Annals of Social Sciences & Management Studies
ISSN: 2641-838X

Research Article
Volume 11 Issue 1 - October 2024
DOI: 10.19080/ASM.2024.11.555803

Ann Soc Sci Manage Stud

The Economic Dimension of Camel Contribution to Meeting Consumer Needs and Food Security for Red Meat

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Submission: October 13, 2024; **Published:** October 22, 2024

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Abstract

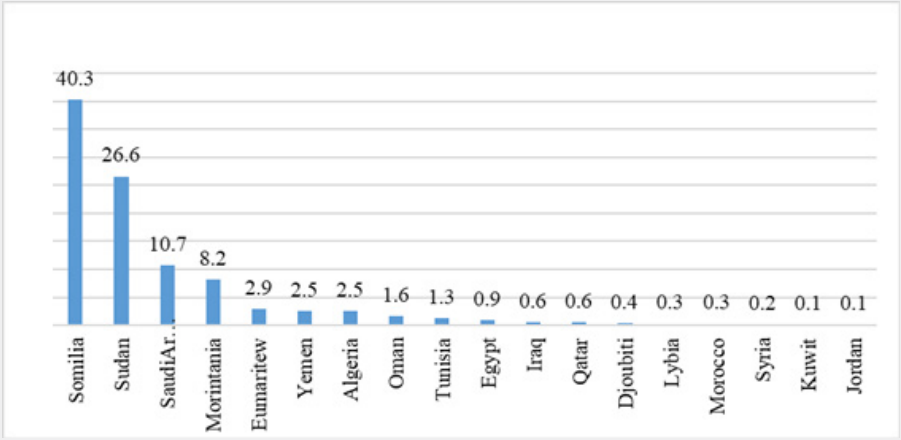
Given the country's interest in naming 2024 as the year of the camel, this study aimed to estimate the economic importance and water used for the contribution of camels to meeting consumer needs and food security for red meat, using economic equations and statistical analysis during the period 1995-2022. This study showed that the strategic stock of red meat is estimated at approximately 186.94 thousand tons. In light of domestic consumption of 398.15 thousand tons in 2022, the food security coefficient for red meat reached 0.47 at the end of the period 1995-2022. The contribution of camels to red meat production ranged between a minimum of 9.01% and a maximum of 41.11% at a confidence level of 95%. The contribution of camels to meeting consumer needs ranged between a minimum of 0.14% and a maximum of 24.48% at a confidence level of 95%. The contribution of camels to achieving the current level of food security for red meat (0.47) ranged between a minimum of 1.79% and a maximum of 8.19. % at 95% confidence. The total water used in camel meat production to contribute to both meeting consumer needs and food security for red meat amounted to 12.51 billion m3, representing 2.72% of the total water used for agricultural purposes during the period 1995-2022. The percentage of the amount of water used in camels' contribution to meeting consumer needs decreased.

Keywords: Saudi Arabia; Self-Sufficiency; Strategic Stock; Production Adequacy Period; Import Coverage Period

Introduction

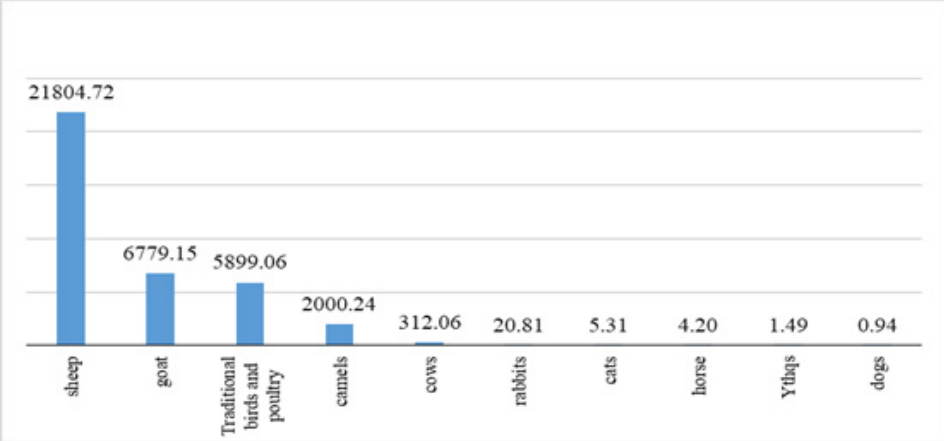
Camels occupy an important position in arid, semi-arid, and even pastoral areas, where they are used for carrying, pulling, and agricultural work, in addition to benefiting from their meat, milk, skin, and fur. The number of camels in the Arab countries is about 18.62 million heads, representing 44% of the total number of camels in the world, which amounts to 42.31 million heads in 2022. The distribution of camels in the Arab countries is irregular, as the state of Somalia contains 40.3% of the total number of camels in the Arab world. , followed by the State of Sudan with a rate of 26.6%, then the Kingdom of Saudi Arabia with a rate of 10.7%, then Mauritania with a rate of 8.2% (Figure 1). Camel breeding is characterized by the fact that it does not require any type of equipment in barns compared to equipment for cows and sheep. The rate of feed consumption for camels is low, as the camels (young camels) are fed an amount of concentrated feed amounting to 1.5% of their live weight. As well as the possibility of benefiting from desert plants spread in various regions that are accepted only by camels and no other animals.

The Kingdom of Saudi Arabia possesses an animal wealth amounting to 36.83 million heads in 2022, of which 21.8 million heads of sheep, at a rate of 59.21%, followed by goats at a rate of 18.41%, then traditional birds and poultry at a rate of 16.02%, then camels and cows at a rate of 5.43%, 0.85% for each, respectively (Figure 2). Livestock is concentrated in the Riyadh region, which possesses the equivalent of 18.08% of the total livestock, followed by Makkah Al-Mukarramah with 11.19%. Then the Asir, Jazan, Najran, Qassim, Eastern, and Al-Jawf regions, with rates reaching 9.75%, 9.69%, 9.23%, 9.15.15%, 7.49%, and 5.95% for each of them, respectively. From the above, it is clear that the eight aforementioned regions own livestock wealth amounting to 80.53%, while the percentage of possession of the rest of the regions does not exceed 19.47% in 2022 (Figure 3).



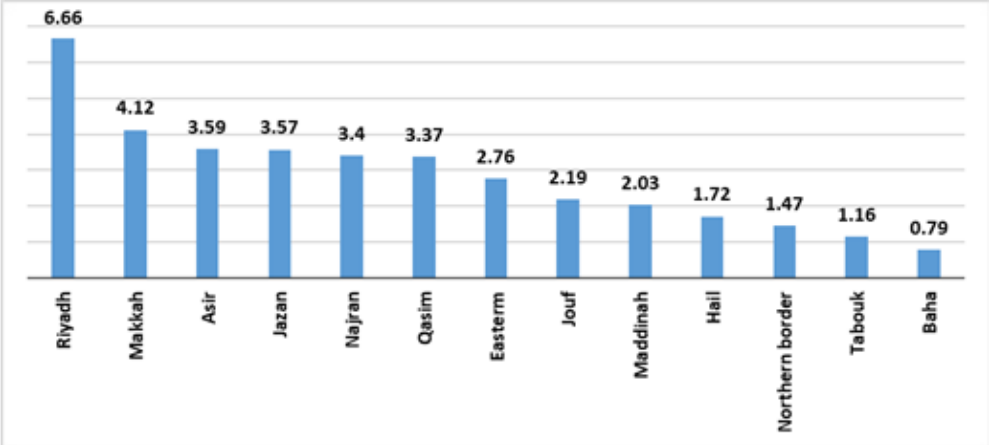
Source: Food and Agriculture Organization (FAOSTAT), 2022.

Figure 1: The relative importance of the camel's numbers in the Arab world in 2022.



Source: Ministry of Environment, Water and Agriculture (2022). The Statistical Book, pp. 206-207.

Figure 2: Number of livestock per thousand heads, in 2022.



Source: Ministry of Environment, Water and Agriculture (2022). The Statistical Book, pp. 206-207.

Figure 3: Geographical distribution of livestock numbers in million heads in 2022.

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The state provided direct and indirect support to the animal production sector, as it was shown from a study [1] that the total value of support for red meat production amounted to 724.5 million riyals, with an average of 200.4 riyals/ton during the period 1990-2012. The value of the virtual support for red meat exports amounted to 45.87 million riyals, representing 6.33% of the total value of direct and indirect support for red meat during the study period. Due to the insufficient local production to meet consumer needs, the state was forced to expand the import of red meat from abroad, as a study [2] showed an increase in the amount of Saudi imports of red meat from 105.12 thousand tons, with a value amounting to 202.49 million dollars in 2000, to 152.61 thousand tons, with a value of $789.56 million in 2021. The quantity of Saudi red meat exports also increased from 0.68 thousand tons, with a value of $1.17 million in 2000, to 23.7 thousand tons, with a value of $57.45 million in 2012, then decreased until it reached 1.88 thousand tons, with a value of $7.55 million in 2021. Given the superiority of the value of imports over exports. The value of the deficit in the trade balance of red meat increased from $201.32 million in 2000 to $782.01 million in 2021. That is, the value of the deficit in the trade balance of red meat increased at an annual growth rate of 7.4% during the period 2000-2021.

Many studies have addressed the current and hoped status of food security for red meat, as the study [3] showed that the strategic stock of red meat amounted to 189.34 thousand tons at the end of the period 2018-2030, and in light of the expected domestic consumption of red meat amounting to 510.3 thousand tons in 2030. The food security coefficient for red meat is estimated at about 0.37 during the period 2018-2030. The study recommended the need to increase the strategic stock of red meat to sufficient for local consumption for a period of no less than 6 months in accordance with food security considerations.

The study [4] showed that the contribution of local production to meeting local consumption needs for red meat ranged between a minimum of 27.54% and a maximum of 64.46% at a confidence level of 95%. The total amount of water used in the production of red meat amounted to 46.68 billion m3, representing 10.14% of the total amount of water used in the agricultural sector during the period 1995-2022. Given the dependence of red meat production on water-depleting fodder crops, the area of green fodder increased from 305.3 thousand hectares. In 1995, to 502.2 thousand hectares in 2016, then it decreased continuously until it disappeared from the crop structure beginning in 2022, with the aim of rationalizing water consumption in the agricultural sector [5].

In light of the Saudi National Agriculture Strategy for 2030, the Kingdom's directions lie in maintaining the current self-sufficiency rate for red meat (25%-30%) and reducing the number of livestock heads by 40%, with a focus on organizing the livestock sector, doubling its productivity, and reducing losses. Despite the directions of the Saudi National Agriculture Strategy, the livestock production index (2004-2006=100) increased from 44.02 in 1995, to 144.3 in 2021 [6]. The self-sufficiency rate for red meat also increased from 39.8% in 2015, to 60% in 2022, which means an increase in the amount of water used in the production of red meat [5].

Research Objectives

This research aimed to estimate the economic importance and the water used for the contribution of camels to meeting consumer needs and food security for red meat during the period 1995-2022, by studying the following objectives:

i. The current status of production, consumption, self-sufficiency and food security of red meat.

ii. Estimating the percentage of camels' contribution to production, meeting consumer needs and food security for red meat.

iii. Estimating the quantity and value of water used for the contribution of camels to meeting consumer needs and food security for red meat.

Materials and Methods

To achieve its objectives, this study relied on secondary data published in: (1) the website of the Food and Agriculture Organization (FAO) [7], and (2) the statistical book issued by the Ministry of Environment [5], Water and Agriculture. In estimating the annual growth rates for Saudi production, consumption, exports and imports of red meat during the period 2005-2022, this study relied on the exponential model and can be expressed in the following equation:

$$LnY = B_0 + B_1 T$$

The previous equation can be written as follows:

$$Y = e^{B_0 + B_1 T}$$

Where: e represents the base of the natural logarithm and equals 2.71828, B_1represents the annual growth rate, and is obtained through the first differentiation of the model, then dividing by Y as follows [8]:

$$\frac{dY}{dT} = B_1 e^{B_0 + B_1 T}$$

$$\frac{dY}{dT} \div Y = B_1$$

In estimating the strategic stock and the food security factor for red meat, this study relied on the following economic equations:

$$PSP_{lc} = LPRO_m \div LCONS_d$$

$$PCI_{lc} = QIMPO_m \div LCONS_d$$

$$ASD_m = \left[\left(SLSPCI_{lc} - 365 \right) \text{x } LCONS_d \right] - QSPO_m \text{ [9]}$$

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$FSF_m = QSS_{lm} \div LCONS_y$ [10]

PSP_{lc}: represents the period of sufficient production for domestic consumption of red meat.

$LPRO_m$: Represents the total domestic production of red meat.

$LCONS_d$: Represents the daily domestic consumption of red meat.

PCI_{lc}: represents the import coverage period for domestic consumption of red meat.

$QIMPO_m$: Represents the amount of imports of red meat.

ASD_m: Represents the amount of surplus and deficit in local consumption of red meat.

$SLSPCI_{lc}$: Represents the sum of the periods of production adequacy and import coverage for domestic consumption of red meat.

$QSPO_m$: Represents the export quantity of red meat.

FSF_m: represents the food security coefficient for red meat.

QSS_{lm}: Represents the amount of the strategic stock of red meat.

$LCONS_y$: Annual domestic consumption of red meat.

The value of the food security coefficient ranges between zero and the correct one. The closer the value of the food security coefficient is to zero, the more food security there is, and vice versa. The closer the value of the food security factor is to one, the greater the level of food security for red meat [10].

The Bernoulli distribution, which is sometimes known as the binomial distribution, and standard errors at 95% confidence were used to estimate the percentage or probability that camels will contribute to both local production, meeting consumer needs, and food security for red meat during the period 1995-2022. When estimating the percentage or probability of contribution, the estimation is accompanied by standard errors that are considered when estimating confidence intervals as follows:

Standard error of probability at 95% confidence = $\pm 1.96 * \sqrt{\frac{P(1-P)}{N}}$

95% confidence interval for probability = $P \pm 1.96 * \sqrt{\frac{P(1-P)}{N}}$

Where: P represents the probability of contributing to production, meeting consumer needs and food security, $(1-P)$ represents the probability of not contributing, represents the length of the time series 1995-2022 [11].

Finally, this study relied on the following economic equations to estimate the quantity and value of water used in contribution of camels to meet consumption needs and food security for red meat:

i. The amount of water used in the production of camel meat in contribution to meet consumer needs $(QWMPC_{cn})$ = camel meat production (MP_{cam}) × the average water requirement for the unit of red meat produced $(AWRM_{un})$.

ii. The value of water used in the production of camel meat to contribute to meeting consumer needs $(VQWMP_{CN})$ = the amount of water used in the production of camel meat to contribute to meeting consumer needs $(QWCMP_{CN})$ × the average cost of extracting a $(ACEG_{un})$ groundwater unit.

iii. The ratio of the production adequacy period for domestic consumption $(PPAP_{lc})$ = the production adequacy period for domestic consumption (PSP_{lc}) ÷ the sum of the production adequacy period and import coverage period for domestic consumption $(SLSPCI_{lc})$.

iv. The share of domestic production in the strategic stock (SLP_{ss}) = the ratio of the production adequacy period for domestic consumption $(PPAP_{lc})$ × the amount of the strategic stock (QSS_{lm}).

v. Share of camel meat in the strategic stock (SCM_{ss}) = Share of local production in the strategic stock (SLP_{ss}) × average contribution of camels to local red meat production $(ACCP_{rm})$.

vi. The amount of water used in the production of camel meat to contribute to food security $(QW+MPC_{fs})$ = the share of camel meat in the strategic stock (SCM_{ss}) × the average water requirement of the unit of red meat produced $(AWRM_{un})$.

vii. The value of water used in camel meat production to contribute to food security $(VQWMP_{fs})$ = the amount of water used in camel meat production to contribute to food security $(QWMPC_{fs})$ × the average cost of groundwater extraction unit $(ACEG_{un})$.

Result and Discussion

Production, Consumption, and Nutritional Gap of red meat during the period 1995-2022

By studying the current situation of red meat production during the period 1995-2022, it is clear from the data presented in the (Figures 4, 5) and (Tables 1,2) that the local production of red meat increased from 155.14 thousand tons in 1995, to 265.0 thousand tons in 2022. The growth rates ranged for red meat production between a minimum of 0.47% for sheep meat and a maximum of 2.9% for beef meat. In general, local production of red meat increased at an annual growth rate of 1.4%. Sheep ranked first in red meat production with a rate of 42.45%, followed by camels with a rate of 26.33%, then cows and goats with a rate of 17.17% and 14.05% for each of them, respectively, during the period 1995-2022.

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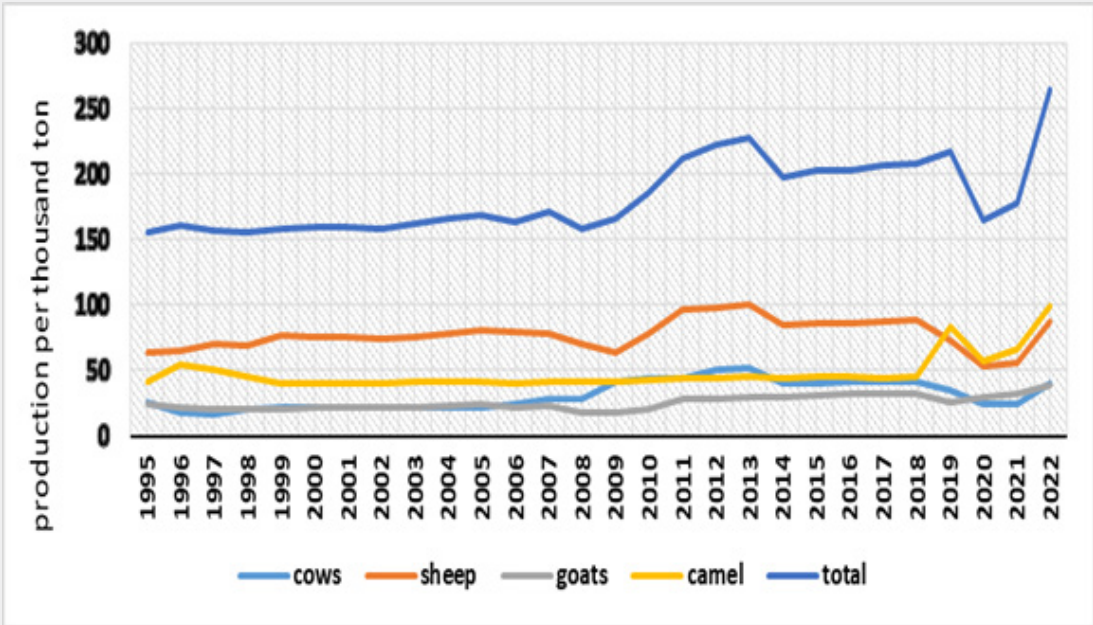
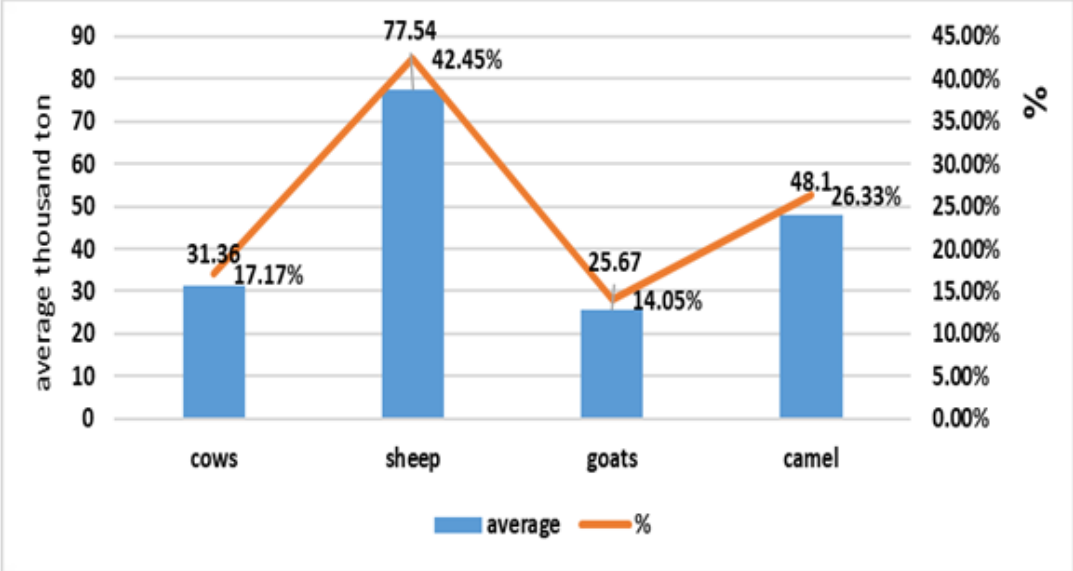


Source: (1) Ministry of Environment, Water and Agriculture (2022). Statistical Book, (2) Food and Agriculture Organization, website (FAOSTAT).

Figure 4: Red meat production per thousand ton in Saudi Arabia 1995-2022.



Source: Data contained in Figure (4).

Figure 5: Average and relative importance of red meat production during the period 1995-2022.

Domestic consumption of red meat increased from 370.65 thousand tons, at a rate of 1.02 thousand tons/day in 1995, to 533.29 thousand tons, at a rate of 1.46 thousand tons/day in 2019, then decreased to 441.7 thousand tons, at a rate of 1.21 thousand tons/day in 2022. In general, domestic consumption of red meat increased at an annual growth rate of 1.7% during the study period. In light of the local production and consumption of red meat, the food gap increased from 215.51 thousand tons in 1995, to 306.13 thousand tons in 2015, then decreased to 176.67 thousand tons in 2022. In general, the nutritional gap for red meat increased at an annual growth rate of 1.6%. The self-sufficiency rate also ranged between a minimum of 38.6% in 2002 and a maximum of 66.7% in 2001, with an annual average estimated at about 46.02% during the period 1995-2022 (Figure 6).

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Table 1: Production, consumption, and nutritional gap of red meat during the period 1995-2022.

Year	Local production	Local consumption in thousand ton		Food gap in thousand tons
	Thousand ton	Annual	Daily	
1995	155.14	370.65	1.02	215.51
1996	161.14	377.69	1.03	216.55
1997	157	323.38	0.89	166.38
1998	155.02	286.27	0.78	131.25
1999	158.69	309.63	0.85	150.94
2000	159.64	322.18	0.88	162.54
2001	159.96	240	0.66	80.04
2002	158.67	410.9	1.13	252.23
2003	161.93	363.17	0.99	201.24
2004	165.84	358.8	0.98	192.96
2005	168.97	435.09	1.19	266.12
2006	164.08	398.78	1.09	234.7
2007	171.24	405.94	1.11	234.7
2008	158.24	356.25	0.98	198.01
2009	166.5	374.95	1.03	208.45
2010	185.3	366.95	1.01	181.65
2011	212.16	433.23	1.19	221.07
2012	222	469.64	1.29	247.64
2013	227.96	490.58	1.34	262.62
2014	197.2	467.71	1.28	270.51
2015	202.65	508.78	1.39	306.13
2016	203.39	444.41	1.22	241.02
2017	206.17	438.14	1.2	231.97
2018	207.89	403.71	1.11	195.82
2019	217	533.29	1.46	316.29
2020	165	402.44	1.1	237.44
2021	178	413.95	1.13	235.95
2022	265	441.67	1.21	176.67
average	182.56	398.15	1.09	215.59

Source: Collected and calculated from: (1) data in Figure 3, (2) Food and Agriculture Organization (FAOSTAT), period 1995-2022.

Table 2: General trend equations for the development of production, consumption, and the nutritional gap for red meat during the period 1995-2022.

Statement	Annual growth %	F	R^2	*equation*
cows	2.9	23.48	0.47	$Ln\hat{Y}_1 = 2.967 + 0.029X$ $(29.85)^{**}\ (4.85)^{**}$
sheep	0.47*	4.75	0.28	$\hat{Y}_2 = 59.296 + 2.973X - 0.090X^2$ $(9.45)^{**}\ (2.98)^{**}\ (-2.70)^{**}$

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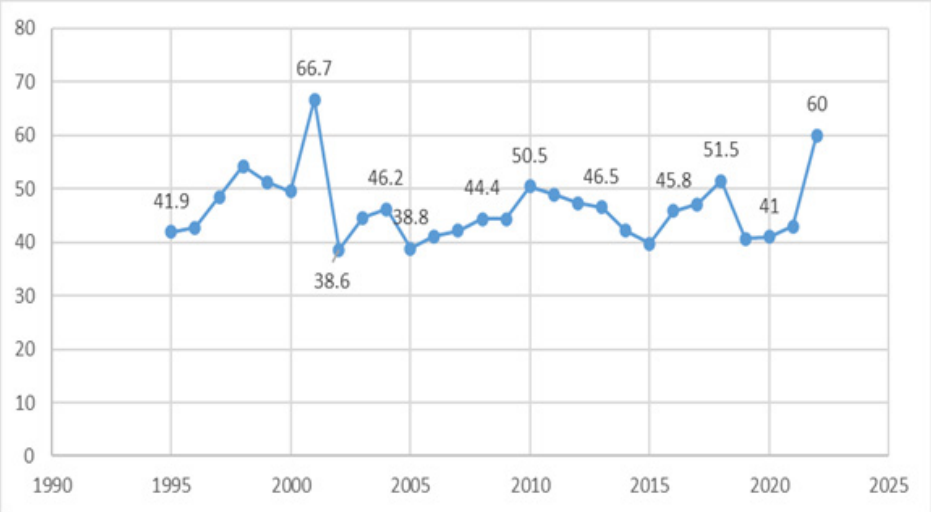
goats	1.8	34.29	0.57	$\widehat{LnY_3} = 2.958 + 0.018X$ $(56.58)^{**}\ (5.86)^{**}$
camel	1.5	10.98	0.3	$\widehat{LnY_4} = 3.630 + 0.015X$ $(48.95)^{**}\ (3.31)^{**}$
Total production	1.4	36.04	0.58	$\widehat{LnY_5} = 4.998 + 0.014X$ $(132.29)^{**}\ (6.00)^{**}$
Total consumption	1.7	28.97	0.53	$\widehat{LnY_6} = 5.742 + 0.017X$ $(111.74)^{**}\ (5.38)^{**}$
Food gap	1.6	7.41	0.22	$\widehat{LnY_7} = 5.111 + 0.016X$ $(52.81)^{**}\ (2.72)^{**}$
*The annual growth rate was calculated from the following law: $r = \left(\frac{dY}{dT} \div \overline{Y}\right) \text{x}100$				

**Significant at the 1% probability level.

Source: Collected and calculated from the data in Figure 3 and Table 1.



Source: Collected and calculated from the data in Table 1.

Figure 6: Self-sufficiency ratio of red meat during the period 1995-2022.

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Estimating the strategic stock and the food security coefficient for red meat

Given the dependence of food security for red meat on both local production and imports from abroad, the strategic stock and the food security coefficient for red meat were estimated by estimating the periods of production adequacy and import coverage and the amount of surplus and deficit in local consumption of red meat during the period 1995-2022. It is clear from the data in (Tables 3-5) that:

i. The amount of Saudi red meat imports ranged between a minimum of 124.66 thousand tons in 2001 and a maximum of 338.82 thousand tons in 2015, with an annual average estimated at about 248.55 thousand tons. The amount of Saudi red meat imports increased at a small annual growth rate of 0.8%. The amount of red meat exports ranged between a minimum of 3.84 thousand tons in 2000 and a maximum of 91.0 thousand tons in 2021, with an annual average estimated at about 28.31 thousand tons. The amount of red meat exports increased at an annual growth rate of 6.7% during the period 1995-2022.

ii. The period of adequacy of production for domestic consumption ranged between a minimum of 109.5 days in 2020 and a maximum of 243.3 days in 2001, with an annual average estimated at about 167.94 days during the study period. The coverage period for imports for domestic consumption ranged between a minimum of 162.6 days in 2019 and a maximum of 263.3 days in 2005, with an annual average estimated at about 228.54 days during the study period. The period of coverage of imports for domestic consumption decreased at a small rate of 0.7% annually during the period 1995-2022.

iii. A surplus of red meat amounted to 573.78 thousand tons during the years 1995-2007, 2010, 2013-2015, 2017, and 2022, sufficient for local consumption for a period of 584.1 days, or 19.47 months. There was also a deficit in local consumption of red meat during the years 2008-2009, 2011-2012, 2016, 2018-2021, where the amount of the deficit amounted to 386.84 thousand tons by 327.2 days, or about 10.9 months. The ratio of the surplus to the deficit in red meat reached 148.3% at the end of the period 1995-2022.

iv. According to the concept of the strategic stock, as the sum of the difference between the total surplus and deficit, the strategic stock is estimated at approximately 186.94 thousand tons. In light of the domestic consumption of red meat amounting to 398.15 thousand tons in 2022, the food security coefficient for red meat is estimated at about 0.47 at the end of the period 1995-2022.

Table 3: The quantity of imports and exports, the two periods of production adequacy, and import coverage of domestic consumption of red meat during the period 1995-2022.

Year	Import quantity in thousand ton	Export quantity in thousand ton	Daily local consumption in thousand ton	Production adequacy period per day	Import coverage period per day
1995	251.16	4.29	1.02	152.8	246.2
1996	250.51	3.96	1.03	155.7	243.2
1997	206.91	4.46	0.89	177.2	232.5
1998	184.22	7.08	0.78	197.7	236.2
1999	197.45	9	0.85	187.1	232.3
2000	211.47	3.84	0.88	180.9	240.3
2001	124.66	6.91	0.66	243.3	188.9
2002	282.35	8.81	1.13	140.9	249.9
2003	248.81	11.61	0.99	162.7	251.3
2004	250.39	15.21	0.98	168.7	255.5
2005	313.29	23.86	1.19	141.8	263.3
2006	276.72	29.4	1.09	150.2	253.9
2007	274.66	36.41	1.11	154	247.4
2008	226.9	42.26	0.98	162.1	231.5
2009	222.32	38.81	1.03	162.1	215.8
2010	232.94	46.56	1.01	184.3	230.6
2011	260.09	44.55	1.19	178.7	218.6
2012	284.85	52.32	1.29	172.5	220.8
2013	282.34	17.27	1.34	169.6	210.7
2014	306.87	19.08	1.28	153.9	239.7

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2015	338.82	18.27	1.39	145.4	243.8
2016	255.03	20.53	1.22	167	209
2017	256.11	21.29	1.2	171.8	213.4
2018	215.03	22.58	1.11	188	193.7
2019	237.46	21.35	1.46	148.5	162.6
2020	225.86	82	1.1	109.5	205.3
2021	249.36	91	1.13	156.9	220.7
2022	292.78	90	1.21	219	241.9
average	248.55	28.31	1.09	167.94	228.54

Source: Collected and calculated from: (1) the data presented in Table 1, (2) the Food and Agriculture Organization (FAOSTAT).

Table 4: General trend equations for both imports, exports, the two periods of production adequacy and import coverage of domestic consumption of red meat during the period 1995-2022.

Statement	Annual growth rate %	F	R^2	Equation
Import quantity	0.8	3.9	0.13	$\widehat{LnY_1} = 5.374 + 0.008X$ $(74.75)^{**}\ (1.97)^{*}$
Export quantity	6.7	24.07	0.48	$\widehat{LnY_2} = 1.848 + 0.067X$ $(48.95)^{**}\ (3.31)^{**}$
Production adequacy period	-	0.73	0.03	$\widehat{LnY_3} = 5.156 - 0.003X$ $(88.14)^{**}\ (-0.85)^{ns}$
Import coverage period	-0.7	10.36	0.29	$\widehat{LnY_4} = 5.527 + 0.007X$ $(150.70)^{**}\ (-3.22)^{**}$

****S**ignificant at the 1% probability level, *Significant at the 5% probability level, ns not significant.

Source: Collected and calculated from the data presented in Table 3.

Table 5: The amount of surplus and deficit in domestic consumption of red meat during the period 1995-2022.

year	surplus		Deficit	
	Quantity in thousand ton	Surplus sufficiency period per day	Quantity in thousand ton	deficit period per day
1995	30.39	29.8	-	-
1996	30.96	30.1	-	-
1997	35.32	39.7	-	-
1998	46.66	59.8	-	-
1999	37.24	43.8	-	-
2000	45.62	51.8	-	-
2001	37.44	56.7	-	-
2002	20.34	18	-	-

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2003	36.9	37.3	-	-
2004	42.81	43.7	-	-
2005	23.86	20	-	-
2006	13.22	12.1	-	-
2007	3.99	3.6	-	-
2008	-	-	14.23	14.5
2009	-	-	25.52	24.8
2010	3.84	3.8	-	-
2011	-	-	6.11	5.1
2012	-	-	15.81	12.3
2013	3.23	2.4	-	-
2014	17.53	13.7	-	-
2015	15.37	11.1	-	-
2016	-	-	7.11	5.8
2017	2.95	2.5	-	-
2018	-	-	4.04	3.6
2019	-	-	100.04	68.5
2020	-	-	137.22	124.7
2021	-	-	76.76	67.9
2022	126.11	104.2	-	-
total	573.78	584.1	386.84	327.2
Strategic stock	186.94			
Food security coefficient	0.47			

Source: Collected and calculated from the data in Tables (1, 3).

Table 6: The relative importance of camels' contribution to production and meeting consumption needs for red meat during the period 1995-2022.

Year	Camel meat production In thousand tons	Total production of red meat in thousand tons	Total consumption of red meat in thousand tons	Camel contribution rate %	
				production	consumption
1995	41.6	155.14	370.65	26.81	11.22
1996	55.2	161.14	377.69	34.26	14.62
1997	50	157	323.38	31.85	15.46
1998	45.5	155.02	286.27	29.35	15.89
1999	39.59	158.69	309.63	24.95	12.79
2000	39.84	159.64	322.18	24.96	12.37
2001	39.92	159.96	240	24.96	16.63
2002	40.5	158.67	410.9	25.52	9.86
2003	41.25	161.93	363.17	25.47	11.36
2004	41.96	165.84	358.8	25.3	11.69
2005	41.07	168.97	435.09	24.31	9.44
2006	39.58	164.08	398.78	24.12	9.93
2007	41.14	171.24	405.94	24.02	10.13
2008	41.14	158.24	356.25	26	11.55

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2009	42	166.5	374.95	25.23	11.2
2010	43	185.3	366.95	23.21	11.72
2011	43.56	212.16	433.23	20.53	10.05
2012	44	222	469.64	19.82	9.37
2013	45.8	227.96	490.58	20.09	9.34
2014	48	197.2	467.71	24.79	10.26
2015	51	202.65	508.78	25.34	10.02
2016	57	203.39	444.41	27.04	12.83
2017	61	206.17	438.14	28.18	13.92
2018	63	207.89	403.71	27.51	15.61
2019	59	217	533.29	21.63	11.06
2020	61	165	402.44	18.62	15.16
2021	60.55	178	413.95	19.24	14.63
2022	73.75	265	441.67	28.51	16.7
average	48.25	182.56	398.15	25.06	12.31

Source: Food and Agriculture Organization, FAOSTAT website.

Table 7: General trend equations for the contribution of camels to production and meeting consumption needs for red meat during the period 1995-2022.

contribution	Annual growth ratio %	F	R^2	equation
production	-0.8	8.09	0.2	$Ln\hat{Y}_1 = 3.335 - 0.008X$ $(66.85)^{**}\ (-2.84)^{**}$
consumption	-8.10*	10.9	0.2	$\hat{Y}_2 = 16.185 + 0.793X - 0.027X^2$ $(14.53)^{**}\ (-4.48)^{**}\ (4.67)^{**}$
*The annual growth rate was calculated from the following law: $r = \left(\frac{dY}{dT} \div \overline{Y}\right) x100$				

**Significant at the 1% probability level.

Source: Collected and calculated from the data in Table 6.

The Relative importance of Camels' Contribution to Production and meeting Consumer needs and Food Security of Red Meat

The Relative importance of Camels' Contribution to Red Meat Production:

By studying the contribution of camels to red meat production, it is clear from the data in (Tables 6,7) that the contribution of camels to red meat production ranged between a minimum of 18.62% in 2020 and a maximum of 34.26% in 1996, with an annual average of 25.06% during the study period. Estimating the contribution of camels to red meat production at a confidence level of 95%, it is clear that it ranged between a minimum of 9.01% and a maximum of 41.11% (Table 8).

The Relative importance of Camels' Contribution to Achieving the Current level of Food Security for Red Meat:

By examining the contribution of camels to achieving the current level of food security for red meat, it is clear from the data in (Table 9) that the contribution of camels to achieving the current level of food security for red meat ranged between a minimum of 1.79% and a maximum of 8.19% at a confidence level of 95%. In general, the total production of red meat contributed to achieving the current level of food security at a rate that ranged between a minimum of 11.31% and a maximum of 28.51% at a confidence level of 95%. The relative importance of the contribution of red meat imports to achieving the current level of food security ranged between a minimum of 18.49% and a maximum of 35.69% at a confidence level of 95%.

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Table (8): The relative importance of camels' contribution to production and meeting consumption needs for red meat at 95% confidence during the period 1995-2022.

Statement	Camel contribution ratio at 95% level	
	Production	Consumption
Average for the period 1995-2022	25.06%	12.31%
Contribution probability	0.2506	0.1231
Non-Contribution probability	0.7494	0.8769
Standard error of contribution probability	0.0819	0.0621
Standard error at 95% confidence	0.1605	0.1217
Contribution probability at 95% level	0.2506 ± 0.1605	0.1231 ± 0.1217
Contribution ratio at 95% level		
Lower limit	9.01%	0.14%
Upper limit	41.11%	24.48%

Source: Collected and calculated from the data in Table 6.

Table 9: The relative importance of the contribution of total production, camel meat, and imports to achieving relative food security for red meat during the period 1995-2022.

Statement	Relative food security for red meat (0.47)		
	Total production	Camel meat	imports
Contribution probability	0.1991	0.0499	0.2709
Non-Contribution probability	0.2709	0.1492	0.1991
Standard error of contribution probability	0.0439	0.0163	0.0439
Standard error at 95% confidence	0.086	0.032	0.086
Contribution probability at 95% level	0.1991 ±	0.0499 ±	0.2709 ±
	0.086	0.032	0.086
Contribution ratio at 95% level			
Lower limit	11.31%	1.79%	18.49%
Upper limit	28.51%	8.19%	35.69%

Source: Collected and calculated from the data in Tables (5, 6).

The quantity and value of water used by camels to meet consumer needs for food security of red meat

Quantity and value of water used to by camels to meet consumption needs for red meat:

The amount of water used was estimated for camels' contribution to meeting consumption needs for red meat, using an average water requirement per ton of 9.13 thousand m3/ton [4]. It is clear from the data in (Table 10) that the amount of water used in the production of camel meat to meet consumer needs increased from 379.81 million m3, representing 2.6% of the total amount of water used for agricultural purposes, which amounted to 14.82 billion m3 in 1995, to 673.34 million m3, representing 8.9%. Of the total amount of water used for agricultural purposes amounting to 7.58 billion cubic meters in 2022. The total amount of water used in the production of camel meat to meet consumer needs amounted to about 12.33 billion m3, representing 2.68% of the total amount of water used for agricultural purposes, amounting to 460.41 billion m3 during the period 1995-2022. In light of the average cost of groundwater extraction of 0.482 riyals/m3. At a discount price of 10% [12], the value of water used in producing camel meat to meet consumer needs increased from 183.07 million riyals in 1995, to 324.55 million riyals in 2022.

Quantity and value of Water used for Camels' Contribution to Food security for red meat:

The amount of water used in camel meat production was estimated to contribute to achieving the current level of food security of (0.47), through the strategic stock of red meat amounting to 186.94 thousand tons at the end of the period 1995-2022. In light of the ratio of the two periods of production adequacy and import coverage for local consumption, it was determining the contribution of both local production and imports to the formation of the strategic stock of red meat, which amounted to 79.19 and 107.75 thousand tons for each, respectively. In light of the average relative importance of the contribution of camels to red meat production, the share of camels in the composition of the strategic stock of red meat was determined to be 19.85

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thousand tons, representing 10.62% of the strategic stock of red meat amounting to 186.94 thousand tons at the end of the study period. In light of the average water requirement per ton of 9.13 thousand m3/ton [13], the amount of water used in camel meat production to contribute to achieving the current level of food security amounted to 181.23 million m3, with a value of 87.35 million riyals at the end of the period 1995-2022.

Table 10: The amount of water used in the production of red meat and its ratio to the total water consumption for agricultural purposes during the period 1995-2022.

year	Water used in red meat production		Water used in camel meat production		Water used in the agricultural sector In billion m3	Percentage of the amount of water used in camel meat production %	
	Quantity in billion cubic meters	Value in million riyals	Quantity in million cubic meters	Value in million riyals		Water used in the production of red meat	Water used in agriculture sector
1995	1.42	682.72	379.81	183.07	14.82	26.7	2.6
1996	1.47	709.12	503.98	242.92	15.32	34.3	3.3
1997	1.43	690.9	456.5	220.03	18.66	31.9	2.4
1998	1.42	682.19	415.42	200.23	18.05	29.3	2.3
1999	1.45	698.34	361.46	174.22	18.3	24.9	2
2000	1.46	702.52	363.74	175.32	18	24.9	2
2001	1.46	703.93	364.47	175.67	18.64	25	2
2002	1.45	698.25	369.77	178.23	18.28	25.5	2
2003	1.48	712.6	376.61	181.53	18.03	25.4	2.1
2004	1.51	729.81	383.09	184.65	19.85	25.4	1.9
2005	1.54	743.58	374.97	180.74	18.59	24.3	2
2006	1.5	722.06	361.37	174.18	17	24.1	2.1
2007	1.56	753.57	375.61	181.04	15.42	24.1	2.4
2008	1.44	696.36	375.61	181.04	15.08	26.1	2.5
2009	1.52	732.71	383.46	184.83	14.75	25.2	2.6
2010	1.69	815.44	392.59	189.23	14.41	23.2	2.7
2011	1.94	933.64	397.7	191.69	15.97	20.5	2.5
2012	2.03	976.95	401.72	193.63	17.51	19.8	2.3
2013	2.08	1003.17	418.15	201.55	18.64	20.1	2.2
2014	1.8	867.81	438.24	211.23	19.61	24.3	2.2
2015	1.85	891.79	465.63	224.43	20.83	25.2	2.2
2016	1.86	895.05	520.41	250.84	19.79	28	2.6
2017	1.88	907.28	556.93	268.44	19.2	29.6	2.9
2018	1.9	914.85	575.19	277.24	19	30.3	3
2019	1.98	954.94	538.67	259.64	10.5	27.2	5.1
2020	1.51	726.11	556.93	268.44	8.5	36.9	6.6
2021	1.63	783.32	552.82	266.46	10.08	33.9	5.5
2022	2.42	1166.17	673.34	324.55	*7.58	27.8	8.9
total	46.68	22495.18	12334.19	5945.07	460.41	-	-

*estimated.

Source: Collected and calculated from: (1) Data in Table 6, (2) Ministry of Environment, Water and Agriculture, Statistical Book, period 1995-2022.

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Conclusion

Given the importance of camels in meeting consumer needs and food security for red meat, in addition to their cultural value, and their spread in arid and semi-arid regions, the Council of Ministers approved, on 12/19/2023, to designate 2024 as the Year of the Camel. This study showed that the Kingdom of Saudi Arabia possesses an animal wealth amounting to 36.83 million heads in 2022, including 21.8 million heads of sheep, at a rate of 59.21%, followed by goats at a rate of 18.41%, then traditional birds and poultry at a rate of 16.02%, then camels and cows at a rate of 5.43%. 0.85% for each, respectively.

Due to water scarcity and the reduction in the amount of water available to the agricultural sector, the cropped area decreased from 1.34 million hectares in 1995, to 534.5 thousand hectares in 2022. Despite the continuing decrease in the cropped area, the value of agricultural output increased from 31.4 billion riyals, representing 5.85% of the total the gross domestic product in 1995, to 99.98 billion riyals, representing 2.41% of the gross domestic product in 2022. This is due to organizing the livestock sector, doubling its productivity and reducing losses, as evidenced by the increase in the livestock production index (2004-2006=100), from 44.02. in 1995, to 144.3 in 2021 [6]. The self-sufficiency rate for red meat also increased from 39.8% in 2015 to 60% in 2022.

Despite the small relative importance of the number of camels in the Kingdom, they contributed to the local production of red meat at a rate that ranged between a minimum of 9.01% and a maximum of 41.11% at a confidence level of 95%. The contribution of camels to red meat production declined at a slight rate of 0.8% during the period 1995-2022. This is due to changes in consumption patterns and their bias toward other types of meat, especially lamb, goat, and poultry meat, as well as the relationship between the increase in per capita income and the demand for camel meat. Camels contributed to meeting consumption needs for red meat at a rate ranging between a minimum of 0.14% and a maximum of 24.48% at a confidence level of 95%. The contribution of camels to achieving the current level of food security for red meat (0.47) ranged between a minimum of 1.79% and a maximum of 8.19% at a confidence level of 95%.

The study also showed that the contribution of camels to meeting the consumption needs for red meat resulted in the consumption of an amount of water amounting to 12.33 billion m3, representing 2.68% of the total amount of water used for agricultural purposes, which amounted to 460.41 billion m3 during the period 1995-2022. The amount of water used in the production of camel meat to contribute to achieving the current level of food security, reached181.23 million m3, with a value amounting to 87.35 million riyals at the end of the period 1995-2022. From the above, it is clear that the percentage of water used for camels' contribution to both meeting consumer needs and food security amounted to 2.72% of the total water used for agricultural purposes during the period 1995-2022. The percentage of the amount of water used in camel meat production to contribute to meeting consumer needs and food security decreased. It justifies moving forward in increasing camel meat production with the aim of reducing the food gap and trade deficit on the one hand and increasing the self-sufficiency rate and food security factor for red meat on the other hand.

Data Availability Statement

The data that support this study are available in the article and accompanying online supplementary material.

Acknowledgement

The authors extend their sincere appreciation to the Deanship of Scientific Research at King Saud University for supporting the work.

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