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Dairy Sector Dynamics and Their Implications for Food Security in Libya: An Empirical Study

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ديناميكيات قطاع الألبان وآثارها على الأمن الغذائي في ليبيا: دراسة تطبيقية

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Abstract:
This study analyses the dynamics of the dairy sector and its implications for food security in Libya over the period 1990–2024. It focuses on the key components of the dairy system, namely production, consumption, imports, and the dairy gap, using log-linear trend specifications to identify long-term growth patterns. The results reveal a statistically significant decline in dairy production, with an average annual contraction of approximately 1.24%, indicating structural weaknesses in domestic supply capacity. In contrast, dairy consumption exhibits a modest upward trend of about 0.88% per year, although with limited statistical significance, suggesting variability in demand conditions. Dairy imports show a strong and statistically significant increase, growing at an annual rate of 1.71%, reflecting a growing reliance on external sources to meet domestic needs. Consequently, the dairy gap shows a positive trend, increasing by approximately 1.38% annually, although this trend is only weakly significant. Despite this, the combined evidence points to a persistent structural imbalance in the dairy sector, characterized by declining domestic production and rising import dependence. These findings highlight growing pressures on food security, as reliance on imports exposes the sector to external shocks and market volatility. The study underscores the importance of enhancing domestic production capacity and improving sectoral resilience as key policy priorities for achieving sustainable food security.

Keywords: Dairy sector; Food security; Dairy gap; Imports; Agricultural Economics.

الملخص
تحلّل هذه الدراسة ديناميكيات قطاع الألبان وآثارها على الأمن الغذائي في ليبيا خلال الفترة 1990–2024. وتركّز الدراسة على المكونات الرئيسة لمنظومة الألبان، وهي الإنتاج والاستهلاك والواردات والفجوة اللبنية، وذلك باستخدام نماذج الاتجاه اللوغاريتمي الخطي بهدف تحديد أنماط النمو طويلة الأجل. أظهرت النتائج وجود انخفاض معنوي إحصائيًا في إنتاج الألبان، بمعدل تراجع سنوي متوسطه نحو 1.24%، مما يعكس وجود اختلالات هيكلية في القدرة الإنتاجية المحلية. وفي المقابل، أظهر استهلاك الألبان اتجاهًا تصاعديًا طفيفًا بلغ حوالي 0.88% سنويًا، إلا أن دلالته الإحصائية كانت محدودة، وهو ما يشير إلى وجود تباين في ظروف الطلب. كما بيّنت النتائج ارتفاعًا قويًا ومعنويًا إحصائيًا في واردات الألبان، بمعدل نمو سنوي بلغ 1.71%، مما يعكس تزايد الاعتماد على المصادر الخارجية لتلبية الاحتياجات المحلية. ونتيجة لذلك، أظهرت الفجوة اللبنية اتجاهًا متزايدًا بمعدل يقارب 1.38% سنويًا، رغم أن هذا الاتجاه كان ضعيف احصائيا. وعلى الرغم من ذلك، فإن مجمل النتائج تشير إلى وجود اختلال هيكلي مستمر في قطاع الألبان، يتسم بتراجع الإنتاج المحلي وارتفاع الاعتماد على الواردات. وتبرز هذه النتائج الضغوط المتزايدة على الأمن الغذائي، حيث إن الاعتماد على الواردات يجعل القطاع أكثر عرضة للصدمات الخارجية وتقلبات الأسواق العالمية. وتؤكد الدراسة أهمية تعزيز القدرة الإنتاجية المحلية وتحسين مرونة القطاع باعتبارهما من الأولويات الأساسية لتحقيق الأمن الغذائي المستدام.

الكلمات المفتاحية: قطاع الألبان؛ الأمن الغذائي؛ فجوة الألبان؛ الواردات؛ الاقتصاد الزراعي.

Introduction

Food security and meeting the population's food requirements are among the top priorities of agricultural economic policies in all nations worldwide. Improving the nutritional status of citizens and enhancing the quality of their dietary consumption are also key objectives of sustainable development. The issue of food security is one of the most significant challenges facing many countries, particularly developing nations. Despite the availability of natural resources in these countries such as land, water, and human resources agriculture has not been able to achieve the targeted increase in production needed to meet the growing demand [5]. This has led to an expanding food gap, forcing these countries to rely on imports to cover the deficit in domestic production.

Livestock production is considered one of the main sources of protein necessary for human nutrition, represented by red meat, milk, and dairy products. Foods derived from animal sources are of higher nutritional value than those derived from plant sources, as animal protein contains greater amounts of the eight essential amino acids. Animal protein is also vital for tissue formation, growth, and repair, and it is a source of fats that provide energy, in addition to vitamins.

Milk and dairy products contribute significantly to providing animal protein for consumers, as they contain essential components required for growth, activity, and health especially in children's nutrition [17]. Milk is one of the oldest food substances known to humans. Milk protein consists of a variety of proteins, the most important of which is casein, which constitutes about 80% of milk protein and is found only in milk. Milk also contains carbohydrates, fats, minerals, and vitamins. [8]

Research Problem:

The research problem lies in the increasing reliance on imports to provide this essential food commodity, which may expose national food security to risks related to global market fluctuations and exchange rate volatility.

Research Objectives:

To analyse the role of foreign trade precisely dairy imports in providing dairy products to consumers, and to assess their impact on meeting local demand.

Importance of the Study:

The study contributes to enriching the economic literature on the impact of foreign trade on food security, particularly in a sensitive sector such as dairy. It helps decision-makers develop balanced trade policies to ensure the availability of dairy products at reasonable prices without harming local production. It also supports local producers in making strategic decisions regarding production expansion

Several studies have examined food security, agricultural production, and food gaps in Libya, highlighting the structural challenges facing the agricultural sector and the increasing dependence on food imports.

One of the most relevant studies is that of [3], which developed a composite index to measure food security in Libya over the period 1990–2022. The study found that food security levels have significantly deteriorated, particularly after 2011, due to political instability and economic constraints, emphasising the vulnerability of the Libyan food system.

Similarly, the study by [10] analysed the reality of food security in Libya and revealed that the country suffers from a widening food gap and structural fragility in its food system, driven by declining domestic production and increasing reliance on imports.

In the same context, [7] examined food sovereignty in Libya and highlighted the country's heavy dependence on food imports due to weak local production, particularly in strategic commodities. The study emphasised that this imbalance poses a serious challenge to achieving sustainable food security.

Earlier empirical work by [5] focused on food security for cereals and meat in Libya, using general trend equations to estimate the food gap over the period 1995–2014. The study confirmed the existence of a persistent food gap and demonstrated the usefulness of trend analysis in evaluating food security indicators.

In addition, [4] analysed the performance of agricultural policies in Libya and found that these policies have been unable to achieve food security. The study attributed this failure to increasing demand for food, declining agricultural sector contribution, and growing dependence on external sources.

With respect to the dairy sector specifically, [16] estimated a milk production function in Libya using econometric techniques and found that production is characterised by decreasing returns to scale, indicating inefficiencies in resource utilisation within dairy production systems.

Other studies have focused on the quality and safety of dairy products. For instance, [1] analysed pasteurised milk in Libya and found significant variations in quality indicators, reflecting inconsistencies in local dairy production systems. Additionally, microbiological studies such as [3] and subsequent research have identified contamination risks in dairy products, highlighting food safety challenges within the Libyan dairy sector.

Synthesis of Previous Studies

Overall, the reviewed literature reveals several consistent findings: Libya suffers from a persistent and growing food gap. Domestic agricultural production is insufficient and declining. Also, there is a high dependence on food

imports. Therefore, the dairy sector faces production inefficiencies and quality challenges. Additionally, Food security in Libya is structurally fragile and vulnerable to shocks [6].

Material and methods

The study adopts both descriptive and econometric approaches to analyse the general trend of Libyan dairy imports, production, consumption and food gap using the least squares method.

Sources of Data: Secondary data obtained from the Arab Organisation for Agricultural Development.

Scope of the Study: The spatial scope is Libya, and the temporal scope covers the period from 1990 to 2024. The thematic scope focuses on meeting consumer demand for dairy products.

Foreign Trade in Libya

The foreign trade sector in Libya is considered one of the important sectors in economic activity due to its significant impact on various productive activities and, consequently, on the Gross Domestic Product (GDP). This is achieved through the provision of most final consumer goods and production inputs. Economic policies have given special attention to this sector by attempting to design and implement appropriate trade policies aimed at developing and diversifying export activities for the benefit of the national economy. These policies also seek to achieve a surplus in the trade balance, gradually reduce the dominance of the oil sector over most economic activities, substitute local products for imported ones, and strive for self-sufficiency in many goods and services based on the best alternatives. This includes understanding the opportunity cost of producing goods and services that achieve a competitive advantage, while importing products that do not meet this condition, thereby saving effort, money, and time and avoiding waste.

Objectives of Foreign Trade:

Foreign trade aims to achieve a set of economic, social, and strategic objectives, promoting economic growth, increasing trade and investment exchange between countries. Specialisation and efficiency: Focusing on producing goods and services in which a country has a comparative advantage. Diversifying sources of income: Reducing dependence on a single sector or market. Improving living standards: Providing a wide range of goods and services to consumers. Enhancing peace and stability: Strengthening economic cooperation and interdependence among countries.

Types of Foreign Trade:

Export Trade: This type of trade occurs when a trader from one country sells a product to a trader in another country. For example, traders in the United States sell products to traders in Germany.

Import Trade: This occurs when a trader in one country purchases goods from a trader in another country. For example, traders in England buy products from traders in the United States to sell in their local markets.

(Re-export) Trade: This type occurs when a trader imports goods from another country, makes changes or adds value, and then re-exports the same product to another country. For example, a trader in the United States imports spare parts, machinery, and raw materials from Japan and Russia, assembles them into a new product, and exports it to other countries.

Importance of Foreign Trade*:* Foreign trade is one of the most important economic activities worldwide, as all countries rely on it within their economic systems. It serves as an indicator of a country's production capacity and competitiveness in global markets, based on production levels and the ability to obtain foreign currency. It is a vital field in both developing and developed economies, contributing to connecting countries together and enhancing marketing capabilities through the creation of new markets. Countries rely on foreign trade to increase their reserves of foreign currency, as export and import processes involve multiple currencies.

Dairy Products*:* Dairy products are among the most important staple foods relied upon by humans for thousands of years. They provide a wide range of essential nutrients necessary for body health, such as calcium, protein, vitamins, and minerals [15]. Dairy products also play a vital role in the daily diet of both adults and children due to their multiple health benefits. Dairy products include all food items derived from the milk of mammals, particularly cows, sheep, and goats. These products include milk, yoghurt, cheese, butter, and cream. Dairy is widely used in the food industry to produce various derivatives that meet nutritional and consumer needs. Milk is the natural secretion of the mammary glands of mammals. The main animals used for milk production include cows, buffalo, sheep, goats, and camels [11]. Milk and its products, such as butter and cheese, were used by ancient Greeks and Egyptians and later spread worldwide. While milk composition varies depending on the animal, all types contain the same essential nutrients, though most milk consumed by humans comes from cows.

Milk is considered a complete food, especially for children, as it contains fats, proteins, and carbohydrates that provide energy and vitality. It also contains essential vitamins for cell function and body growth, as well as key minerals such as calcium and phosphorus, which are indispensable for the human body. The approximate composition of milk is as follows: water 87%, casein 2.5%, globulin and albumin 0.8%, lactose 5%, milk fat 4%, salts 0.7%, and total solids 13%. This unique composition makes milk a complete and essential food for all age groups [11]

Dairy Industry and Products in Libya:
Since ancient times, humans have been able to produce various dairy products such as fermented milk, cheese, butter, and others. With technological advancements and the discovery of processes such as evaporation, pasteurisation, and drying, new products like powdered and pasteurised milk have emerged, leading to the development of dairy-based industries.

Despite the presence of natural pastures in some Libyan regions, reliance on them for raising dairy cattle remains limited due to the lack of dry feed during drought seasons and the shortage of veterinary medicines and extension services. This has reduced dependence on local dairy production to meet domestic needs, and the dairy industry in Libya is still in its developmental stages.

In recent years, several government-owned, high-tech dairy factories have been established under the General Dairy Company. The first factory, "7th of October" in Tripoli, was inaugurated in 1977 with a production capacity of 65,000 litres per day. This was followed by Al-Amal Factory in Benghazi in the same year, with a capacity of 90,000 litres per day. Later, Al-Jabal Al-Akhdar Factory in Al-Bayda was opened in 1981 with a capacity of 90,000 litres per day, and in the same year, with a capacity of 85,000 litres per day.

In general, dairy producers in Libya can be divided into two categories: The first includes farmers who raise dairy cattle, typically owning between 10 and 15 cows, and market their products as fresh milk or processed items such as butter, ghee, and sour milk through local shops. The second includes public dairy farming projects aimed at supplying nearby dairy factories with raw materials to be processed into various dairy products.

The Status of Dairy Production and Consumption in Libya
Domestic Dairy Production Cattle are considered the primary source of dairy production from both local and imported breeds. Despite the high productivity of imported breeds such as Friesian and Jersey cows, their output has declined due to poor management, inadequate care, insufficient monitoring, and improper feeding practices. Table 1 indicates that dairy production reached its lowest level at approximately 181.6 thousand tons in 2017, while it recorded its highest level at about 312 thousand tons in 2007, with an annual average of approximately 243.0 thousand tons.

Dairy Imports represent the gap between domestic consumption and local production, commonly referred to as the food gap. They play a significant role in bridging this gap due to the insufficiency of domestic production. Table 1 shows that dairy imports ranged from a minimum of 102.0 thousand tons in 1992 to a maximum of 509 thousand tons in 2014, with an annual average of approximately 398 thousand tons.

Dairy Consumption Table 1 illustrates that dairy consumption has increased in a fluctuating manner. The lowest level was about 342 thousand tons in 2017, while the highest reached approximately 1132 thousand tons in 2010, with an annual average of 655 thousand tons.

Self-Sufficiency Ratio in Dairy Data from Table (1) indicate that the lowest self-sufficiency ratio in dairy was approximately 25% in1990, while the highest reached about 66% in 2004. The average self-sufficiency ratio during the study period was approximately 41%.

Table 1: The status of Libya's dairy Production, Consumption, Imports, Dairy gap and self-sufficiency ratio

Year	Production 1000 ton	Consumption 1000 ton	Import 1000 ton	Dairy Gap 1000 ton	Self-sufficiency ratio 100%
1990	190.6	738.8	548.2	548.2	25.8
1991	189.0	306.9	117.9	117.9	61.6
1992	183.7	285.8	102.1	102.1	64.3
1993	181.2	460.2	279.0	279.0	39.4

1994	192.4	604.4	412.0	412.0	31.8
1995	203.0	570.0	367.0	367.0	35.6
1996	215.9	584.9	369.0	369.0	36.9
1997	232.0	607.2	375.0	375.2	38.2
1998	224.6	660.6	436.0	436.0	34.0
1999	250.0	690.0	440.0	440.0	36.2
2000	258.4	706.3	447.9	447.9	36.6
2001	259.7	458.1	268.4	198.4	56.7
2002	259.4	664.5	250.1	405.1	39.0
2003	273.8	454.3	280.0	180.5	60.3
2004	285.3	427.2	286.0	141.9	66.8
2005	296.5	778.8	482.4	482.3	38.1
2006	304.7	485.9	400.0	181.2	62.7
2007	312.0	913.9	450.0	601.9	34.1
2008	300.0	816.8	490.8	516.8	36.7
2009	294.6	853.1	508.5	558.5	34.5
2010	283.3	1132.0	491.5	848.7	25.0
2011	288.5	476.7	436.0	188.2	60.5
2012	296.6	635.3	436.0	338.7	46.7
2013	279.5	563.2	437.0	283.7	49.6
2014	232.1	725.5	509.3	493.4	32.0
2015	217.0	675.9	438.9	458.9	32.1
2016	226.0	650.7	404.5	424.7	34.7
2017	181.6	342.3	401.4	160.8	53.0
2018	234.6	642.3	408.1	407.7	36.5
2019	238.0	640.0	420.6	402.0	37.2
2020	231.2	622.3	401.1	391.2	37.1
2021	220.1	695.4	475.3	475.3	31.7
2022	220.1	639.1	459.0	419.0	34.4
2023	227.3	685.5	451.7	458.2	33.2
2024	229.5	690.3	456.4	460.8	33.2
Average	243.2	625.3	398.2	382.1	41.3

Source: Arab Organization for Agricultural Development.

Based on the review of data related to dairy imports into Libya, the following findings were reached .The study found that the quantity of domestic dairy production in Libya during the period 1990-2024 ranged between a maximum of 312 thousand tons in 2007 and a minimum of 181.6 thousand tons in 2017, with an annual average projected at approximately 243.2 thousand tons. Dairy imports into Libya increased from 102 thousand tons in 1992 to about 509 thousand tons in 2014, then declined to 401.4 thousand tons in 2017, before rising again to reach approximately 456.0 thousand tons in 2024. The value of dairy imports fluctuated, showing periods of increase and decrease throughout the study period (2000-2022).

Analysis of the general trend equation revealed a positive relationship between the value of imports and time. The growth rate showed an upward trend, with an estimated positive rate of approximately 2.3%. Furthermore, in analysing the general time trend of dairy consumption in Libya, the logarithmic model was selected as the most appropriate for representing the nature of the data.

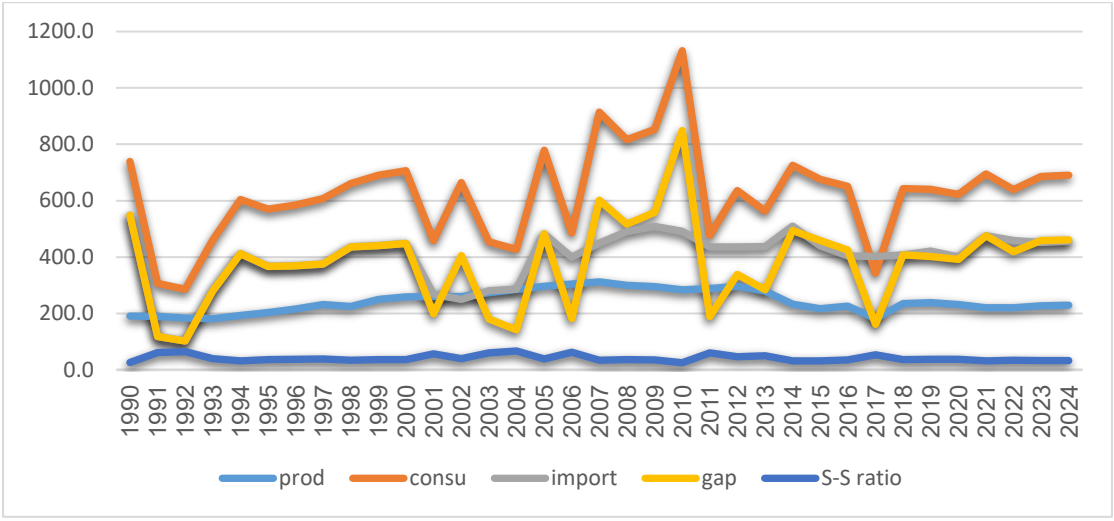

Figure 1: Trend of Libya's dairy Production. Consumption, Import, Dairy Gap, and Self-sufficiency ratio.

Results and discussion

Trend Analysis and Economic Interpretation

1. Trend in Dairy Production

The estimated trend equation for Dairy production is given by:

$$[Y_1 = 5.664996 - 0.012408t]$$

The coefficient on the time variable (t) is -0.012408 and is statistically significant at the 1% level (p = 0.0004). Because the model is specified in logarithmic form, the coefficient approximates the annual growth rate. Thus, dairy production is decreasing at an average annual rate of approximately -1.24%. This result indicates a statistically significant decline in domestic dairy production over the study period. The negative growth rate suggests structural inefficiencies in the agricultural sector, such as limited technological advancement, resource constraints, or inadequate investment. This declining trend weakens the ability of domestic production to meet rising dairy demand.

2. Trend in Dairy Consumption

The estimated trend equation is:

$$[Y_2 = 6.2505 + 0.008779t]$$

The time coefficient is 0.008779, with a p-value of 0.07, indicating weak statistical significance (at the 10% level). The implied annual growth rate is 0.88%. Dairy consumption shows a moderate upward trend, growing at approximately 0.88% annually. However, the weak statistical significance suggests that this increase is not stable over time. This growth may be attributed to factors such as population growth and rising income levels, although fluctuations in consumption patterns are evident.

3. Trend in Dairy Imports

The estimated equation is:

$$[Y_3 = 5.646429 + 0.017106t]$$

The coefficient of time is 0.017106, which is statistically significant at the 1% level (p = 0.0034). The annual growth rate is 1.71%. Dairy imports are increasing at a significant annual rate of 1.71%, indicating a growing reliance on external markets. This reflects the inability of domestic production to satisfy local demand. The increasing dependence raises concerns about food security and vulnerability to international price fluctuations.

4. Trend in Dairy Gap

The estimated equation is:

$$[\ Y_4 = 5.608369 + 0.013824t]$$

The time coefficient is 0.013824, with a p-value of 0.095, indicating weak statistical significance. The implied annual growth rate is 1.38%. The Dairy gap is increasing at an average annual rate of approximately 1.38%, although the statistical significance is limited. This suggests that while the gap is widening, the trend is not consistently strong across the entire period.

Integrated Economic Analysis

By combining the results of all trend equations, a clear structural imbalance emerges:

Dairy Production is declining by 1.24% annually, dairy consumption is increasing by 0.88% annually, and dairy imports are increasing by 1.71% annually

Implication:

The coefficient of determination (R^2) varies across the estimated trend equations. It reaches approximately 0.42 for dairy production, indicating that time explains a moderate proportion of its variation, reflecting a relatively clear trend. In contrast, R^2 values for dairy consumption (0.096) and the dairy gap (0.08) are relatively low, suggesting that time alone is insufficient to explain their behaviour and that additional economic factors influence these variables. The R^2 for food imports (0.23) indicates a moderate explanatory power of time, reflecting a noticeable but not dominant trend. The decline in domestic production, coupled with rising consumption, creates a supply-demand imbalance. This gap is primarily compensated through increased dairy imports, which explains their higher growth rate. As a result, the dairy gap tends to increase (1.38% annually), even though its statistical significance is relatively weak. This indicates that the widening gap is driven more by structural changes in its components than by a strong independent trend.

Conclusion

The trend analysis highlights a deteriorating dairy sector structure, characterised by declining production and increasing reliance on imports. Although the growth in the dairy gap is not strongly significant, the underlying factors clearly point toward a gradual expansion of the gap over time.

These findings emphasise the need for policies aimed at enhancing domestic agricultural productivity and reducing dependency on dairy imports in order to achieve sustainable food security.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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