreases total production by -0.06 per cent and decreases -0.07 per cent in the long run. Siege shows negative effect on the decision of farmers regarding allocation of maize production maize. The production in long run is inelastic to the land usage lagged one year i.e. one per cent increase in land usage lagged one year bring about 0.84 per cent increase in production allocation to maize crop. The maize elasticity for production shows that with the increase in the technology by 1 percent during the period of analysis, the quantity of maize production increased by 0.06 percent in the short run and long run. As expected the long-run elasticity is higher than the short-run elasticity. This is an important characteristic of individual crop supply elasticities and occurs due to the fact that in the short-run some factors of production are fixed, whilst in the long-run all factors are variable (Leaver, 2003).

Given the low response of maize supply to own price in the short-run and long run it does not necessarily
imply that domestic maize supply is unresponsive to maize price. But, it is likely that non-price incentives may be hindering the transformation of price incentives to stimulate maize supply in Iraq. This remark is in acknowledgment that non-price factors could dominate price factors in factors affecting decision-making process (Mythili, 2008).

The findings of this study coincide with results obtained by Alemu et al (2003) who calculated the short-run price elasticity and the long-run price elasticity of maize in Ethiopia to be 0.38 and 0.51 respectively. The inelastic short-run and long-run price elasticities clearly show us that not only price factors stimulate maize producers in Iraq but a package of other various non-price factors may elicit a better response.

Table 7: Short and Long-Run Elasticities for Maize production in Iraq During (1986-2015)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Short run elasticities</th>
<th>Long run elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnP</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td>LnP_{t-1}</td>
<td>0.34</td>
<td>0.37</td>
</tr>
<tr>
<td>LnA_{t-1}</td>
<td>0.84</td>
<td>0.91</td>
</tr>
<tr>
<td>Lny_{t-1}</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>LnC_{t-1}</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td>D</td>
<td>-0.06</td>
<td>-0.07</td>
</tr>
<tr>
<td>T</td>
<td>0.06</td>
<td>0.07</td>
</tr>
<tr>
<td>LnR</td>
<td>0.87</td>
<td>0.95</td>
</tr>
<tr>
<td>Adjustment coefficient λ</td>
<td></td>
<td>0.92</td>
</tr>
</tbody>
</table>


23. Conclusion

This chapter has detailed the empirical results obtained from the annual data from 1986–2015. Results obtained from the analysis are as expected for the long-run and short-run supply elasticities. The results also match well with those obtained in the literature on similar studies on supply response analysis. On assessing supply response, negative and significant relationship of siege. While positively significant influence of maize price, price lagged one year, maize production lagged one year, rainfall, land usage, price risk and technologies observed on the maize supply response in Iraq over a period of time series data from 1986 to 2015. The numeric of quantitative analysis estimated, indicate that short and long run elasticities in maize production for siege as -0.06 and -0.07, respectively. Maize supply response is found to be inversely related to the siege and in a direct relation with the other factors. The adjustment coefficient for maize production indicated slow pace of farmers’ adjustment toward desired production level of maize which suggests that production is influenced more by technological and institutional constraints. This result supported the view of many researchers that farmers seem to be reluctant to make larger adjustments in main cereal crops which are used for self consumption.

24. Recommendations for Farther Research

On the basis of the above limitations, future empirical research is called for to extend the study. The present study framework may be added to and extended to strengthen the findings and overcome the limitations. The research variables may be used in different crops like the wheat, barley and rice. Moreover, the findings may differ when considered in other behavior groups. This indicates a need for future studies to conduct cross-behavior research to determine whether or not farmers have the same
behavior all over the globe, or whether Iraqi farmers are unique due to their behavior.

This study was conducted using national historical time series data which can be limiting. It is, therefore, vital for future studies to narrow down to farm level analysis in order to capture household facets such as technical efficiency and socioeconomic characterization of farmers using cross-sectional data. This study did not include input cost variables because of unavailability of data. Therefore future studies should include more explanatory variables like costs of fertilizer and seed as they have the effect on maize supply. An institutional analysis of factors affecting maize production should also be studied in the future to embrace issues such as market access in order to evaluate the impact of institutional activities especially in the post-siege era.

REFERENCES


