



Estimating Financing Needs and Water Amount of Self-Sufficiency for Eggs According to Saudi Vision 2030

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Abstract

This study aimed to estimate the financing needs, the quantity and value of water needed to maintain the current self-sufficiency rate for eggs until 2030, according to the Saudi National Strategy for Agriculture. This study yielded a set of results, using statistical analysis and economic equations used in this field. The most important of which is that the value of the geographical concentration coefficient for the number of projects and egg production reached 50.3% and 47.5% respectively, in 2021. This indicates that there is a geographical concentration of projects and egg production in several regions which makes it a monopoly power in the production and marketing of eggs. Projects specialized in egg production and its affiliated projects (grandmothers and mothers of laying hens) acquired about 10.51% of the total investment loans for food security projects since the establishment of the Agricultural Development Fund until the end of 2021. To maintain the current self-sufficiency rate for eggs until 2030, this requires investments estimated at about 162.59 million dollars. The Agricultural Development Fund contributes about 81.30 million dollars, in addition to a quantity of water amounting to 11.76 billion m³, with a value of 1.51 billion dollars during the period 2023-2030.

Keywords: Investment, Loans, Economic Equations, Water Scarcity, Gini-Hirschman Coefficient, The Agricultural Development Fund, Consumption

Introduction

Poultry and its meat products and table eggs are one of the main sources of animal protein with high nutritional value and its cost is lower compared to red meat. Eggs contain many vitamins and minerals that are essential parts of any healthy diet. Eggs are considered one of the best sources of protein available. In most countries, eggs are a staple food source that is low cost and readily available. Table eggs are included in many food and chemical industries, as they are used in the preparation of medical serums and the preparation of bacterial cultures that enter the medical and food industries. Table eggs that are not fit for human food are also used in the preparation of animal feed and some fertilizers. Egg whites are also used in the manufacture of medicines, glue, paint, textile dyeing and leather tanning. As for the egg yolk, it is used in the manufacture of paints, hair dyes, shampoos, and soaps, and the shell is used in the manufacture of fertilizers and in the preparation of mixtures of mineral salts [1].

Given the state's interest in food security projects, including laying chicken projects, the egg self-sufficiency rate increased from

107.9% in 1990 to 121.8% in 2010, then decreased to 112.0% in 2021. The Agricultural Development Fund provided 286 loans, with a value of 930.86 million riyals, it represents 8.57% of the total value of loans provided for food security projects amounting to 10,867.94 million riyals since the establishment of the fund until the end of 2021 [2]. The Saudi national strategy for agriculture for the year 2030 included maintaining the current self-sufficiency rate for eggs until 2030. In this regard, the study raises several questions, the most important of which are the following:

- i. How much financing is needed to maintain the current eggs self-sufficiency ratio until 2030?
- ii. What is the amount and value of water needed to maintain the current self-sufficiency rate for eggs until 2030?

In the field of egg production, [3] measured the investment efficiency of the commercial production of table eggs in small projects. It was found that the two components of nutrition and work determine the production of eggs by 94%. It also showed a high investment efficiency in egg production, as the internal

rate of return was 55% for the white strain and about 68% for the brown strain. By studying the impact of the project on the national economy, it was found that the added value amounted to 60 thousand pounds for the white breed and about 67 thousand pounds for the brown breed. A study [1] indicated that due to the increase in the population and the improvement in their income level, the demand for eggs increased in Egypt. Under the policy of economic liberalization and liberalization of internal trade, egg prices became subject to supply and demand conditions. It was found that the local production of eggs increased at an annual growth rate of 4.99%, while the domestic consumption increased at an annual growth rate of 5.11% during the period 1996-2012. This study recommended the need to develop strains with high productivity of eggs, disease resistance and suit the Egyptian environment.

A study [4] showed that about 74.5% of poultry projects conducted an environmental feasibility study before implementing the project. The Ministry of Health imposed fines on about 12.7% of the sample research projects, due to their failure to comply with environmental laws and regulations. The Ministry of Health also closed about 10.9% of the research projects in the sample during the last ten years. It was also found that about 65.5% of the poultry projects in the research sample have a plan to mitigate environmental impacts. About 32.7% of the sample research projects conducted studies to reduce environmental pollution. A significant percentage of 56.4% of the research projects in the sample also used experts and consultants in the field of environmental protection.

The study [5] aimed to reduce the cost of egg production, by reducing the cost of poultry feed, by using barley grown according to hydroponics technology. The cost of producing eggs using barley grown using hydroponics technology was estimated and compared to its counterpart estimated in the case of using concentrated feed during the period 2011-2018. It was found from this study that the cost of producing one egg in the case of using cultured barley amounted to 14.19 Syrian lyra, while it amounted to 37.0 Syrian lyra. In the case of concentrated feed in 2018, that is, the cost of producing eggs using sprouted barley is 61.6% less than its estimated counterpart in the case of concentrated feed.

[6] assessed the financing needs and the amount of water needed to achieve self-sufficiency and food security for poultry meat in the Kingdom of Saudi Arabia. The study showed that the value of the investments required to achieve self-sufficiency and full food security for poultry meat is estimated at 218.19 and 671.21 million riyals each, respectively. Achieving self-sufficiency and food security for poultry meat also requires the use of a quantity of water amounting to 6.29 billion cubic meters, with a value of 3.03 billion riyals. [7] studied the reality of the agricultural sector in the Asir region. This study showed that egg production

in the Asir region amounted to 256.5 thousand eggs, representing 4.9% of the total egg production of 5.19 million eggs in 2018. Also, the decrease in the volume of loans granted may represent a threat to expansion and growth in the agricultural sector.

From the foregoing, it is clear from the results of previous studies that it dealt with the efficiency of investment in egg production projects and the comparison between white and brown strains, in addition to estimating the financing needs and the amount of water needed to achieve self-sufficiency and food security for poultry meat. This study is distinguished from previous studies in that it is linked to the national strategy for Saudi agriculture, as it deals with estimating financing needs and the quantity and value of water required to maintain the self-sufficiency rate for eggs until 2030.

Research Objectives

This research aimed to estimate the financing needs and the quantity and value of water needed to maintain self-sufficiency for eggs until 2030, according to the Saudi national strategy for agriculture, by studying the following:

- i. The current situation of projects specialized in egg production in the Kingdom of Saudi Arabia.
- ii. The development of domestic production and consumption and the percentage of self-sufficiency for eggs during the period 1990-2021.
- iii. Estimating the financing needs needed to maintain self-sufficiency for eggs until 2030.
- iv. Estimating the quantity and value of water used to achieve self-sufficiency for eggs until 2030.

Materials and Methods

In achieving its objectives, this research relied on secondary data published in: (1) the annual statistical book issued by the Ministry of Environment, Water and Agriculture, (2) annual reports issued by the Agricultural Development Fund, (3) the website of the Food and Agriculture Organization (FAOSTAT), (3) Research and economic studies related to the subject of the research. This research was also based on the following economic equations:

a) Gini-Hirschman coefficient in measuring the geographical concentration coefficient of egg production projects. It was calculated using the following equation [8,9]:

$$G_i = \sqrt{\sum_{i=1}^n \left(\frac{x_i}{X}\right)^2} \times 100$$

Where: G_i represents the geographical concentration coefficient, x_i represents the number and production of specialized projects in the region, X represents the total number of specialized projects and their production of eggs at the level

of the Kingdom of Saudi Arabia. The geographical concentration coefficient is considered high if it exceeds 40.

b) The equations used in estimating the financing needs necessary to maintain the current self-sufficiency rate for eggs until 2030, according to the Saudi national strategy for agriculture. These equations are as follows [10]:

Domestic production needed to achieve the current self-sufficiency ratio ($PNCR_{sf}$) = Expected Domestic Consumption (EDC) × Current Self-Sufficiency Ratio (CR_{sf}).

The value of investment loans needed to maintain the current self-sufficiency ratio ($LNCR_{sf}$) = the average per ton of investment loans for eggs (STE_{ii}) × the amount of domestic production needed to achieve the current self-sufficiency ratio ($PNCR_{sf}$).

c) The equations used in estimating the amount and value of water needed to maintain the current self-sufficiency rate for eggs, and those equations are as follows [11]:

1. Amount of water used to maintain current egg self-sufficiency ratio ($WUCR_{sf}$) = domestic production needed to maintain current self-sufficiency ratio ($PNCR_{sf}$) × average water requirement or water footprint for producing per ton of eggs (AWR_{ie}).

2. Value of water needed to maintain current self-sufficiency ratio for eggs ($VWUCR_{sf}$) = amount of water used to maintain current self-sufficiency ratio ($WUCR_{sf}$) × average unit extraction cost of groundwater (ACE_{ug}).

Results and Discussion

The current situation of projects specialized in egg production in the Kingdom of Saudi Arabia

Pattern of geographical distribution of projects specialized in egg production: By studying the geographical distribution of egg production projects in the Kingdom of Saudi Arabia in 2021, it is clear from the data in (Table 1) that the specialized projects for egg production are distributed in nine regions in the Kingdom of Saudi Arabia, while there are no specialized projects for egg production in four regions: Al-Jawf, Jazan, the northern border and Al-Baha. The specialized projects for egg production are concentrated in the Riyadh region, where there are 40 projects, with a rate of 44.94% of the total number of projects amounting to 89 projects in 2021. The projects operating in the Riyadh region also contribute about 40.57% of the total egg production of 359.20 thousand tons in 2021. The eastern region ranks second in the number of projects, followed by the Qassim region, Makkah Al-Mukaramah and Asir. And by calculating the geographical concentration coefficient for the number of projects and egg production, it is clear that the value of the coefficient amounted to 50.3% and 47.5% for each of them, respectively, which indicates that there is a geographical concentration of projects and egg production in several regions that make it monopolistic in the production and marketing of eggs. The geographical concentration of egg production and projects in the regions (Riyadh, Sharqiya, Al-Qassim, Makkah Al-Mukarramah, and Asir) is due to those regions' acquisition of most of the agricultural loans and subsidies provided by the Agricultural Development Fund.

Table 1: The geographical distribution of specialized white chicken projects in 2021.

Region	Number of projects	%	Production of table eggs (thousand tons)	%
Riyadh	40	44.94	145.72	40.57
Eastern Region	11	12.36	41.54	11.56
Al Qaseem	9	10.11	43	11.97
Makkah Al Mukaramah	9	10.11	44.13	12.29
Aseer	9	10.11	42.76	11.9
Hail	5	5.62	16.82	4.68
Al Madinah Al Munawarah	3	3.37	14.01	3.9
Tabuk	2	2.25	9.42	2.62
Najran	1	1.12	1.79	0.5
Total	89	100	359.2	100
Geographical concentration factor	50.30%	-	47.50%	-

Source: [12]. Statistical book.

Agricultural Development Fund loans for laying hens Projects: The Agricultural Development Fund was interested in financing food security projects, including specialized projects for egg production, as it is clear from (Figure 1) that the value of loans provided by the Agricultural Development Fund for laying hens

projects amounted to 930.86 million riyals, representing 8.57% of the total value of loans for food security projects amounting to 10867.94 million Riyals since the establishment of the fund until the end of 2021. The projects of poultry grandmothers and mothers of laying hens acquired investment loans amounting

to 110.45 and 100.46 million riyals each, respectively. From the foregoing, it is clear that projects specialized in egg production and its affiliated projects (grandmothers and mothers of laying

hens) acquired about 10.51% of the total investment loans for food security projects since the establishment of the Agricultural Development Fund until the end of 2021.

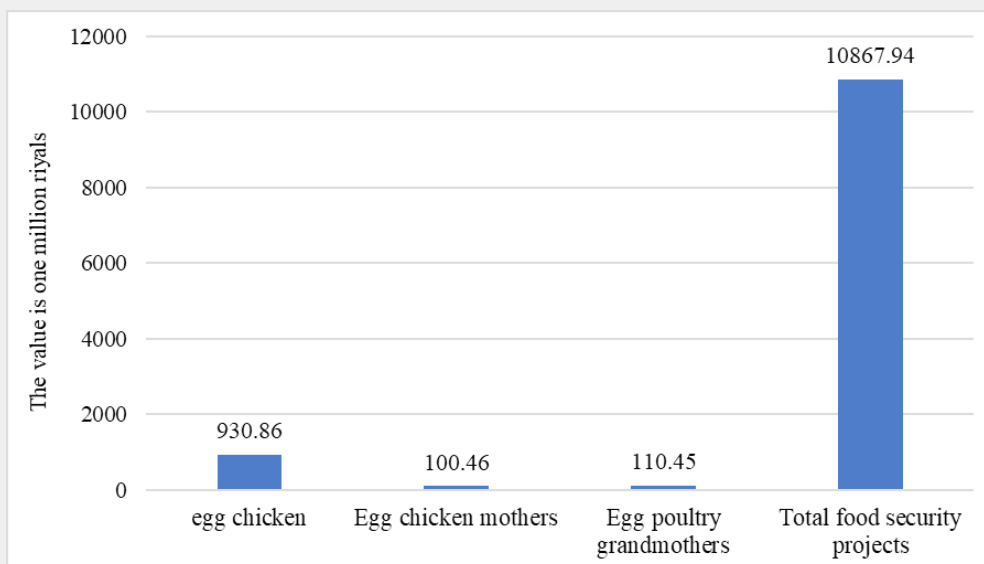


Figure 1: The total value of investment loans for specialized projects from the establishment of the fund until the end of 2021. Source: [2]. The fifty-eighth annual report.

Table 2: Average retail prices of table eggs in various regions in the Kingdom of Saudi Arabia in 2021.

Region	dollar/dish			Average
	Large	Medium	Small	
Riyadh	4.32	3.3	3.07	3.56
Makkah Al Mukaramah	4.18	3.73	3.2	3.7
Al Qaseem	3.86	3.2	2.8	3.29
Eastern Region	3.48	3.14	2.75	3.13
Asir	4.27	3.73	3.2	3.73
Hail	3.32	3.14	2.92	3.13
Northern Border	4	3.73	3.55	3.76
Jazan	3.97	3.52	3.33	3.61
Najran	4	3.47	2.93	3.47
Al Bahah	4.46	3.87	3.65	3.99
Al Jawf	4	3.8	3.2	3.67
Average	3.99	3.51	3.15	3.55

Source: [12]. Statistical book.

The discrepancy in the retail prices of table eggs between the regions of the Kingdom of Saudi Arabia: By studying the amount of variation in the retail prices of table eggs between the regions of the Kingdom in 2021, it is clear from the data in (Table 2) and (Figure 2) that the average retail prices for eggs ranged between a minimum of 3.13 dollar/dish in the Eastern and Hail regions and a maximum of 3.99 dollar/dish in the Al-Baha region,

with an average estimated at 3.55 dollar/dish. And by comparing the average retail prices of eggs in the Hail region, as it is the lowest region in the average retail prices of eggs, with the rest of the regions, especially those that do not have specialized projects for egg production, it becomes clear that the average retail prices of eggs in each of Al-Baha, the northern borders, Al-Jawf and Jazan, is more than that of the Hail region, at a rate of 27.8%, 20.4%,

17.3%, and 15.4% for each, respectively. The discrepancy in the retail prices of eggs between regions is due to the following: (1) the geographical concentration of specialized egg production projects

in certain regions, (2) the cost of transporting eggs from the regions where production projects are concentrated, to the rest of the regions that have a shortage of eggs for human consumption.

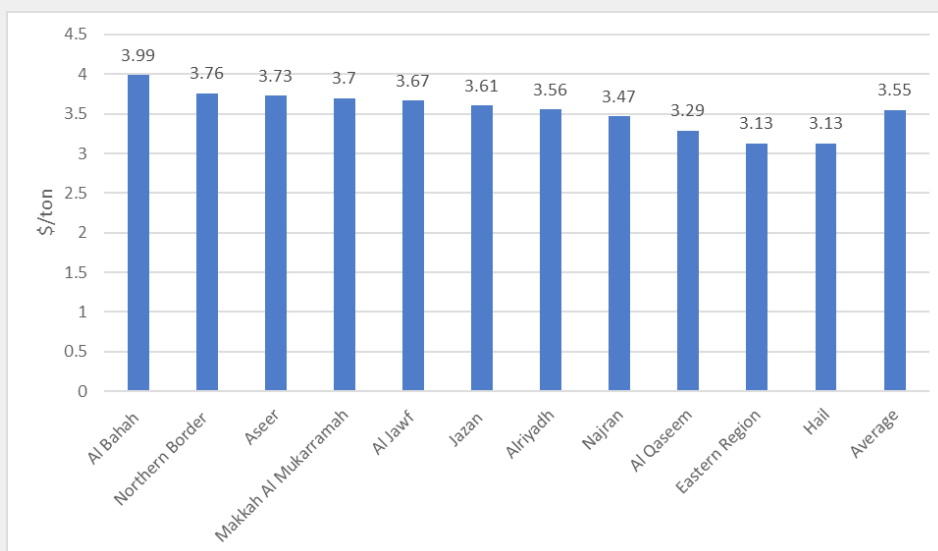


Figure 2: Average retail prices of table eggs in different regions in 2021.

Source: Data presented in Table 2.

The development of domestic production and consumption and the percentage of self-sufficiency for eggs during the period the period 1990-2021

By studying the development of domestic production and consumption and the rate of self-sufficiency for eggs during the period 1990-2021, it is clear from the data in Tables (3,4) that the domestic production of eggs increased from 113 thousand tons in 1990 to 359.2 thousand tons in 2021, i.e. the domestic production of eggs increased at an annual growth rate reached 3.9% during the period 1990-2021. The domestic consumption of eggs also increased from 104.75 thousand tons in 1990 to 320.7 thousand tons in 2021, meaning that the domestic consumption of eggs increased at an annual growth rate of 3.8% during the period 1990-2021. The rate of self-sufficiency for eggs ranged from a minimum of 95.5% in 2018 to a maximum of 121.8% in 2010. Given the achievement of self-sufficiency for eggs during the study period, the National Strategy for Agriculture in 2030 recommended the need to maintain the current self-sufficiency rate for eggs until 2030 [13].

Estimating the financing needs necessary to maintain self-sufficiency for eggs until 2030

The National Strategy for Saudi Agriculture recommended maintaining the current self-sufficiency rate until 2030. From the data presented in table (3), it is clear that the current self-sufficiency rate reached 112% in 2021. To achieve the goal of

maintaining self-sufficiency for eggs, it requires forecasting local consumption needs for eggs until 2030. In light of the general trend equation estimated for local consumption of eggs presented in (Table 4), which has a good predictive power according to the indicators measuring the efficiency of the models, the most important of which is the unequal coefficient of (U-Theil), whose value is close to zero. It is expected that the domestic consumption of eggs will increase from 325.4 thousand tons in 2023 to 424.5 thousand tons in 2030, with an estimated annual average of about 373.1 thousand tons during the period 2023-2030. By forecasting the domestic consumption of eggs, the local production required to maintain the current self-sufficiency rate for eggs is expected to increase from 364.4 thousand tons in 2023 to 475.5 thousand tons in 2030, with an estimated annual average of about 417.85 thousand tons during the period 2023-2030 (Figure 3).

And by examining the evolution of the value of loans provided by the Agricultural Development Fund to specialized projects for egg production during the last five years (2017-2021), it is clear from the data in (Table 5) that the average share of a ton of eggs in the value of loans ranged between a minimum of 7.60 dollars / ton in 2020 And a higher limit of 38.64 dollars / ton in 2017, with an annual average of 24.32 dollars / ton during the period 2017-2021. The value of loans required to maintain the current self-sufficiency rate for eggs until 2030 was estimated, based on the production required to maintain the current self-sufficiency rate and the average share of a ton of eggs from loans provided to

projects specialized in egg production. The data in (Table 6) shows an increase in the value of loans from 11.57 million dollars in 2023 to 23.13 million dollars in 2030. In light of the lending regulations of the Agricultural Development Fund, the Agricultural Development Fund finances 50% of the total investment costs of the projects to be established, and therefore the value of the investments

required to maintain the current rate of self-sufficiency for eggs is twice the value of the loans that must be provided to maintain the current self-sufficiency rate. The value of investments is expected to increase from 17.73 million dollars in 2023 to 23.13 million dollars in 2030 with a total of 162.59 million dollars during the period 2023-2030.

Table 3: The development of domestic production and consumption and the percentage of self-sufficiency for eggs during the period 1990-2021.

Year	Domestic production in thousand tons	Domestic consumption in thousand tons	Self-sufficiency %
1990	113	104.75	107.9
1991	113	103.98	108.7
1992	120	111.43	107.7
1993	123	115.26	106.7
1994	127	121.27	104.7
1995	132	122.28	107.9
1996	125	114.15	109.5
1997	131	120.97	108.3
1998	136	126	107.9
1999	136	129.63	104.9
2000	129	125.9	102.5
2001	138	135.69	101.7
2002	138	138.07	99.9
2003	137	138.28	99.1
2004	145	139.93	103.6
2005	169	160	105.6
2006	174	150.62	115.5
2007	188	163.12	115.3
2008	170	163.35	104.1
2009	191	164.64	116
2010	219	180.05	121.8
2011	218	179.07	121.7
2012	220	187.47	117.5
2013	237	198.14	119.6
2014	255	213.1	119.8
2015	275	256.87	107.1
2016	280	270.43	103.5
2017	283	278.42	101.6
2018	345	361.1	95.5
2019	349	357.64	97.6
2020	351	302.6	116
2021	359.2	320.7	112

Source: [14].

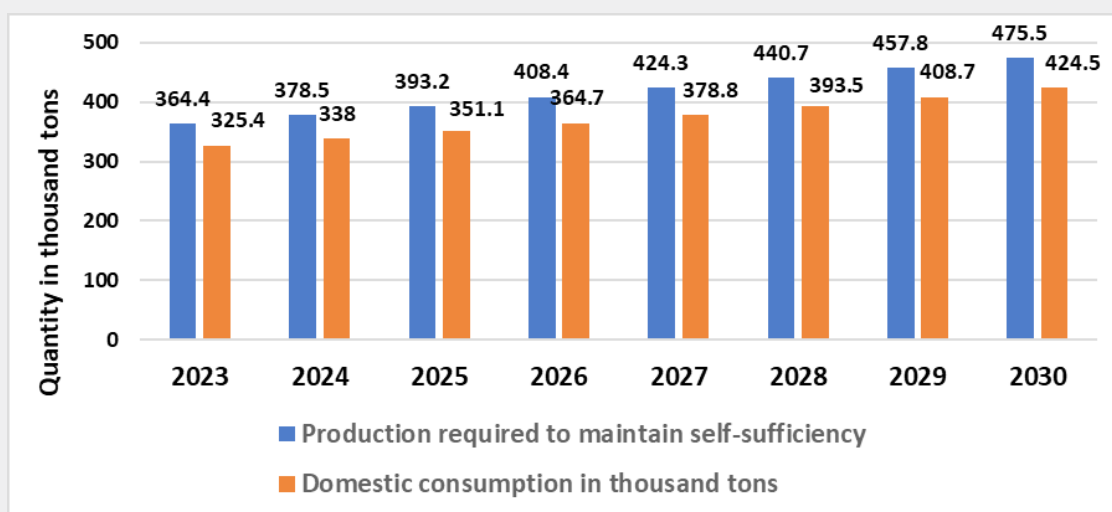


Figure 3: Forecasting the domestic consumption and production required to maintain the current self-sufficiency rate of eggs until 2030. Source: The general trend equation estimated for domestic consumption and the equation used to estimate the domestic production needed to maintain the current self-sufficiency rate for eggs.

Table 4: Equations for the general trend of the development of domestic production and consumption of eggs and indicators for measuring their efficiency during the period 1990-2021.

Statement	Annual growth rate %	F	R ²	Equation
Domestic production	3.9	450.19	0.94	$LnY_2 = 4.556 + 0.039X$ (131.24)** (21.22)**
Domestic consumption	3.8	299.31	0.91	$LnY_1 = 4.493 + 0.038X$ (108.37)** (17.30)**
Indicators measuring the efficiency of general trend equations				
Statement	R. M. S. E.	M. A. E.	M. A. P. E.	U- Theil
Domestic production	0.093	0.076	1.48	0.009
Domestic consumption	0.111	0.092	1.78	0.011

**Significant at the 1% probabilistic level. Source: Data presented in Table 3.

Table 5: Financing needs for the production of a ton of eggs during the period 2017-2021.

Year	Egg production thousand tons	The value of investment loans for specialized egg production projects in one million dollars	Financing requirements for the production of tons of eggs	
			Loans dollars / ton	Investments dollars / ton
2017	283	10.93	38.64	77.28
2018	345	4	11.6	23.2
2019	349	13.33	38.21	76.4
2020	351	2.67	7.6	15.2
2021	359.2	9.18	25.55	51.09
Average	3337.44	8.02	24.32	48.63

Source: Compiled and calculated from: (1) [2], (2) data contained in Table 3.

Table 6: The amount of loans and investments needed to maintain the current white self-sufficiency rate until 2030.

Year	Production required in thousand tons	Domestic consumption in thousand tons	Self-sufficiency %	Loan value in million dollars	Investments in millions of dollars
2023	364.4	325.4	112	8.86	17.73
2024	378.5	338	112	9.21	18.41
2025	393.2	351.1	112	9.56	19.13
2026	408.4	364.7	112	9.93	19.86
2027	424.3	378.8	112	10.32	20.64
2028	440.7	393.5	112	10.72	21.43
2029	457.8	408.7	112	11.13	22.27
2030	475.5	424.5	112	11.57	23.13
Total	-	-	-	81.3	162.59

Source: Collected and calculated from the data in Tables (4,5).

Estimating the quantity and value of water used to maintain the current self-sufficiency rate for eggs until 2030

The amount of water used to maintain the current self-sufficiency rate for eggs until 2030 was estimated by multiplying the local production needed to maintain the self-sufficiency ratio for eggs by the average water needs or water footprint per ton of eggs, which is 3519 m³/ton (Table 7).

It is clear from the data in (Table 8) that the amount of water used to maintain the current self-sufficiency rate for eggs has increased from 1.28 billion m³ in 2023 to 1.67 billion m³ in 2030. In light of the average cost of groundwater extraction of 0.1285 dollars/m³ at a discount rate of 10% [16], the value of water used to maintain the current self-sufficiency rate for eggs increases from 164.82 million dollars in 2023 to 215.07 million dollars in 2030, with a total amount of 1511.98 million dollars during the period 2023-2030.

Table 7: Average water needs (water footprint) for egg production in cubic meters/tons.

Source	Water needs for eggs
Chapagain and Hoekstra (2003)	4657
Zimmer and Renault (2003)	2700
Oki et al., (2003)	3200
Average	3519

Source: [15].

Table 8: Quantity and value of water required to maintain the self-sufficiency of eggs until 2030.

Year	Production required in thousand tons	Quantity in million m ³	Value in millions of dollars
2023	364.4	1282.32	164.82
2024	378.5	1331.94	171.2
2025	393.2	1383.67	177.85
2026	408.4	1437.16	184.72
2027	424.3	1493.11	191.91
2028	440.7	1550.82	199.33
2029	457.8	1611	207.07
2030	475.5	1673.28	215.07
Total	3342.8	11763.31	1511.98

Source: Data included in Tables (6,7).

Conclusion

Given the state's interest in food security projects, including projects specialized in egg production, the total value of loans for egg production projects and affiliated projects (grandmothers and mothers of laying hens) amounted to 304.47 million dollars, representing 10.51% of the total value of investment loans for food security projects amounting to 2898.12 million dollars since Establishment of the Agricultural Development Fund until the end of 2021. And by studying the geographical distribution of the number of projects and egg production, it was found that there is a geographical concentration of egg production projects in several regions, which makes them have a monopoly power in the production and marketing of eggs. Evidence for this is that the Riyadh region has 40 projects, at a rate of 44.94% of the total number of projects amounting to 89 projects in 2021. The projects operating in the Riyadh region also contribute about 40.57% of the total egg production of 359.20 thousand tons in 2021. The geographical concentration in egg projects and production is due in the regions of Riyadh, Qassim, Sharqiya, Makkah Al-Mukarramah and Asir receiving most of the agricultural loans and subsidies provided by the Agricultural Development Fund.

By comparing the retail prices of eggs between the regions of the Kingdom of Saudi Arabia, it was found that there is a discrepancy in the prices of eggs, which is attributed to several factors, the most important of which are: (1) the geographical concentration of specialized egg production projects in certain regions, (2) the cost of transporting eggs from regions that have a surplus for their consumption needs, to the rest of the regions that have a shortage of eggs for human consumption.

The Ministry of Environment, Water and Agriculture, in cooperation with the Agricultural Development Fund, was able to achieve self-sufficiency for eggs during the period 1990-2021. To implement the directions of the National Strategy for Saudi Agriculture until 2030, this requires an increase in the value of loans allocated to egg production projects from 17.73 million dollars in 2023 to 23.13 million dollars in 2030 with a total investment estimated at approximately 162.59 million dollars. The Agricultural Development Fund contributes approximately 81.30 million dollars. It is known that expansion in production is accompanied by an increase in the amount of water used. To achieve the goal of maintaining the current self-sufficiency rate for eggs, this requires the use of an amount of water amounting to 11.76 billion cubic meters, with a value of 1.51 billion dollars during the period 2023-2030.

Finally, this study recommends the need to maintain the current self-sufficiency rate for eggs, in line with the directions of the National Strategy for Saudi Agriculture until 2030. This recommendation is implemented through several mechanisms, the most important of which are the following: (1) The Ministry

of Environment, Water and Agriculture issues licenses to establish projects new projects, especially in areas that do not have projects specialized in egg production (Al-Jawf, Jazan, Al-Baha, and the northern borders) or expanding the production capacity of existing projects. (2) The Agricultural Development Fund provided the necessary loans and investments to increase local production of eggs until 2030.

Data Availability Statement

"No datasets were generated or analyzed during the current study".

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