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IMPACT OF AGRICULTURAL POLICY ON EGYPTIAN RICE

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ABSTRACT

Egypt is the largest rice producer in the Middle East, with total production accounting for 1.25% of the world's rice production. Rice is considered as an important export crop and a source of hard currency earnings required to finance sustainable economic and social development. In 2016, rice exports value amounted to US$ 24.277 million. To achieve the research objective, rice production and economic indicators were estimated by applying simple regression analysis, as well as partial equilibrium model based on two scenarios; under governmental intervention and under non-intervention by the government in order to assess the economic impacts of interventions in pricing and production policies. The research used field data a multistage stratified sample collected from 256 rice farmers in Kafr El Sheikh governorate to identify farmers' opinions regarding agricultural policies applied to the crop and the different impacts thereof. the results showed that the rice production declined at a rate lower than the rate of decline in planted area, which can be attributed to the increase in yield. Also, domestic rice consumption increased at a high rate that reached 2.76% per annum despite the decline in production that reached 1.92% per annum, the nominal protection coefficient recorded an average of 0.6 for the study period 2001-2018, which means that the government has been imposing either direct or indirect taxes on domestic rice producers in favor of consumers, where farmgate price has been lower than the border price of rice. The problem that rice production is influenced by limiting rice planted area ranks first, with a relative importance amounting to 100%. Low productivity ranks second, with a relative importance amounting to 96.88%.

Keywords: Agricultural Policy, Partial Equilibrium Model, Production, Egyptian Rice.

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INTRODUCTION

Rice occupies great importance in the structure of Egypt's national economy. It is one of the grain crops in which Egypt enjoys self-sufficiency and realizes a surplus for exports. Rice is important in terms of the possibility to plant in saline lands, especially in the North Delta regions. (Soliman and El-Syed 2017). It is worth mentioning that many of the vital industries is based on rice, along with other industries that rely on rice byproducts such as animal feed, starch, etc. (Mostafa *et al.,* 2016). Rice is also an important food grain crop. It is the staple food for different classes of most of the Egyptian population, especially in coastal governorates (Bastawy *et al.,* 2018; Eliw *et al.,* 2019c), given the fact that it is the first alternative to bread. In 2018, domestic rice consumption amounted to 5.17 million tons representing 279.31% of Egypt's total rice production, estimated at 3.122 million tons. Self-sufficiency in rice amounted to 60.37%, while per capita average share reached 38.7 kg during the same year (CAPMAS, 2018). At the level of production seasons, the area under summer rice amounted to 858.7 million acres representing 15.35% of the total area under summer crops and 5.35% of the total cropped area (MALR, 2018). It is worth mentioning that Egypt is the largest rice producer in the Middle East, with total production accounting for 1.25% of the world's rice production. In addition, rice is an important export crop, thus a source of hard currency earnings required to finance sustainable economic and social development. In 2016, rice export value amounted to US$ 24.277 million.

In addition, the government has adopted several policies to boost rice productivity by developing high yielding varieties and promoting extension and technology transfer, as well abolishing compulsory delivery of crops in the framework of economic reform programs, which resulted in increased total production (Hamed and Mostafa, 2015). In recent years, the government resorted to implanting the policy of defining rice cultivated areas and banning exports in order to address the problem of limited irrigation water, resulting in negative impacts on Egypt's rice exports. In 2017, Egypt did not export rice to any country as a result of this ban (Samir, 2018). Such policy also resulted in reducing

self-sufficiency rate in rice (El-Bardisy, 2015). It is worth noting that Egypt has been facing the problem of increased prices of most agricultural commodities, including rice, which pushed the government to ban rice exports in order to increase domestic supply to cover consumption need of the population (Soliman and Hafez, 2018). However, the adopted policy of reducing rice planted areas to address the problem of limited irrigation water (Amer, 2017) despite the fact that many farmers rely on the crop as a source of income given the fact that it is one of the most profitable crops, as well as a preferable table commodity for consumers (EL-Zanaty *et al.,* 2016). Undoubtedly, continuing to implement such policy in the coming years will have implications on self-sufficiency in rice. Based on what proceeded, the current research attempts to answer the following questions: What is the impact of agricultural policy on rice production and consumption? What are the future expectations of the impact of the Government's decision to limit rice cultivated area? What are the scenarios related to rice planted area, which can help achieve self-sufficiency and ensure fair prices for consumers? Accordingly, the research aims to investigate the impacts of agricultural policy on rice grown in Egypt by evaluating the production and pricing policies applied to rice and measuring the impacts of distortions between local and international prices on producers, consumers and society, in addition to changes in the government's revenues, and estimating the projected scenarios of the impacts of the implemented agricultural policy on self-sufficiency and consumer price of rice by 2025, and developing alternative scenarios for achieving self-sufficiency in rice, as well as identifying rice farmers' opinions in Kafr El Sheikh governorate regarding the policy of reducing rice planted areas and banning rice exports in order to assess the impacts on farmers and consumers.

MATERIALS AND METHODS

To achieve the research objective, production and economic indicators regarding rice crop will be estimated using simple regression analysis, as follows:

$$\hat{Y}t = \alpha + \beta 1\, x + \beta 2\, x + \beta 3\, xD + \varepsilon$$

Where,

$\hat{Y}_t$: the dependent variable

X : independent variable (time)

ε : Error term

In addition, the research intends to measure the impacts of agricultural policies applied to the rice, as one of the main food commodities in Egypt, with the help of partial regression analysis methods, namely the Partial Equilibrium Model (Tsakok,1990) using the General Algebraic Modeling System (GAMS) in order to identify the economic impacts of governmental interventions in production and price policies. It is worth mentioning that GAMS are used to build models that provide a detailed picture on each agricultural commodity, which allows decision and policymakers draw proper and timely policies given the fact that such models help in measuring the impacts of implementing a certain policy on the government's revenue and social cost by estimating changes in the government's revenues, proceeds of hard currency and net social loss (El-Gundy, 2014). Efficiency of inputs and outputs can also be measures by estimating net loss incurred by producers, as an indicator of the efficiency of inputs, and net loss incurred by consumers, as an indicator of the efficiency of outputs (Eliw *et al,* 2019a). Moreover, changes in producer and consumer surpluses are used to measure their welfare. To achieve these objectives, the model has been estimated under two assumptions, namely intervention and non-intervention by the government. According to (Eliw *et al,* 2019b; El-Gundy, 2014) the estimated model is based on the following set of equations:

Under Governmental Intervention:

Change in Government Revenue:

$$\triangle GR = t\,(v` - w`)\ o \qquad \triangle GR = \left(\frac{1-Npc}{Npc}\right)(v` - w`) \tag{1}$$

Change in Foreign Exchange Earnings

$$\triangle FE = -\left(\frac{Pb}{Pd}\right) t\,(es\,v` - nd\,w`)\ o \quad \triangle FE = -\left(\frac{1-Npc}{Npc2}\right)(es\,v` - nd\,w`) \tag{2}$$

Change in Producer Surplu

$$WGp = -(t\,v` + NELp)\ o \quad WGp = -\left[\left(\frac{1-N}{N}\right)v` + NELp\right] \tag{3}$$

Change in Consumer Surplus

$$WGc = t\,w` - NELc\ o \quad WGc = \left(\frac{1-Npc}{Npc}\right)w` - NELc \tag{4}$$

Net Economic Loss in Production

$$NELp = 0.5es\,t\,2\,v`\ o \quad NELp = 0.5es\left(\frac{1-Npc}{Npc}\right)2\,v` \tag{5}$$

Net Economic Loss in Consumption

$$NELc = 0.5nd\,t2\,w`\ o \quad NELc = 0.5nd\left(\frac{1-Npc}{Npc}\right)2\,w` \tag{6}$$

Net Effect

$$= \text{NELc} - (\text{NELp} + \text{NELc}) \quad (7)$$

Under Non-intervention by the Government:

Change in Government Revenue:

$$\triangle \text{GR} = t`[v(1 - t`es) - w(1 - t`nd)] \text{ or } \triangle \text{GR} = (1 - \text{NPC})\{v[1 - es(1 - \text{NPC})] - w[1 - nd(1 - \text{NPC})]\} \quad (8)$$

Change in Foreign Exchange Earnings

$$\triangle \text{FE} = -t`(v\,es - w\,nd) \quad o \quad \triangle \text{FE} = -(1 - \text{NPC})(v\,es - w\,nd) \quad (9)$$

Change in Producer Surplus

$$\text{WGp} = -(t`v + \text{NELp}) \quad o \quad \text{WGp} = -[(1 - \text{NPC})v + \text{NELp}] \quad (10)$$

Change in Consumer Surplus

$$\text{WGc} = t`w - \text{NELc} \quad o \quad \text{WGc} = [(1 - \text{NPC})\,w] + \text{NELc} \quad (11)$$

Net Economic Loss in Production

$$\text{NELp} = 0.5\,es\,t`2\,v \quad o \quad \text{NELp} = 0.5\,es\,(1 - \text{NPC})2\,v \quad (12)$$

Net Economic Loss in Consumption

$$\text{NELc} = 0.5\,nd\,t`2w \quad o \quad \text{NELc} = 0.5\,nd\,(1 - \text{NPC})2\,w \quad (13)$$

Net Effect

$$\text{NE} = -(\text{NELp} + \text{NELc}) \quad (14)$$

Where: P_d = domestic price, P_b = border price, t = tax or tariff rate, t` = $P_d/(t\,P_b)$, v` = value of domestic production in local prices, v = value of production using border prices, w` = value of domestic consumption in local prices, w = value of domestic consumption using border prices, P_d/P_b = NPC = Nominal Protection Coefficient, e_s = price elasticity of supply, n_d = price elasticity of demand.

Sources of Data: The research relied on published and unpublished secondary data from various sources, including: The Ministry of Agriculture and Land Reclamation (MALR). The Central Agency for Public Mobilization and Statistics (CAPMAS), the National Planning Institute, websites of Food and Agriculture Organization of the United Nations, the United Nations and the World Bank, in addition to other websites specialized in publishing data statistics. The research also used some references and researches relevant to the study subject.

Besides, Primary data were collected by drawing a multistage stratified sample of rice farmers during the agricultural season 2020 in order collect data required to serve the research objectives and identify the main problems confronted in rice production. Kafr El Sheikh governorate has been selected on the basis that it ranks first in terms of rice planted area in Egypt, estimated at 190.460 thousand acres, representing 22.18% of the total area under rice in the Lower Egypt, amounting to 858.742 million acres. For the primary data, the author designed, organized and conducted a very comprehensive agricultural survey in two representative districts during April-June 2020. A multi-stage sampling technique is used for the selection of 255 farmers for interviews.

Besides, Primary data were collected by drawing a multistage stratified sample of rice farmers during the agricultural season 2020 in order collect data required to serve the research objectives and identify the main problems confronted in rice production. Kafr El Sheikh governorate has been selected on the basis that it ranks second in terms of rice planted area in Egypt, estimated at 190.460 thousand acres, representing 22.21% of the total area under rice in the Lower Egypt, amounting to 856.95 thousand acres. Also representing 22.2% of the total area under rice in the Egypt, amounting to 857.7 thousand acres. For the primary data, the author designed, organized and conducted a very comprehensive agricultural survey in two representative districts during April-June 2020. A multi-stage sampling technique is used for the selection of 256 farmers for interviews, about 128 farmers selected from each district. Figure 1 shows the sampling framework. At each stage the following elements are selected: Kafr El Sheikh governorate as the main study area. At stage 1, two districts, keeping in view the geography, perceptions and attitude towards problems. At stage 2, 64 sample representative districts among two districts using a random sampling technique. At stage 3, two cities from each district using a simple random sampling technique. At stage 4, four villages from each city using the stratified random sampling technique. At stage 5, About 16 farmers randomly selected from each village. In order to select the required sample, all farm holders in the villages and hold areas

were selected from "record (2) services" kept in the agricultural cooperative societies at the villages.

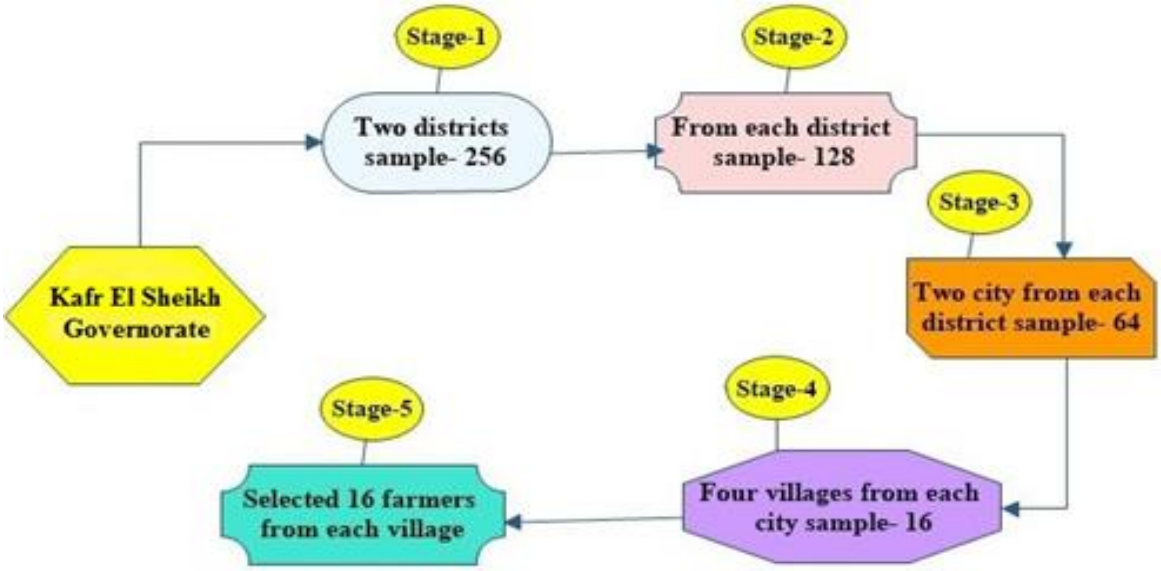

Figure 1: Sampling Stages for Selecting Rice Farmers in the Study Area

RESULTS AND DISCUSSION

Evolution of Rice Production Economic Indicators: This part of the research focuses on analyzing the economic and production indicators of rice over the period 2001-2018.

Planted Area: As shown in (Table 1 in the Annex), rice planted area averaged 1402 million acres and ranged between a minimum of 857.7 thousand acres in 2018 and a maximum of 1.77 million acres in 2008. On the other hand, the estimated regression equation No. (1) in a table (1) indicates that rice planted area followed a declining trend, at an annual rate of 23.598 thousand acres and a statistically significant rate of change amounting to 1.68% of the study period's average planted area. The adjusted coefficient of determination ($\overline{R}^2$) indicates that 32% of the change in rice planted area is due to the time variable.

Yield: Rice yield averaged 4.00 tons per acre and ranged between a minimum of 3.64 tons per acre in 2018 and a maximum of 4.23 tons per acre in 2006, as shown in Table 1 in the annex. Applying regression analysis revealed that the simple linear form is the form that best fits for estimating trend in rice yield (equation No. 2). Results indicate that rice yield followed a declining trend, not statistically significant.

Table 1: Estimated Regression Equations for Rice Planted Area, Yield, Total Production and Total Consumption over the Period 2001-2018.

Eq. No	Dependent variable	Model Equations	Annual average	Amount of change	Annual Chang rate%	$\overline{R}^2$	F
1	Total Area (1000 Acres)	$\hat{Y}t = 1626.647 - 23.598\ x$ $(19.099)^{**}\ (-2.999)^{*}$	1402.5	-23.598	-1.68	0.32	8.995^{**}
2	Yield (Ton /Acre)	$\hat{Y}t = 4.129 - 0.013\ x$ $(58.67)^{**}\ (-1.941)$	4.00	-	-	0.19	3.77^{ns}
3	Total Production (1000 tons)	$\hat{Y}t = 6671.869 - 108.497\ x$ $(16.862)^{**}\ (-2.968)^{*}$	5641.2	-108.497	-1.92	0.35	8.810^{**}
4	Total consumption (1000 tons)	$\hat{Y}t = 3406.275 + 127.533\ x$ $(9.985)^{**}\ (4.047)^{**}$	4617.83	127.533	2.76	0.48	16.375^{**}

Source: Table 1 in the Annex ** **Significant at the level 0.01** * **Significant at the level 0.05**

Total Production: Data in (Table 1 in the annex) indicate that total rice production averaged 5.641 million tons and ranged between a minimum of 3.121 million tons in 2018 and a maximum of 7.241 million tons in 2008. The estimated regression equation No. 3 in Table 1 indicates that total rice production has been declining by 108.497 thousand tons/annum, a statistically significant annual rate of 1.92% of the period's average rice production. The adjusted coefficient of determination ($\overline{R}^2$) indicates that 35% of the change in total rice production is due to the time variable.

Domestic Consumption: Data in (Table 1 in the annex) indicate that rice consumption averaged 4617.83 million tons and ranged between a minimum of 3.112 million tons in 2005 and a maximum of 6.659 million tons in 2009. Regression analysis results, (equation 4 in Table 1) indicate that rice consumption has been increasing by 127.533 thousand tons/annum, at a statistically significant annual rate of 2.76% of the period's average rice consumption. The adjusted coefficient of determination ($\overline{R}^2$) indicates that 48% of the change in domestic rice consumption is due to the time variable.

Impact Analysis of Agricultural Price Policies on Rice using Partial Equilibrium Model

Price Protection Indicator

Nominal Protection Coefficient: Nominal protection coefficient (NPC) refers to implicit taxes or subsidy related to a given commodity during a certain period. Data in (Table 2) indicate that NPC recorded an average of 0.6 for the study period 2001-2018, which means that the government has been imposing either direct or indirect taxes on domestic rice producers in favor of consumers[(1)], where farmgate price has been lower than the border price of rice. It can also be noticed that NPC recorded a minimum of 0.4 in 2009 and a maximum of 0.8 in 2001, and 2018 indicating that rice producers received 40% of the international price of rice in 2009, while received 80% of the international price of rice in 2001 and 2018.

Economic Efficiency Indicators: Partial equilibrium model has been applied using traditional pricing approach (on the basis that farmgate price is the price at which farmers sell their produce at the farm gate). It can be calculated using the following formula:

$$\text{Farmgate price} = \frac{\text{Total cost} - \text{Rent} - \text{Straw crop value}}{\text{Yield per Acer}}$$

Where total cost is considered, while rent is added as producer's profit using the elasticities of supply and demand estimated in this research. Data in (Table 2) presents indicators obtained from estimating the Partial Equilibrium Model, which clarifies the spill-over effects of price deviations (resulting from the differences between farmgate prices and international prices) on producers, consumers, the society, the country's proceeds of hard currency and national income as a result of ignoring border prices (shadow prices).

Net Economic Loss for Producers: Findings indicate that the society realized gains from rice production, both under intervention and non-intervention by the government. Average net economic gain for rice producers reached US$1.8 and US$0.80 million, respectively, and ranged between a minimum of US$7.4 and US$2.9 million in 2014. Such result might be attributed the value of farmgate price that recorded levels higher than the border price during those periods.

Net Economic Loss for Consumers: Findings revealed that the society incurs losses in consumption, both under intervention and non-intervention by the government. Average net economic loss resulting from exporting rice reached US$150.1 and US$ 70.3 million, respectively. Net economic loss for consumers ranged between a minimum of US$1.8 and US$1.6 million in 2007, and a maximum of US$675.9 and US$267.4 million in 2014 under the two scenarios, respectively. Such high value can be attributed to the gap between consumption volume at border price and that at farmgate price, the increase in direct and indirect taxes that leads to transferring consumption expenditure from high-utility to low-utility cheaper goods, resulting in misallocation of consumption expenditure, where it can be noted that the years during which taxes imposed are increased net economic loss for consumers also increase, and vice versa.

Economic Welfare

Producer Surplus: Results in (Table 2) indicate that average gain in producer surplus from exporting rice over the study period reached US$ 925.8 and 926.8 million under intervention and non-intervention by the government, respectively. It can also be noted that producer surplus ranged between a maximum of US$37.8 and US$37.8 million in 2018 and a minimum of US$2499.6 and US$2504.1 million in 2014. Data indicate that economic welfare has been realized for producers over the study period, probably due to earning higher revenue because of receiving a farmgate price that is higher than the border price.

Consumer Surplus: Results in (Table 2) indicate that, average loss in consumer surplus under intervention and non-intervention by the Government reached US$709.2 and US$ 929.6 million, which means that domestic consumers incurred losses due to consuming less quantity for higher prices.

Government's Revenues: Government's revenues have been assessed using two indicators; change in the country's hard currency earnings and change in the Government's proceeds.

(1) Taxes in the context of this research refers to direct taxes such as real estate taxes on agricultural land, or indirect taxes (implicit) such as taxes on production and exports

Change in the Country's Hard Currency Earnings: Hard currency earnings are influenced by imposing taxes or offering subsidies for producing the commodity, either an export or import commodity. It is clear from (Table 2) that average hard currency earnings under intervention and non-intervention by the Government reached US$ 597.8 and US$ 294 million, respectively. It can also be noticed that hard currency earnings recorded a maximum of US$2261 and US$ 898 million in 2014 and 2009, while recorded a minimum of US$38.4 and US$ 34.7 million in 2007, respectively. The high records of hard currency earnings can be attributed to the increase in domestic consumption, associated with higher levels of farmgate prices compared with border prices.

Change in Governmental Revenues: These are changes in Governmental revenues, either due to imposing implicit taxes or offering implicit subsidy for the produced commodity, which leads to incurring burdens or earning revenues by the government. Results in (Table 2) indicate that, in 2009, the government incurred burdens estimated at US$ 451 million under intervention policies in 2009, and 175.8 in 2018 under non-intervention, hard currency earnings increased to a high of US$726.1 and 978.8 million in 2008, respectively.

Net Effect: It can be noticed from (Table 2) that net economic loss, under intervention and non-intervention by the government, due to imposing taxes on imports averaged US$ 148.4 and US$ 69.5 million, respectively. Average economic loss ranged between a minimum of US$668.5 and US$264.4 million in 2014, while a maximum of US$1.8 and US$1.6 million in 2007.

Future Scenarios for the impacts of Agricultural Policies on Rice Production and Marketing in Egypt

Future Scenarios for the impacts of Agricultural Policies on Rice Production: Two scenarios have been studied and analyzed to assess the impact of agricultural policy on rice production in Egypt. The first scenario focuses on limiting rice planted area to 724.2 thousand acres to overcome the problem of limited water resources, whereas the second scenario analyzes the opposite situation, i.e., keeping rice planted areas at the normal rates recorded over the study period 2001-2018, expected to reach 1130.30 thousand acres. Expectations for the two scenarios have been calculated for the period 2019-2025, six years from now, and 7 years from the end of the study period (2018).

First Scenario: This scenario is based on abiding to rice planted area set by government (724.2 acres), and a rice productivity that is expected to reach 4.00 ton/acre. in which case total production is estimated to reach 2.896 million tons. Results indicate that Egypt will suffer a shortage in rice estimated at 3.52 million tons, where domestic consumption is expected to reach 6.4 million tons, in which case self-sufficiency is expected to decline to a low of 45.15%.

Second Scenario: under this scenario, rice planted area is limited by the government. Results indicate that rice planted area is expected to reach 1130.30 thousand acres by 2025. Assuming that rice productivity is 4.00, total production will reach 4521.2 thousand tons in 2025, in which case shortage will be 1894.90 thousand tons assuming that rice consumption will reach 6416.102 thousand tons. Under this scenario, rice gap will reach 1894.90 thousand tons, while self-sufficiency will be 70.47%.

Impact of Implementing the Policy of Limiting Rice Planted Area: It is clear from the two scenarios that limiting rice planted area will result in reducing rice planted area in 2025 by 35.93%, leading to reducing self-sufficiency in rice by 25.32%. In this case, the government will incur the cost of importing rice to meet domestic consumer demand, which will increase deficit in the Balance of Agricultural Trade.

Proposed Alternative Scenarios to Achieve Self-sufficiency in Rice by 2025: The authors proposed two alternative scenarios in order to reduce the negative impacts of implementing the policy of limiting rice planted area on self-sufficiency in rice.

Alternative Scenarios to Achieve Self-sufficiency in Rice by 2025: The following are alternative scenarios proposed to achieve self-sufficiency in rice by 2025:

First Alternative: Increasing productivity at a rate higher than that estimated using the study period's data (4.00 tons/acre). The proposed productivity is to 5.4 tons/acre. In case it is not possible to develop the hoped for high yielding varieties to achieve the proposed productivity, or to increase rice planted area to 1567.2 thousand acres, it is possible to plant an area less than 1567.2 thousand acres and greater than the area defined by the government (724.2 thousand acres), in which case self-sufficiency in rice can be realized by planting varieties yielding between 4.00 and 5.4 tons per acre and using the amount of irrigation water that the government can provide.

Second Alternative: Either planting an area less than 1567.2 thousand acres with rice varieties that yield more than 5.4 tons/acre to achieve self-sufficiency in rice or reducing per capita consumption of rice to reduce total consumption. However, it is difficult to reduce per capita consumption of rice given the fact that it is a low-elasticity commodity, especially in costal governorates.

Table 2: Results of Applying Partial Equilibrium Model on Rice Crop Grown in Egypt over the Period 2001-2018

(Value in US$ Million)

		First Scenario: In case The State intervention							Second scenario: In case of non-intervention by the state						
Year	NPC Pd/Pb	GR	FE	NEL_c	NEL_p	WGc	WG_p	Net Effect	GR	FE	NEL_c	NEL_p	WGc	WG_p	Net Effect
2001	0.8	77.4	60.2	5.8	-0.1	134.7	-217.8	-5.7	86.9	48.3	4.7	-0.1	145.3	-217.9	-4.6
2002	0.7	79.7	98.8	13.3	-0.2	195.7	-288.5	-13.1	99.4	71.7	9.7	-0.2	218.7	-288.5	-9.5
2003	0.7	169.4	115.7	16.2	-0.3	223.6	-408.9	-15.9	193.0	82.6	11.6	-0.2	251.4	-409.0	-11.4
2004	0.7	236.7	162.4	27.2	-0.5	282.8	-546.1	-26.7	273.2	106.9	17.9	-0.4	327.9	-546.3	-17.5
2005	0.7	207.8	101.8	13.5	-0.3	201.1	-422.1	-13.2	227.9	74.2	9.9	-0.2	224.5	-422.2	-9.6
2006	0.7	270.5	165.5	26.0	-0.5	300.1	-596.0	-25.4	306.5	112.5	17.6	-0.4	343.7	-596.2	-17.3
2007	0.9	89.4	38.4	1.8	0.0	98.7	-189.9	-1.8	92.8	34.7	1.6	0.0	102.2	-189.9	-1.6
2008	0.5	726.1	1013.1	260.3	-4.5	1145.9	-2127.8	-255.8	978.8	483.4	124.2	-2.2	1530.4	-2130.1	-122.1
2009	0.4	-451.0	2215.8	652.7	-6.2	1979.7	-2175.2	-646.6	83.1	898.0	264.5	-2.5	2896.9	-2178.9	-262.0
2010	0.6	-162.5	730.9	155.7	-1.5	1064.1	-1055.9	-154.2	16.7	416.3	88.7	-0.9	1308.6	-1056.5	-87.8
2011	0.9	65.2	87.4	5.6	-0.1	215.9	-286.6	-5.5	75.1	76.0	4.9	-0.1	226.4	-286.6	-4.8
2012	0.6	266.2	800.0	174.1	-2.4	1130.4	-1568.4	-171.7	463.5	446.9	97.3	-1.3	1401.8	-1569.4	-95.9
2013	0.6	50.7	529.7	98.4	-1.2	867.9	-1015.9	-97.3	175.0	330.5	61.4	-0.7	1027.8	-1016.3	-60.7
2014	0.4	-110.7	2261.0	675.9	-7.4	1941.8	-2499.6	-668.5	429.8	894.3	267.4	-2.9	2885.1	-2504.1	-264.4
2015	0.5	-156.1	1176.9	305.9	-3.2	1330.6	-1477.3	-302.7	137.4	558.8	145.2	-1.5	1781.8	-1478.9	-143.7
2016	0.5	118.8	867.7	224.8	-2.8	980.9	-1321.6	-222.0	335.2	412.5	106.9	-1.3	1312.5	-1323.1	-105.5
2017	0.7	-58.9	240.4	36.4	-0.4	452.5	-429.7	-36.0	-7.8	166.9	25.3	-0.3	514.1	-429.8	-25.0
2018	0.8	-189.7	94.0	8.5	0.0	219.1	-37.8	-8.4	-175.8	77.0	6.9	0.0	234.5	-37.8	-6.9
Average	**0.6**	**68.3**	**597.8**	**150.1**	**-1.8**	**709.2**	**-925.8**	**-148.4**	**210.6**	**294.0**	**70.3**	**-0.8**	**929.6**	**-926.8**	**-69.5**
Max		**726.1**	**2261.0**	**675.9**	**0.0**	**1979.7**	**-37.8**	**-1.8**	**978.8**	**898.0**	**267.4**	**0.0**	**2896.9**	**-37.8**	**-1.6**
Min		**-451.0**	**38.4**	**1.8**	**-7.4**	**98.7**	**-2499.6**	**-668.5**	**-175.8**	**34.7**	**1.6**	**-2.9**	**102.2**	**-2504.1**	**-264.4**

Elasticity of demand = 0.454, Elasticity of supply = 0.111.

Source: Authors Calculation

Table 3: Expected Results of Applying the Scenario of Limiting Rice Planted Area on Self-sufficiency in Rice by 2025.

Items	Scenario (1)	Scenario (2)	(2) – (1)	Impact of area %
Planted area 1000/acers	724.2	1130.30	406.1	35.93
Yield ton/acer	4.00	4.00	0	0
Total production 1000/tons	2896.8	4521.2	1624.4	35.92
Total consumption 1000/tons	6416.102	6416.102	0	0
Gap 1000/tons	(3519.302)	(1894.902)	1624.4	0
Self-sufficiency%	45.15%	70.47%		25.32

Source: Authors calculation

( ) Numbers between brackets are negative

	Proposed Scenario
First Scenario Raising Rice Productivity to 5.4 tons/acre	This scenario is based on two assumptions: achieving a rice productivity of 5.4 tons/acre and a planted area of 1130.30 thousand acres, which has been computed using data of the period 2001-2018. Under these assumptions, total rice production will reach 6416.102 thousand tons, which covers total consumption and in the same time realizes self-sufficiency. However, rice productivity should be increased by 1.4 tons/acre compared to that expected for the year 2025 (4.00 tons/acre). To achieve that, efforts should be exerted to develop new high yielding varieties.
Second Scenario Increasing Rice Planted Area to 1567.2 thousand acres	This scenario is based on two assumptions: rice productivity remains as expected for the year 2025 (4.00 tons/acre). In this case, it is important to find another alternative for achieving self-sufficiency in rice, which is increasing rice planted area to 1567.2 thousand acres. Under this scenario rice production is expected to reach 6416.102 thousand tons, which is sufficient to cover domestic consumption. This scenario requires increasing rice planted area to 436.9 thousand acres by 2025. However, increasing rice planted area requires more irrigation water, which makes it difficult to achieve compared to the first scenario of developing new high yielding varieties.

Table 4: Expected Results of Applying the Scenario of Limiting Rice Planted Area on Self-sufficiency in Rice by 2025.

Items	Scenario (1)	Scenario (2)	(2) – (1)
Planted area 1000/acers	1130.30	1567.2	436.9
Yield ton/acer	5.4	4.00	1.4
Total production 1000/tons	6416.102	6416.102	0
Total consumption 1000/tons	6416.102	6416.102	0
Self-sufficiency%	100%	100%	0
Consumer price **US$/ton**	224.126	224.26	0

Source: Authors calculation

Relative Importance of the Problems Rice Farmers Confront in Kafr El Sheikh: Investigating Kafr El Sheikh farmers' perspectives regarding the problems confronted in rice production during the agricultural season 2019/2020 reveals that such problems differ according to impact on production revenue.

As shown in (Table 5), the problem that rice production is influenced by limiting rice planted area (X_1) ranks first, with a relative importance amounting to 100%. Testing the difference between farmers' responses revealed that there is no statistically significant difference. Low productivity (X_2) ranks second, with a relative importance amounting to 96.88%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. The problem that farmgate price is influenced by limiting rice planted area (X_7) ranks third, with a relative importance amounting to 87.10%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. The problem that Lacks new high yielding varieties to compensate for limiting rice planted area (X_5) and farmgate price is influenced by banning rice exports (X_9) ranks forth, with a relative importance amounting to 83.20%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. The problem that farmer's income is influenced by limiting

rice planted area (X_{11}) ranks fifth, with a relative importance amounting to 71.09%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level.

Table 5: Relative Importance of the Problems Kafr El Sheikh Rice Farmers Confronted during the Agricultural season 2020.

	Problem	Exist	% of Total Sample Farmers	Does not Exist	% of Total Sample Farmers	Chi^2
1	Production is influenced by limiting rice planted area.	256	100	0	0	-
2	Low productivity	248	96.88	8	3.13	227.8**
3	Infections by diseases and pests	52	20.31	204	79.69	91.80**
4	Shortage in skilled labor	96	37.5	160	62.5	16.57**
5	Lack of new high yielding varieties to compensate for the reduction in rice planted area by virtue of the decree	213	83.20	43	16.80	114.67**
6	High production cost and low revenue per acre	38	14.84	218	85.16	128.47**
7	Farmgate price is influenced by limiting rice planted area	223	87.10	33	12.89	143.06**
8	Shortage in fertilizers and pesticides	94	36.72	162	63.28	18.67**
9	Farmgate price is influenced by banning rice exports	213	83.20	43	16.80	114.67**
10	High loss during harvesting	29	11.33	227	88.67	155.29**
11	Farmer's income is influenced by limiting rice planted area	182	71.09	74	28.90	46.59**
12	Farmers' carelessness regarding implementing the decree of limiting rice planted are	2	0.78	254	99.22	251.02**
	Total	1646	100	1426	100	

Source: field data collected using a designed questionnaire

Shortage in skilled labor (X_4) ranks sixth, with a relative importance amounting to 37.5%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. Shortage in fertilizers and pesticides (X_8) rank seventh, with a relative importance amounting to 36.72%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. Infections by diseases and pests (X_3) ranks eighth, with a relative importance amounting to 20.31%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. High production cost and low revenue per acre (X_6) ranks ninth, with a relative importance amounting to 14.84%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. The problem that High loss during harvesting (X_{10}) ranks tenth, with a relative importance amounting to 11.33%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level. Farmers' carelessness regarding implementing the decree issued to limit rice planted area (X_{12}) ranks eleventh, with a relative importance amounting to 0.78%. Testing the difference between farmers' responses regarding this problem revealed that a statistically significant difference exists at 0.01 level.

Since Chi^2 cannot be used to rank problems according to relative importance, "F" test for ANOVA has been applied to identify the existence or lack of a significant difference between the mentioned problems. It can be noted from the results of applying F test in (Table 6) that differences exist between averages of the study variables due to obtaining a high F value.

Table 6: Results of Applying ANOVA to Problems Rice Farmers in Kafr El Sheikh Governorate Confronted during the Agricultural Season 2020.

Source of Variation	D.F.	Sum of Squares	Mean Square	F
Between Problems	11	298.06	27.10	220.77**
Within Problems	3048	374.10	0.12	
Total	3059	672.16	—	—

**Significant at the 0.01 level

Since "F" test does not indicate whether the differences are significant or not, it was necessary to apply L.S.D in order to achieve that thus rank them according to relative importance, as shown in (Table 7). Results of applying L.S.D revealed that statistically significant difference exist between all the study problems, based on which it

was possible to rank them in a descending order according to the average of farmers' opinions.

Table 7: Ranking Kafr El Sheikh Rice Farmers' Opinions Regarding the Problems they Confronted during the Agricultural Season 2020 in a Descending Order using L.S.D Method.

Problems	Average	X1	X2	X7	X5	X9	X11	X4	X8	X3	X6	X10	X12
		1.00	0.97	0.87	0.83	0.83	0.71	0.38	0.37	0.20	0.15	0.11	0.008
X1	1.00	0.00											
X2	0.97	0.03	0.00										
X7	0.87	0.13*	0.10*	0.00									
X5	0.84	0.17**	0.14**	0.04	0.00								
X9	0.84	0.17**	0.14**	0.04	0.00	0.00							
X11	0.71	0.29**	0.26**	0.16**	0.13**	0.13**	0.00						
X4	0.37	0.62**	0.62**	0.49**	0.45**	0.45**	0.33**	0.00					
X8	0.36	0.63**	0.60**	0.50**	0.46**	0.46**	0.34**	0.01	0.00				
X3	0.20	0.80**	0.77**	0.67**	0.64**	0.64**	0.51**	0.17**	0.16**	0.00			
X6	0.15	0.85**	0.82**	0.72**	0.69**	0.69**	0.56**	0.22**	0.21**	0.05	0.00		
X10	0.11	0.89**	0.86**	0.76**	0.73**	0.73**	0.60**	0.26**	0.25**	0.09**	0.04	0.00	
X12	0.004	0.99**	0.96**	0.86**	0.82**	0.82**	0.70**	0.37**	0.36**	0.19**	0.14**	0.10**	0.00

**Significant at the 0.01 level (L.S.D. critical value is estimated at 0.055 at the level 0.01 and 0.07 at the level 0.05)
Source: Calculated using field data collected from sample farmers with the help of the designed questionnaire

Recommendations

Based on the research results, we recommend the following:

I. Revisiting governmental policies and devoting more attention to increasing Rice planted areas in main producing governorates based on production efficiency indicators and considering rice profitability relative to the profitability of competing crops.

II. Vertical expansion in rice production via developing new high yielding varieties to boost rice production; in addition to providing support to rice farmers in the form of good varieties of seed, fertilizers and other production inputs to encourage farmers cultivate the crop.

III. Setting a procurement price, close to the international prices of rice, three months prior to rice planting season, such that the announced price is fair to producers, i.e., it covers production cost and provide a fair profit margin, and in the same time is a fair price for consumers.

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Table 1: Evolution of Economic and Production Indicators of Rice Crop Grown in Egypt over the Period 2001-2018.

Year	Total Area (1000 Acres)	Yield Ton /acer	Total Production (1000 tons)	Total Consumption (1000 tons)
2001	1569	3.83	6009.3	3876
2002	1340.3	3.90	5227.3	3784
2003	1507.6	4.09	6174.5	3618
2004	1536.6	4.13	6350.7	3601
2005	1459	4.20	6124.0	3112
2006	1592.8	4.23	6744.2	3686
2007	1672.7	4.15	6868.2	3635
2008	1769.8	4.09	7240.5	4775
2009	1369.2	4.03	5518.1	6659
2010	1093.3	3.96	4327.1	4992
2011	1403.8	4.04	5667.2	4379
2012	1413.1	4.18	5906.0	4905
2013	1419.4	4.03	5717.1	5432
2014	1363.9	4.00	5460.8	5702
2015	1215.8	3.96	4818.0	5326
2016	1353.3	3.92	5308.2	4832
2017	1307.1	3.79	4957.6	5636
2018	858.7	3.64	3121.9	5171
Average	**1402.5**	**4.00**	**5641.2**	**4617.83**

Source:

1- Calculated using data collected from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics and Bulletin of Agricultural Economics (different Issues).

2- The Central Administration for Public Mobilization and Statistics, Foreign Trade Database, Foreign Trade Bulletins; Different Issues.