

Research Article

Environmental Management of the Dairy Industry in the Riyadh Region: A Study in Environmental Geography

Fatimah Muqbil Naja Al-Mutairi*

College of Arts, Department of Geography, King Faisal University, Dammam, Kingdom of Saudi Arabia

Abstract

The dairy industry is one of the important food industries in the Kingdom of Saudi Arabia that needs Conscious environmental management. This research aims to identify the extent to which environmental management is applied in dairy factories in Riyadh in order to achieve environmental sustainability. The importance of research lies in preserving the environment, treating its industrial waste, and ensuring the quality of food, and the health of milk, which represents the main food for society. The study relied on several approaches, including: the inductive approach, relies on observing the phenomenon, and in our study, the development of the dairy industry in the Kingdom of Saudi Arabia was observed, and the Kingdom became one of the dairy exporting countries, and this approach was used to analyze how the Kingdom of Saudi Arabia achieved this great achievement in the development of the dairy industry, And the inferential approach that was used to deduce the factors that helped and made the dairy industry one of the leading industries in the Kingdom, And the descriptive approach that relies on an accurate description of the phenomenon, and is based on describing the dairy industry from ancient times until the present and environmental management in the Kingdom of Saudi Arabia. Several tools and were used, including: quantitative methods like statistical packages for social sciences (SPSS), cartographic methods (GIS), laboratory analysis of water, soil and air quality. many tools were used to collect data, like questionnaires, interviews, observations, and field studies to verify environmental management within factories. The research sample included four dairy production factories in the Riyadh region. the research reached several results, such as the adoption of dairy industry companies in the Riyadh region of agricultural methods that take into account the preservation of the environment, like regenerative agriculture, the fallow cultivation system, and organic farming, The research also reached good environmental management of water, the use of environmentally friendly materials for product packaging in order to reduce environmental pollution, and the adoption of appropriate methods to reduce gas emissions and air pollution, the development of the dairy industry in the Kingdom of Saudi Arabia and its use of modern technology. The study recommends the need for agencies to update their data related to the environment and facilitate access to it, the importance of securing water supplies from sustainable sources. and the importance of establishing environmental units within various institutions, companies and industries.

Keywords

Environment, Environmental Conservation, Sustainability, Waste and How to Use It

*Corresponding author: asdfkk444@gmail.com (Fatimah Muqbil Naja Al-Mutairi)

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1. Introduction

One of the most magnificent aspects of God's creation is the environment's ability to maintain the balance of its elements under natural conditions through self-regulating processes. These systems are capable of addressing internal disruptions-unless such disruptions exceed the ecosystem's carrying capacity. These disturbances often unfold through complex mechanisms that remain unnoticed until advanced or near-irreversible stages. The environment operates as an interconnected system of cycles; any disturbance in one part of the system can trigger a chain reaction that disrupts the overall balance and harmony of environmental elements.

Human behavior plays a pivotal role in maintaining or disturbing this harmony. The environment is the space in which humans conduct all their activities-activities that inevitably impact it either positively or negatively. This impact reflects a dynamic interaction between human behavior and the natural ecosystem, a relationship that is neither fixed nor uniform but varies across time and space. [11].

Among the most influential human activities affecting the environment is industrial production. Industrial processes, while economically significant, often generate negative environmental consequences and pose serious threats to ecological sustainability. The dairy industry in the Kingdom of Saudi Arabia is one of the most vital and widespread industries across various regions and cities. This research examines the environmental management practices of dairy factories in the Riyadh region, with the aim of evaluating the extent to which environmental considerations and sustainability principles are implemented in these facilities.

1.1. Research Objectives

This study aims to achieve the following objectives:

- 1) To identify the agricultural methods adopted in dairy factories and assess the extent to which they preserve the environment.
- 2) To explore the water management practices used in the dairy factories within the study area.
- 3) To evaluate the methods used for managing industrial waste in dairy factories.
- 4) To investigate the materials used for packaging dairy products and determine their environmental friendliness.
- 5) To identify the types of energy used and the approaches applied to reduce gas emissions in dairy factories.
- 6) To examine occupational safety practices for workers in the dairy factories.

1.2. Research Methodology

The study relies on several research methodologies, including:

- 1) Descriptive Methodology: Used to identify the

characteristics of the phenomenon by providing detailed descriptions, which may be verbal or numerical. It involves observing and documenting the phenomena as they appear. [9].

- 2) Analytical Methodology: Focuses on analyzing the phenomenon in depth to uncover interrelationships among different variables, aiding in accurate diagnosis and understanding of causes and effects. [9].
- 3) Comparative Methodology: Involves comparing two or more phenomena to highlight similarities and differences. [10].

1.3. Research Tools and Techniques

The researcher employs several tools, the most important being:

- 1) Statistical Data and SPSS Analysis: One of the most accurate methods for delivering reliable facts.
- 2) Cartographic Techniques (GIS): Used to present geographic data visually through graphs and distribution maps.

In this study, these methods will be used to identify the locations of dairy factories, analyze their geographic distribution, and assess environmental sample results (soil, water, and air) from those locations.

1.4. Past Researches

The researcher found no academic study specifically dedicated to the topic of this research. However, there are several scientific studies addressing industrial waste and soil pollution in Saudi Arabia that touch upon related aspects. The current study aims to benefit from these prior works. Some of the relevant studies include:

- 1) Mohamed-Nasser-Ahmed (2008): *"Environmental and Economic Effects of Some Industrial Waste – A Comparative Study Between Sudan and Egypt,"* unpublished doctoral dissertation, University of Khartoum. This study examined environmental pollution, compared it with Egypt, and explored recycling industrial waste to reduce pollution. The research emphasized conserving non-renewable resources and reusing waste as raw materials for other industries.
- 2) Dr. Moutanious-Makhoul & Dr. Adnan-Ghanem (2009): *"Environmental Management Systems and Their Role in Sustainable Development,"* a peer-reviewed journal from the Faculty of Economic and Legal Sciences. This study highlighted the importance of environmental management systems in supporting sustainability, conserving resources, and establishing legal commitments to reduce environmental harm.
- 3) Taher (2009) Issue-No.: 33: *"Environmental Pollution –*

Waste Management and Treatment,” published in the Assiut Journal for Environmental Studies. The researcher detailed waste types, causes, disposal methods, and air pollution control, all of which are relevant to understanding and managing industrial waste.

- 4) Al-Mutairi (2014): “*Heavy Metal Concentrations and Their Behavior in Soils Affected by Industrial Liquid Waste*,” a master’s thesis from King Saud University.
- 5) This study explored the danger of industrial liquid waste, especially due to its non-biodegradable nature and heavy metal contamination.
- 6) Al-Furaidi (2016): “*Impact of Pollution on Soil, Plants, and Livestock Milk in Some Saudi Environments*,” doctoral dissertation from King Saud University. It assessed pollution levels in soil and grazing areas and their effects on livestock products, which helps in evaluating environmental risk from dairy farms.
- 7) Dr. Ghallab Fattah, Dr. Bouabker Zarifat, and Dr. Maimoun Taher (2017): “*The Role of Environmental Management in Improving Environmental Performance of Small and Medium Enterprises: Barriers and*

Requirements,” published in *Fikr Journal for Management, Accounting, and Auditing*, University of Ghardaia. The researchers addressed how industrial behavior affects environmental resources and how small and medium enterprises can improve sustainability performance through environmental management.

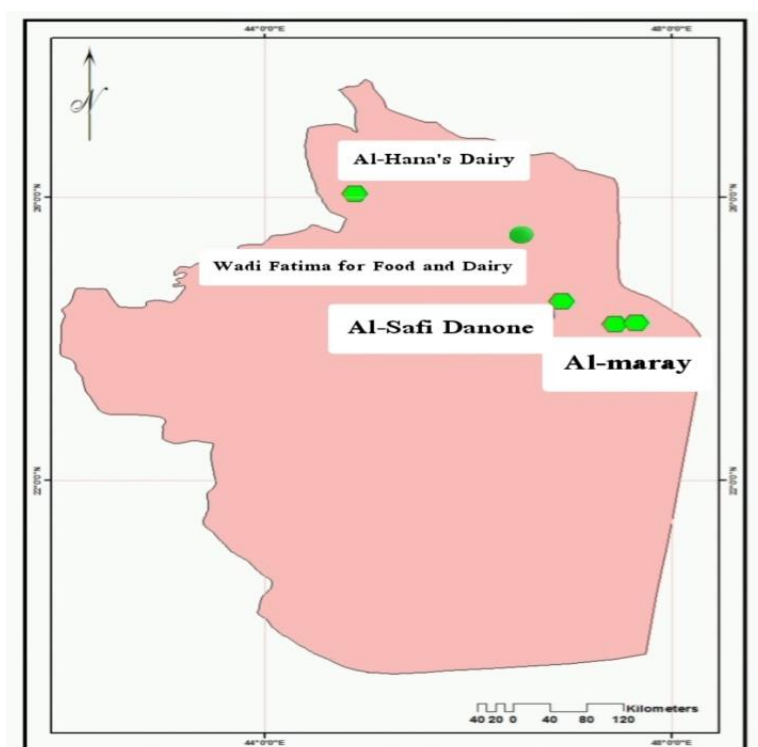
While the previous studies partially align with the current research in emphasizing the role of environmental management and waste disposal methods, none fully cover the specific goals of this study. The unique contributions of this research include evaluating the implementation of environmental management in dairy factories in Riyadh, the agricultural methods used, water management techniques, and the environmental compatibility of packaging materials.

1.5. Research Population

This research relies on a comprehensive survey sample of four dairy factories in the study area:

(Almarai Company- Al Safi Company- Wadi Fatima Company for Food and Dairy- Al Hana Dairy Company).

Field studies were conducted at these sites.



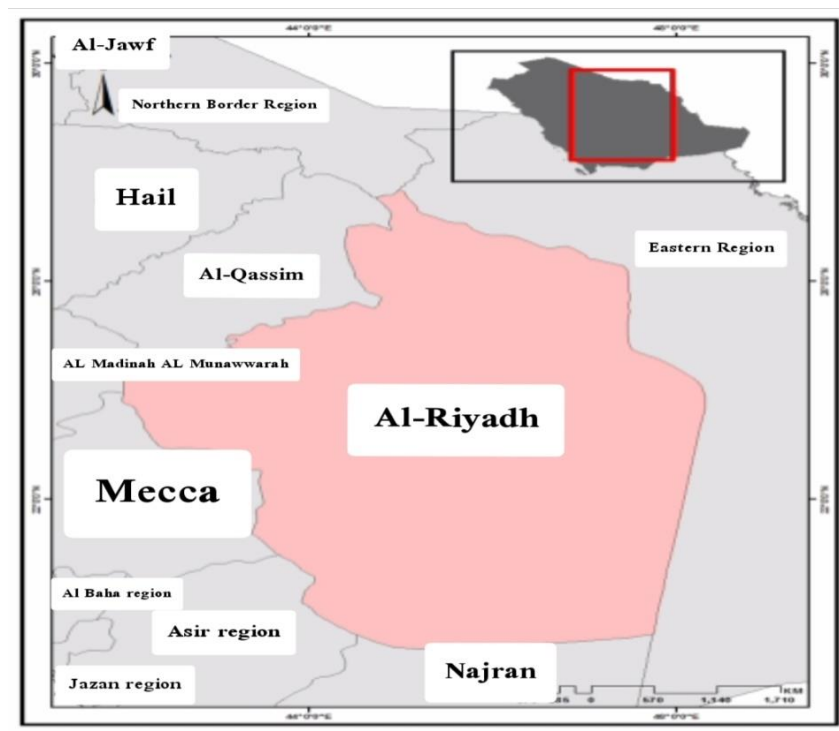
Source: Prepared by the researcher using Google Maps.

Figure 1. Dairy factories in Riyadh.

2. Study Area

The Riyadh region is located in the central part of the

Kingdom of Saudi Arabia, between latitudes 34 °to 38 °North and longitudes 43 °to 46 °East. It occupies a central position within the country and shares borders with:



Source: Prepared by the researcher using Google Maps.

Figure 2. Location of Riyadh Region.

2.1. Beginning of the Dairy Industry in Saudi Arabia

The dairy industry in the Kingdom began in the late 1960s, with the first dairy factory established in 1967 in Dammam. The sector witnessed rapid development due to generous government support through loans, grants, and encouragement of agriculture via institutions such as the Saudi Agricultural Bank and the Industrial Development Fund.

Today, the dairy industry is among the most modern and technically advanced sectors globally. Saudi dairy companies export 20% to 30% of their products to the Gulf markets. The Saudi market itself accounts for 60% of total dairy demand in the Gulf. [8].

Years of planning and development have led the Kingdom to achieve self-sufficiency in dairy production, and many Saudi products now compete in global markets thanks to their high quality and competitive pricing. [4].

According to the latest statistics provided by the Chairman of the National Committee for Fresh Dairy Producers (Council of Saudi Chambers), as of 2020, there were 12 national companies specializing in dairy production in Saudi Arabia. These companies collectively produce 7 million liters of fresh milk per day, with a daily packaging capacity exceeding 18 million containers, covering around 35 diverse dairy products, meeting the full domestic demand across the Kingdom. (Al-Harbi, Saudi Press Agency, 2021).

The sharp increase in milk consumption has driven expansion in dairy production and product diversification. Additionally, rising awareness of dairy's importance to human health has shifted consumption patterns toward dairy products. [4].

2.2. Development of the Dairy Industry in Saudi Arabia

The dairy industry in Saudi Arabia began on a modest scale, primarily relying on home-based production in rural and Bedouin areas. These traditional methods used basic, manual techniques with minimal mechanization. Only a few factories operated in major cities, with limited capacity. They mainly depended on imported powdered milk due to difficulties in obtaining fresh milk locally.

However, by the late 1960s and early 1970s, Saudi Arabia witnessed a significant boom in its food industry sector, and the dairy industry received special focus. It was identified as a priority industry that could help achieve self-sufficiency and reduce reliance on imports.

In 1970, there were only 4 licensed dairy factories, but by the end of the First Five-Year Development Plan in 1975, that number had increased to 17 factories.

The total capital investment in these projects reached about 200 million SAR, and the combined annual production capacity was approximately 70,000 tons. By 1980, the number of factories had risen to 25, with a production capacity of 100,000 tons annually. According to 1987

statistics, Saudi imports of fresh milk dropped from 9,067 tons in 1983 to 1,983 tons in 1987, thanks to increased local production. During that same period, fresh milk production by specialized dairy projects increased from 97 million liters in 1983/84 to 198 million liters in 1986/87-an increase of 104%. [3].

The dairy industry has now become a central pillar of the Saudi food industry. The growth of specialized agricultural and livestock production projects has helped meet much of the domestic demand for dairy and other essential goods.

This growth was enabled by:

- 1) The use of modern production technologies
- 2) Strong government support
- 3) Incentives for private investors (loans, subsidies, land grants)
- 4) Development of transportation and storage infrastructure
- 5) Support services such as veterinary care, agricultural

extension, and fertilizer distribution

By 2011, according to the Ministry of Agriculture, Saudi Arabia produced 1 billion liters of milk. The Riyadh region alone accounted for 66% of the country's dairy farm projects.

Although the total number of dairy projects nationwide remained 27 between 2008 and 2011, their production increased significantly:

- 1) 2008: 1.37 billion liters
- 2) 2009: 1.5 billion liters
- 3) 2010: 1.6 billion liters

The number of milking cows also increased:

- 1) 2008: 147,000 cows
- 2) 2009: 157,000 cows
- 3) 2010: 160,000 cows

However, certain regions such as Makkah, Madinah, Asir, the Northern Borders, Jazan, Najran, Al-Baha, and Al-Jawf had no dairy farm projects and did not produce raw milk.

Table 1. Estimates of milk consumption for the period (2001-2011) (thousand tons).

Year	Fresh milk	Reconstituted Local Milk	Bottled/Packaged	Canned	Total
2001	354.13	2.38	1350.37	6.19	1713.07
2002	337.01	3.42	1282.8	7.84	1631.07
2003	459.79	3.94	1382.11	9.84	1855.68
2004	701.76	8.72	1605.2	8.4	2323.99
2005	886.84	6.29	1897.85	20.66	2811.64
2006	601.93	2.12	1925.54	26.30	2555.89
2007	1304.47	8.62	2294.78	27.20	3635.07
2008	1304.47	8.62	2294.78	27.65	3635.07
2009	1370.39	4.25	2348.03	30.60	3753.27
2010	1508.38	2.77	2348.03	30.60	3889.78
2011	1508.38	8.60	2053.43	25.66	3596.07

Source: Arab Organization for Agricultural Development – FAO Statistics – Dairy Projects Studies.

The remarkable success of Saudi Arabia's dairy industry is largely attributed to the wise government policies designed to promote and sustain the sector. Some of the most impactful strategies include:

- 1) Expanding livestock resources to boost milk production
- 2) Supporting the establishment of dairy projects through technical and financial assistance
- 3) Encouraging scientific research related to dairy production to improve product quality

These efforts reflect a deliberate and structured national policy to ensure self-sufficiency, improve public health, and reduce dependence on imports.

3. Livestock Development

The Ministry of Agriculture and Water has implemented a comprehensive development plan targeting livestock improvement. The key objectives of this plan include:

- 1) Strengthening veterinary programs.
- 2) Enhancing disease research and control measures for livestock.
- 3) Improving livestock breeds.
- 4) Using soil and nutrition research to boost productivity and manage animals more effectively.

- 5) Expanding feed resources.
- 6) By cultivating more forage crops and grains and improving pasture conditions.
- 7) Developing cost-efficient local feed formulas.
- 8) Creating nutritionally balanced feed from local crops to ensure healthy livestock and reduce feed costs.

3.1. Encouraging Dairy Projects and Establishing New Farms

Through the Ministry of Agriculture, the government motivates breeders to plan and manage their farms efficiently. It also conducts full economic feasibility studies and supervises dairy projects directly. Key forms of support include:

- 1) Providing agricultural land needed for dairy projects.
- 2) Offering free veterinary services.
- 3) Conducting technical and economic assessments for each factory-free of charge-via the government-established Industrial Research and Development Center Project Financing and Support Programs.
- 4) To promote investment in the dairy sector, the government offers extensive financial support through the Saudi Agricultural Bank, including:
 - a. Subsidies covering the full cost of air-shipping dairy cattle, with a minimum of 200 cows per shipment.
 - b. 50% subsidies on concentrated feed, chemical fertilizers, and agricultural machinery.
 - c. Medium-term loans covering 40% of the total investment cost, repayable over 5 years with no interest, starting from the production launch.
 - d. Long-term loans of up to 10 years for large-scale cow projects, provided specific technical requirements are met (e.g., farm layout, proper care practices, Ministry of Agriculture inspection).

In recent years, these benefits-along with successful “acclimatization” experiments by the Ministry-have led to a sharp increase in investor interest in dairy farming and milk processing.

3.2. Advancement in Dairy Research

Recognizing the importance of scientific research in advancing any industry and integrating modern technologies, a pilot dairy research laboratory was established at the College of Agriculture at Riyadh University (now King Saud University).

The lab was built at a cost of 4 million SAR and includes facilities for milk pasteurization and the experimental production of various dairy product, In addition to its academic role, the lab aims to:

- 1) Improve dairy industry performance.
- 2) Solve technical challenges through applied research.
- 3) Distribute findings to professionals in the dairy sector.
- 4) Train skilled workers and technicians for future employment in dairy factories.

3.3. Ensuring Milk Supply to Dairy Plants

One of the major challenges in dairy production has been ensuring a steady and reliable supply of fresh milk. This is due to the scattered nature of livestock across rural and desert areas, making milk collection difficult.

- 1) To overcome this, two main strategies were adopted:
- 2) Use of imported powdered milk, which is reconstituted and processed.

Establishment of dairy farms directly linked to factories, ensuring access to high-quality fresh milk with ideal chemical and bacteriological characteristics.

3.4. Production Planning in Dairy Factories

The nature of production varies from one dairy factory to another depending on its technology, resources, and market focus. However, common product lines include:

- 1) Pasteurized milk using the High-Temperature Short-Time (HTST) method.
- 2) Vitamin D-fortified pasteurized milk using infrared and ultraviolet rays (also called *Actionized Milk*).
- 3) Ultra-high-temperature (UHT) sterilized milk, suitable for hot climates like Saudi Arabia, since it does not require refrigeration during transport or storage.
- 4) Flavored milk shakes, such as those with fruit or cocoa.
- 5) Yogurt and laban (fermented milk).
- 6) White Domiati-style cheese and labneh.
- 7) Table butter and a wide variety of ice cream. [3].

3.5. Milk Production

The Saudi dairy market experienced significant growth between 1983 and 1988, and again from 2018 to 2021, as shown in the following table. This reflects the country’s increasing capacity for fresh milk production and the shift away from imported or reconstituted milk.

Table 2. Milk Consumption in the Period (1983–1988) (in tons).

Year	Fresh milk	Reconstituted Local Milk	Bottled/Packaged	Canned	Total
1983	20,000	70,000	6,000	500	96,500

Year	Fresh milk	Reconstituted Local Milk	Bottled/Packaged	Canned	Total
1984	22,500	83,000	9,000	2,500	116,500
1985	23,000	9200	10,000	3,500	129,500
1986	28,000	107,000	6,000	4,000	145,500
1987	63,000	111,000	2,000	5,000	181,000
1988	42,000	120,000	1,000	5,000	168,000

Source: [3]

Table 3. Estimates of Milk Consumption (2018–2021) (in thousand tons).

Year	Fresh Milk	Reconstituted Local Milk	Bottled/Packaged	Canned	Total
2018	1,282.99	477.43	2,184.88	290.54	4,235.84
2019	1,398.46	528.56	2,182.45	268.93	4,378.40
2020	1,481.47	568.20	2,225.58	307.22	4,582.47
2021	1,414.11	580.83	1,923.79	322.03	4,240.76

Source: Arab Organization for Agricultural Development – FAO Statistics – Dairy Project

Analysis of Production Trends

From the two tables above, it is clear that Saudi Arabia has witnessed significant growth in both the production and consumption of milk. This growth reflects the increasing attention the government gives to food products in general, and to the agricultural and dairy sectors in particular.

Saudi Arabia is now among the leading countries in dairy exports, and dairy products have become a key part of the Kingdom's food self-sufficiency strategy.

- 1) In 2016, production reached 1.8 million tons.
- 2) In 2020, it rose to 2.2 million tons.
- 3) By 2021, production was at 2.32 million tons, with a self-sufficiency rate of 129%.

The Ministry has set a goal to reach 4.5 million tons of dairy production, according to field research conducted in 2022.

4. Sources of Raw Milk Production in the Kingdom

4.1. The Traditional Sector

The traditional sector refers to milk production from pastoralists who own cows, goats, sheep, and camels. These animals are raised in traditional farms or by nomadic groups.

- 1) In 1986, this sector produced around 266,000 tons of raw milk.
- 2) By 1996, production had increased to 296,000 tons, a

growth of only 11% over ten years.

This slow growth is mainly due to:

- 1) The low productivity of local animal breeds.
- 2) The primitive care methods, relying on natural rangelands that are often poor in nutrients-especially since Saudi Arabia is largely a desert country. [8].

Government Support for the Traditional Sector

To boost this sector, the Saudi government launched several initiatives:

- 1) Establishing the General Authority for Irrigation to develop irrigation systems.
- 2) Creating state-owned agricultural service companies.
- 3) Approving the privatization of feed mills and founding four companies for that purpose.
- 4) Expanding the Agricultural Development Fund's role to include international agricultural investment.
- 5) Forming a Special Food Security Committee to oversee the national food strategy-part of Saudi Vision 2030.(Ministry of Environment, Water and Agriculture – National Agricultural Strategy).

4.2. The Specialized Sector

This sector consists of modern dairy farms specialized in breeding cows and producing milk at a large scale.

- 1) In 1986, this sector produced around 166,000 tons of raw milk.
- 2) By 1996, production increased to 453,000 tons, showing a growth rate of 173%, with an annual growth rate of 11%.

In the same year (1996).

- 1) The total number of milking cows in these projects reached about 59,000 cows.
- 2) The average milk yield per cow was approximately 7,700 kilograms annually.

5. Milk Production Forecast for the Year 2000

According to projections, the Kingdom's raw milk production was expected to reach 876,000 tons by the year 2000, compared to 749,000 tons in 1996.

This increase in raw milk supply would allow more of it to be used for producing secondary dairy products, such as:

- 1) Fresh cream.
- 2) White cheese.
- 3) Ice cream.
- 4) Labneh (strained yogurt).

This shift would promote new dairy industries, support the national economy, and help reduce imports of processed dairy products. [8].

5.1. Self-sufficiency

A quick look at the numerical tables reveals significant and noticeable development in the dairy industry sector in Saudi Arabia. This growth is tied to improved practices and modern methods in cow farming and dairy production.

In the past, most milk was processed into fresh milk or laban (fermented milk).

But due to the major increase in raw milk production, dairy projects have started shifting toward processing raw milk into a wider range of dairy products, which:

- 1) Meets market demand.
- 2) Provides better economic returns.
- 3) Helps ensure ongoing production and profitability.

Some products have now reached full or near-full self-sufficiency, such as:

- 1) Yogurt: 28,000 tons produced, Self-sufficiency rate: 99%.
- 2) Long-life (UHT) milk: 40,000 tons produced, Self-sufficiency rate: 100%.
- 3) Pasteurized milk: 30,000 tons produced, Self-sufficiency rate: 26.8%.

However, some dairy products are still produced in small quantities, creating an opportunity for industry expansion, such as:

- 1) Labneh and cream: 3,000–5,000 tons produced, Only 23% of local demand met.
- 2) Butter and ghee: 266 tons produced, Self-sufficiency rate: 3%.
- 3) Cheese: 347 tons produced, Self-sufficiency rate: 0.6%.

As for milk powder, it is not produced locally at all. The country imports 100% of its milk powder needs.

This opens a wide door for investment in new dairy product

lines that can absorb the surplus raw milk and generate strong market returns. [8].

5.2. Milk Production and Manufacturing Projects in the Kingdom

The number of projects funded by the Saudi Agricultural Bank reached (31) projects, containing about (21,726) cows, including large projects such as the one presented to the council in the Al-Kharj region, which contains (1500) cows, distributed across the various regions and provinces of the Kingdom. The projects vary according to population density in different areas and the availability of natural resources. Most projects are concentrated around the capital Riyadh, especially in the Al-Kharj and Al-Dawadmi regions.

And if this region is known for high population density and many natural factors that helped the spread of dairy projects in this area - such as soil nature and topography - there is no project that matches the Al-Kharj project in terms of importance; it stands alone.

The number of projects in the Al-Kharj region in 1401 AH amounted to (12) projects, which is about (40%) of the total number of projects in the Kingdom.

The number of cows in the Al-Kharj region is (9950) cows, which is about (45.79%) of the total number of cows in the Kingdom according to the 1981 (1401 AH) agricultural statistics.

In 2019, the number of Number of cows in specialized cow farms was about (334,494) heads, and the total number of female cows reached about (156,183). The Number of calves produced in specialized cow farms was about (31,883) heads. The volume of milk produced in the Kingdom reached about (2,704,562,485) liters (according to 2019 statistics).

The number of dairy factories in the Kingdom reached (12) factories, which cover more than half of the Kingdom's dairy demand. The Kingdom aims to achieve self-sufficiency and export dairy products abroad (dairy industry).

6. Environmental Impacts of the Dairy Industry in Saudi Arabia

Dairy companies have adopted advanced technology, including the entire dairy production process and health care process, according to high standards to maintain production. Therefore, most dairy companies in Saudi Arabia produce green fodder, utilizing the best agricultural production techniques, including irrigation, land preparation, fertilization, and harvesting. They also adhere to environmental requirements and ensure product safety throughout all stages of production, including marketing.

Naturally, the dairy industry and the subsequent cheese and dairy products industry produce liquid industrial waste, solid waste, air pollutants, and noise pollution, including: [6].

6.1. Industrial Liquid Waste

The dairy, cheese, butter, and all dairy-related industries produce raw materials and products that do not meet quality standards, in addition to liquid waste containing dissolved sugar, protein, fatty substances, additives, and mineral salts. Therefore, suspended solids, nitrogen, and phosphorus are one of the most common pollutants in liquid industrial waste generated by this sector is sodium hydroxide, which is a disinfectant. [6].

6.2. Industrial Solid Waste

The dairy industry, including the production of cheese, butter, and other dairy products, produces organic waste, in addition to solid waste from packaging. [6].

These environmental pollutants must be assessed through two important aspects:

6.3. Potential Environmental Impacts of Industrial Projects

The potential environmental impacts of an industrial project result from the implementation of the planned project. These impacts are typically assessed through feasibility studies-both economic and technical-so that appropriate decisions can be made, and the best alternatives for implementation can be selected. Naturally, the environmental assessment process varies depending on the type and size of the project. However, there are general questions that can summarize the evaluation as follows:

- 1) Will the project generate gas, liquid, or solid pollutants that might affect the surrounding environmental system?
- 2) Will the establishment of this industrial project in this specific location lead to long-term environmental and health effects?
- 3) What are the potential risks of industrial disasters resulting from the project? And how severe would their impacts be on humans and the surrounding environment?
- 4) What are the developmental, economic, social, and environmental implications of this project in the area where it is planned?
- 5) Will this project negatively affect other existing projects in the same region? And to what extent?
- 6) Does the project site have the necessary infrastructure components available? If not, what are the impacts of building such infrastructure?
- 7) Are the natural resources required for the project available near the site? Or will they need to be transported from other regions? What environmental consequences might this have?
- 8) What are the various types of pollutants likely to be produced by the project?
- 9) What strategies and methods will be adopted to manage

these pollutants to protect the health of workers, nearby residents, and the environment in general? [13].

Ideally, the environmental assessment should include a detailed quantitative and qualitative analysis of potential environmental impacts-both in the short and long term-alongside cost estimates. This process ensures informed decision-making and helps determine the most appropriate methods for managing and mitigating environmental consequences. [6].

6.4. Assessment of Environmental Impacts from Existing Industries

To effectively address industrial pollution and its consequences on human health and the environment, it is essential to identify the types and quantities of pollutants with precision. This allows for the application of appropriate scientific methods to manage them. This identification process-often referred to as Environmental Impact Assessment (EIA)-involves recognizing and evaluating the potential effects of pollutants stemming from existing or planned industrial projects.

The environmental review of ongoing projects, or those under development, has become a growing international concern. Since the mid-1980s, particularly after the International Conference on Environmental Management in Industry held in Versailles, there has been a gradual shift in perception. Industries began recognizing pollution not only as a problem to be mitigated but as an element whose mitigation costs must be factored into production economics. For example, many advanced countries have improved energy efficiency in industries, leading to substantial financial returns through reduced consumption. [6].

This model proves that addressing environmental concerns can bring both ecological and economic benefits. Hence, many nations now require environmental assessments before implementing or expanding industrial operations, ensuring each project adheres to environmental standards through specific guidelines and frameworks. [6].

6.5. Production Plan in Dairy Factories

The nature of production varies from one factory to another, and so do the types of dairy products manufactured. The production process generally includes:

- 1) Pasteurized Milk Production using the High-Temperature Short-Time (H.T.S.T) method, which involves rapid pasteurization, often enhanced with vitamins, ultraviolet, and infrared radiation.
- 2) Sterilized Milk Production through Ultra-High Temperature (U.H.T) treatment. This method is especially suitable for hot climates like Saudi Arabia, as it eliminates the need for refrigeration during transportation and storage.
- 3) Flavored Milk Products, such as milkshakes with fruit or

cocoa flavors.

- 4) Yogurt and Fermented Milk Production, including traditional yogurt and cultured milk products.
- 5) Production of Soft White Cheeses, such as Damietta cheese and labneh (strained yogurt).
- 6) Production of Butter and Ice Cream in various flavors and types.

7. Challenges Facing the Dairy Industry in the Kingdom of Saudi Arabia and Proposed Solutions

The dairy industry in the Kingdom of Saudi Arabia has encountered several obstacles, including:

7.1. Difficulty in Collecting Raw Milk

Due to the scattered nature of livestock in rural and desert areas, and the animals' constant movement in search of pasture, collecting milk in one location becomes challenging. Additionally, many production sites are far from factories, and roads in those areas are often undeveloped.

7.2. Factories Not Operating at Full Capacity

This issue arises from the difficulty of obtaining sufficient quantities of raw milk. To overcome this, some factories have resorted to using imported powdered milk or establishing dairy farms adjacent to the production sites to ensure a reliable supply of high-quality milk. [17].

7.3. Shortage of Skilled and Qualified Technical Labor

This is a widespread issue across many Arab countries due to a lack of specialized education and training programs focused on preparing skilled workers for the dairy industry.

7.4. Shortage of Spare Parts

Many factories rely on imported spare parts, which becomes problematic-especially during emergencies-due to the lack of locally available replacements.

7.5. Limited Water Resources

The dairy industry depends heavily on water for cleaning, operation, and cooling processes. The available water in many areas contains high levels of dissolved minerals and hardness, which require additional treatment before use.

7.6. High Production Costs

The increasing cost of production demands strong

marketing and distribution support to ensure dairy products reach consumers at reasonable prices while still generating a sustainable profit for manufacturers. [17].

These challenges highlight the need for extensive field studies and surveys to identify actual milk production and demand in various regions, especially urban centers. This would help guide future investments and expansion of dairy projects.

To address these challenges and overcome them, the following measures are suggested:

- 1) The necessity of encouraging farmers to raise dairy cows, by utilizing uncultivated lands for this purpose.
- 2) Educating and training livestock breeders on the proper fundamentals of animal care, and how to look after dairy cows, through ongoing agricultural guidance.
- 3) Working to develop the dairy industry to match the Kingdom's conditions, especially considering the low level of cooling technology in many areas due to the intense heat during most of the year. This requires high degrees of sterilization, which separates milk from non-sterile conditions and delivers it for transport and distribution through sterilized methods. One of the best techniques for this is the Ultra-High Temperature (U.H.T) method, which sterilizes milk and keeps it good for longer periods without refrigeration.
- 4) Special attention must be given to using preserved milk in cheese-making and other dairy products, since this kind of milk may meet the needs of urban communities and areas where fresh milk is unavailable.
- 5) There is also a need to rely on the official institutions and research centers of the Kingdom, such as the Saudi Arabian Standards Organization, as a reliable basis for setting quality standards and specifications for milk production.
- 6) The powdered milk industry, which is manufactured from surplus milk, is also important. It requires high sterilization and drying technologies and can be made using relatively simple methods, which meet the needs of both producers and consumers.
- 7) Focus should also be given to large cities where milk is consumed in large quantities due to population demand, especially for nutritional purposes. Fresh milk is the primary input for cheese production, which is then transferred to cities after consumption of fresh milk in rural. [7].

8. Milk Contamination

Contamination in dairy production can arise from various sources throughout all stages of the process. These include:

8.1. Main Sources of Milk Contamination

8.1.1. The Animal

The animal itself may be a carrier of certain diseases such

as tuberculosis, brucellosis, foot-and-mouth disease, streptococcal and staphylococcal mastitis, *E. coli*, *Pseudomonas*, coccidiosis, and listeriosis.

8.1.2. Milkers and Workers

Contamination may occur through direct contact or poor hygiene practices. Workers may transmit diseases such as pulmonary tuberculosis, diphtheria, dysentery, typhoid, scarlet fever, and hepatitis.

8.1.3. Air

The air in animal shelters, milking areas, or factories can carry airborne bacteria like *Clostridium*.

8.1.4. Milking Containers

If not properly cleaned, containers can harbor bacteria and microbes that transfer to the milk, such as coliforms, *Salmonella*, and *Shigella*.

8.1.5. Water Used in Processing

Water may transfer harmful bacteria to the milk during washing and processing stages.

8.1.6. Insects and Rodents

Flies and other pests can carry disease-causing organisms on their legs and wings, contaminating the milk through contact with waste, wounds, or animal secretions. These can transmit typhoid, paratyphoid, and tuberculosis.

Therefore, it is essential to implement strict preventive measures to ensure milk remains uncontaminated, using all available industrial hygiene practices-such as cooling, sterilization, filtration, pasteurization, drying, and concentration-to eliminate or significantly reduce microbial presence in dairy products. [2].

8.1.7. Methods to Limit Milk Contamination

Milk can carry various types of diseases, which may pose a danger to public health. Therefore, several preventive measures should be followed to limit the spread of contamination and ensure the safety of milk intended for consumption. These include:

- 1) Avoiding the handling or sale of milk that comes from a person or animal infected with contagious diseases.
- 2) Ensuring the health of workers involved in milk production, including regular medical examinations and issuing health certificates confirming they are fit for such work.
- 3) Maintaining cleanliness of all equipment used in milk processing and ensuring they are free from contamination.
- 4) Providing medical care to milk-producing animals, along with regular checkups to guarantee the milk is free from diseases, including microbial infections that can be

transmitted through milk.

- 5) Preventing contamination during transportation, by taking proper care when moving milk and dairy products to marketing and distribution points.
- 6) Proper milking practices and immediate cooling, including knowledge of clean milking methods, storing the milk at temperatures below 10 °C after milking, and preserving it under these conditions until it reaches the factory or consumer.
- 7) Ensuring the safety of water used in washing equipment, by subjecting it to regular bacteriological testing.
- 8) Boiling or pasteurizing milk thoroughly, to ensure it is free of microbes-especially non-spore-forming bacteria-by heating it between 55 °C and 100 °C.

8.2. Some Manifestations of Environmental Pollution and Their Effect on Milk Contamination

Traditional patterns were among the causes leading to milk contamination in the past, through the production process. Then the methods and tools of milk production developed to eliminate contamination, reduce time and effort, and obtain clean milk free of pollution and diseases. However, in recent times, some manifestations of environmental pollution have emerged that affect milk production, such as:

- 1) Milk contamination by pesticides.
- 2) Milk contamination by radiation.

These are among the environmental pollution factors that appeared in the late twentieth century, which affected milk production, despite the interest in technology and advancement, as they had negative effects on milk production.

8.2.1. Contamination of Milk by Pesticides

Pesticides are considered among the most important food contaminants, and are deliberately added to the environment with the goal of killing microbes and germs. However, they have major harms when they transfer from crops to animals. There are several classification systems for pesticides based on chemical composition and effectiveness.

The most commonly used and effective pesticides are:

- 1) Chlorinated organic compounds
- 2) Organophosphorus compounds
- 3) Carbamate compounds
- 4) Pyrethroids

Scientific reports confirm that organophosphorus pesticides are safer and more limited in use, but still have drawbacks. Chlorinated organic compounds have a cumulative effect on human and animal tissues, especially fatty tissues. Among the reasons for the accumulation of chlorinated pesticide residues in milk are:

- 1) Spraying crops that are consumed by milk-producing animals.
- 2) These pesticides transfer to fatty tissues and milk glands in the body.

- 3) The pesticides can transfer not only through crops but also through the soil.
- 4) They may also transfer from nearby fields sprayed with pesticides.
- 5) Irrigation channels that pass through sprayed fields may carry them.
- 6) Spraying the animal's body with pesticides to kill parasites is another method by which pesticide residues can be transmitted into the animal's body, and from there to the milk, affecting its composition and properties. It affects milk production and its quantitative and qualitative characteristics.

8.2.2. Quantitative and Qualitative Effects

Quantitative: There is a noticeable decrease in milk yield throughout the period of exposure to pesticides.

Qualitative: There is a significant impact on the proportion of free fatty acids and the coagulation time only.

Pesticides affect the casein in milk, breaking it down and making kappa-casein disappear, and can also affect beta-casein, causing changes in whey proteins.

8.2.3. Impact of Pesticides on Dairy Processing

Thermal treatments up to (75 °C for 15 seconds) may affect about 40% of the pesticide, meaning 60% remains after treatment.

When yogurt is produced and stored for (7) days, the pesticide residue decreases by about 30%. While in soft cheese made from milk containing pesticide and stored for (30) days, the pesticide residue decreases to only 5%.

When milk containing pesticide is processed into cream and butter, pesticide residue decreases by 30% and 16% respectively.

We must not overlook the fact that these pesticides interact with processing materials that are among the most hazardous substances. Therefore, we must look for alternatives that reduce animal exposure to harmful pesticides. There are methods that can help reduce these harms, including:

- 1) Preventing dairy-producing animals from grazing on crops sprayed with chlorinated pesticides. If sprayed with organophosphate pesticides, they must be destroyed within 10 days of spraying.
- 2) Avoiding the use of milk from animals that fed on pesticide-contaminated fodder. This milk must not be used in any dairy industries. Even if used fresh, it still results in the presence of pesticide residues in dairy products, ranging from 13% to 40%, without completely eliminating the pesticide.
- 3) Providing sufficient information and data about any pesticide during use or recommendation of use to ensure safety for dairy farms. Farmers must be educated about its dangers and toxicity.

The Ministry of Agriculture has organized a precise system to register the pesticides used on farms to regulate their circulation and limit them.

If the recommended proportions and usage methods are not followed, pesticides can become one of the most dangerous sources of human poisoning. Acute and chronic poisoning cases may appear as a result.

Also, pesticide poisoning can occur over long periods of milk consumption despite the small residue amounts remaining for long durations in the body.

8.3. Contamination of Milk by Radiation

Foods exposed to radiation are considered among the most harmful to human health, and one of the most serious modern-day problems. Since the beginning of creation, humans have been exposed to natural cosmic radiation coming from space, and it is reasonable to assume that this natural exposure has no effect on human health.

However, the recent issue of radioactive contamination has mostly resulted from nuclear fission, which has produced more than (300) radioactive products with active radiation. In addition to environmental pollution from industrial radioactive isotopes, there have been disasters caused by nuclear reactors - the most recent being Chernobyl - which led to the release of radioactive isotopes into the environment in the form of atomic dust.

Atomic dust can travel extremely long distances from the Earth's surface and then return due to the effects of wind, storms, and rain. These elements are then pushed into the soil, leading to contamination, which in turn causes plants to become contaminated, and subsequently, animals such as milk-producing animals. As a direct result of these animals feeding on fodder made from plants exposed to these radioactive elements, they produce milk contaminated with radioactive particles, which then reach the consumer.

The danger of radioactive elements generally lies in their ability to replace natural mineral elements in food or in the human body. For example, Strontium-90 can replace calcium in milk due to the strong similarity between the two, making the milk contaminated with this radioactive element, whether used for drinking or processing. When consumed, these elements are absorbed into the body and replace calcium in the bones.

Thus, bones in the body may eventually contain radioactive elements instead of natural calcium. Over time, this radioactive accumulation can cause severe harm.

Over time, it may accumulate and cause severe harm.

All this danger is faced by imported milk, as it may contain high levels of radiation. Therefore, scientists have defined characteristics for measuring radiation levels and developed modern detection methods. The unit of radioactive activity is the Becquerel.

To protect the consumer from the dangers of radioactive contamination in milk, the following steps must be taken:

- 1) Compliance with specific standards for allowable radiation levels in both imported and locally produced milk.

- 2) Supporting monitoring agencies with scientific devices to estimate radiation levels.
- 3) Reducing the importation of milk from countries that do not monitor the food they export.
- 4) Establishing monitoring stations to measure the level of radiation in the environment - including air, soil, plants, and animals. [2].

8.4. Reducing Industrial Pollution in Cow's Milk

Milk is believed to have a significant impact and may help in preventing industrial poisoning. It also contains organic elements thought to reduce the risk of cancer. This is due to the presence of lactose sugar, calcium salts, and phosphate compounds in milk, which work in varying degrees to help reduce the absorption of heavy metals in the blood. Therefore, a sufficient and regular amount of milk must be provided, especially to people who are exposed to the effects of such substances. [2].

8.5. Impacts Associated with the Dairy Industry and How to Deal with Them

Industrial processes produce wastewater due to the presence of solids from milk components, such as proteins, fats, carbohydrates, and lactose. Untreated wastewater from dairy processing facilities may contain large amounts of organic matter, including biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Whey may also contribute to increased organic loads in wastewater. Salting during dairy production may result in increased salinity in wastewater, as well as acids, alkalis, and industrial detergents containing a number of active ingredients and disinfectants, including chlorine compounds, hydrogen peroxide, and quaternary ammonium compounds. Wastewater may contain large amounts of microbiological loads and may contain viruses and bacteria that cause disease.

We can deal with wastewater pollution by:

- 1) Avoiding milk and by-product losses, such as spills and leaks, excessive changeover and closures, by adopting good manufacturing practices and facility maintenance.
- 2) Sorting and collecting waste products, including wash water and by-products, to facilitate recycling or treatment for later use, sale, or disposal, such as whey and casein.
- 3) Installing screens to prevent solids from entering the wastewater network.
- 4) Drain them directly into a treatment plant or the municipal sewer network.
- 5) Separating process drains from other sewage drains in the process areas, and ensuring that cleaning procedures are followed before or after the process.
- 6) Pipes and tanks must be self-draining and equipped with suitable means for draining wastewater before disposal.
- 7) Recycle process water in compliance with health

requirements, including condensate from evaporation processes, for preheating and heat recovery systems for heating and cooling processes, to reduce water and energy consumption.

- 8) Adopt best practice methods for cleaning facilities, which may include manual or automated cleaning systems, using approved chemicals or industrial cleaners with a significantly low environmental impact and compatible with subsequent wastewater treatment processes. Process wastewater is treated using a variety of methods, including grease traps, strippers, or oil-water separators to separate floating solids, balancing the flow rate and the load it contains, and reducing the settling of suspended solids using technical devices. Biological treatment usually begins with aerobic treatment, followed by aerobic treatment to reduce dissolved organic matter and remove biological nutrients, dewatering to reduce nitrogen and phosphorus, and chlorination (chlorination) of the effluent when disinfection is required and the disposal of the settled materials. In some cases, the soil may be mixed or fertilized with the wastewater treatment sludge, provided it is of an acceptable quality. Additional engineering controls may be required to contain and eliminate unpleasant odors. Alternative treatment and separation methods are usually used when High-concentration water contributes to increased levels of total dissolved solids in the water used. Dairy facilities use large quantities of drinking water for treatment, cleaning equipment, process areas, and vehicles. General environmental, health, and safety guidelines and recommendations for reducing water consumption are available, especially in areas where natural resources are limited. [18].

8.5.1. Solid Waste

Solid waste in dairy processing facilities originates primarily from production processes and includes non-conforming products and product losses, such as milk leakage, whey, sludge, screen deposits, filtrates, and sludge from centrifugal separators and wastewater treatment, as well as waste from cleaning operations, such as discarded scraps, used maturation bags, and waxy residues from incoming raw materials and damage to production lines. Recommended measures for reducing and managing solid waste include the following:

- 1) Solid waste generated from non-conforming processes and products can be separated and reprocessed into commercial products and by-products, such as ghee, cooking oil, animal feed, soap-making materials, or other specific industrial grade materials.
- 2) Product packaging equipment should be carefully controlled to avoid product and packaging waste.
- 3) Compliance with food safety standards. -3. Carefully adjust the design of packaging materials to reduce waste

volume, for example, by using recycled materials and reducing their thickness to a degree that negatively impacts the biodiversity.

If the blowing process for PET bottles is carried out on-site, the remaining plastic parts from the blowing process can be reused, classified as plastic waste for recycling, or disposed of off-site.

- 1) Use non-polluted sludge resulting from the treatment of wastewater used in agricultural fertilizers or the production of gas.
- 2) The necessity of handling and disposing of residual waste in accordance with the recommendations for industrial waste.[14].

8.5.2. Air Emissions

(i). Exhaust Gases

Exhaust gas emissions: carbon dioxide, nitrogen oxides, and carbon monoxide in the dairy processing sector result from the combustion of gas, fuel oil, or diesel in turbines, gasifiers, compressors, and other engines used for power and heat generation.

There are guidelines on how to deal with emissions from small combustion sources with a thermal capacity of up to (50) megawatts, including air pollutant emission standards for exhaust gas emissions. Emissions from combustion sources with a capacity greater than (50) megawatts are dealt with in accordance with the Environmental, Health, and Safety Guidelines for Thermal Power.

(ii). Dust

Dust emissions during dairy processing operations include fine sediments and milk powder in the air, exhaust from spray drying systems, and product packaging. Recommended measures to prevent and control dust emissions include installing exhaust fans equipped with dry powder traps, such as spirals or bag filters.

Bag filters are generally preferred over wet washing methods, as they use less water, or produce nothing at all. They use significantly less energy, produce less noise, and the presence of hot air and fine dust can cause fires and explosions. Therefore, all modern spray drying equipment is equipped with mechanisms, explosion-proof alarm systems, and fire-prevention systems.

(iii). Odor

The main sources of odor emissions in dairy processing facilities are related to the wastewater treatment facilities on site, in addition to odor emissions from milk filling/discharging tanks and storage silos.

Recommended methods for preventing and controlling odor emissions include the following:

- 1) Ensure that wastewater treatment facilities are properly designed and maintained, according to the expected

water load.

- 2) Maintain the cleanliness of all work and storage areas.
- 3) Empty and clean grease traps frequently, e.g., empty them daily.
- 4) Ensure good ventilation. -4 Reduce the stock of waste and by-products and store them for short periods in closed, cool rooms.
- 5) Enclose production processes that produce odors and carry them out in the presence of extractors. [14].

8.6. Energy Consumption

Dairy processing facilities consume very large amounts of energy. Typically, the energy required for thermal uses constitutes approximately (80) percent of the total energy, in order to produce hot water and steam for process applications, such as pasteurization, evaporation, milk drying, and cleaning purposes.

The other twenty percent of the total energy required is used in the form of electricity to operate processing equipment, refrigeration units, ventilation, and lighting. In addition to the specific recommendations for increasing energy efficiency, there are several other recommendations recommended in the general guidelines for the environment, health, and safety. The following measures are recommended for this industry to reduce energy consumption and prevent energy loss. These measures can be implemented by adopting methods that help reduce energy consumption and maximize its benefits, as follows:

- 1) Use continuous production pasteurization devices, instead of the operating system, to reduce the volume of heat exchangers.
- 2) Partial milk homogenization.
- 3) Use multi-stage evaporation devices (insulating steam, water, and air pipes/tubes) using a thermostat.
- 4) Eliminate steam leakage and use steam and water valves, controlled remotely.
- 5) Improving cooling efficiency by:
 - a. Insulate designated rooms and cooling areas.
 - b. Equipped with precision switches, using pressurized air chambers, and alarms.
 - c. Installing automatic door closers.
 - d. Using heat recovery systems for both heating and cooling processes in milk pasteurizers and heat exchangers, for example: regenerative flow and counter flow.
 - e. Investigating waste heat recovery methods, including:
 - f. Hot pre-heating. - Waste heat recovery from the refrigeration plant, exhausts, and air compressors, for example: pre-heating.
 - g. Evaporative energy recovery.

9. Occupational Health and Safety

Using heat recovery systems from air compressors and

refrigerators, for example: waste gas exchangers.

9.1. Types of Health Risks

Occupational health and safety risks in dairy processing facilities, along with risks present in other industrial facilities, are addressed in the General Environmental, Health, and Safety Guidelines. In addition, health and safety issues and occupational recommendations specifically related to dairy processing operations include:

- 1) Physical hazards.
- 2) Biological hazards.
- 3) Chemical hazards.
- 4) Exposure to heat, cold, and radiation.

9.1.1. Physical Hazards

Physical hazards include exposure to the risk of falls, due to the presence of large and dangerous tools and equipment, as well as collisions in internal transportation vehicles, such as forklift trucks and containers. The General Environmental, Health, and Safety Guidelines provide guidance on general workplace conditions, including the design and maintenance of working and walking surfaces to prevent slips and falls. Additional industry-specific recommendations include:

- 1) Keep walking and working surfaces clean and dry, provide workers with slip-resistant footwear, and provide them with personal protective equipment, such as hearing protection.
- 2) Train workers on the correct use of equipment, including teaching them how to use it correctly, to avoid slips and falls.
- 3) Ensure that internal planning reduces congestion in the work area and minimizes the possibility of cross-cutting operational activities.
- 4) Plan transport corridors and work areas, and ensure that handrails are properly installed on platforms, stairs, and ladders.
- 5) Ground all electrical equipment and devices in rooms that are frequently exposed to wet conditions.

(i). Injuries Resulting from Lifting, Repetitive Work, and Worker Positioning During Work

Dairy processing operations may involve a variety of situations in which workers can be exposed to injuries, including lifting and carrying, repetitive work, and their body positioning during work. These injuries can result from manual suction lifting, improper worker positioning during work hours, and may also result from improper workstation design and the process itself.

(ii). General Guidelines on the Environment, Health, and Safety

For example:

Mechanical equipment should be used where necessary for

transporting milk cartons to minimize injuries.

9.1.2. Biological Hazards

Exposure to biological and microbiological agents may be associated with the inhalation and ingestion of dust and mist, particularly in milk powder operations. Dust from dairy processing equipment and high humidity levels can also cause skin irritation or other allergic reactions (allergic reactions, as defined by the World Health Organization).

To prevent and control exposure to biological hazards specific to dairy processing, the following should be taken into account:

- 1) Avoid activities that generate dust and mist, such as the use of compressed air or water for cleaning. Where such activities cannot be avoided, provide enclosed or semi-enclosed areas with good ventilation to eliminate or minimize the risk of exposure to dust and mist.
- 2) Install exhaust fans with filters and/or cyclones at dust sources.
- 3) Provide workers with appropriate personal protective equipment during process activities.
- 4) Ensure physical separation from recreational facilities to maintain worker hygiene.
- 5) Avoid direct contact with non-conforming dairy products. [1].

9.1.3. Chemical Hazards

Exposure to chemicals-including gases and vapors-usually involves handling chemicals related to cleaning and disinfecting process areas, as well as maintaining heating (thermal oils) and cooling (ammonia) systems.

There are several recommended methods for dairy processing workers to reduce and control their exposure to chemicals.

9.1.4. Heat and Cold

Workers in dairy processing facilities can be exposed to heat generated by process activities and to cold in cold areas and rooms. General guidelines are recommended for these conditions.

9.1.5. Noise and Vibration

The main sources of noise within a dairy processing facility are centrifuges, homogenizers, spray towers, and packaging machines, all of which are typically located in enclosed buildings.

9.2. Community Health and Safety

The health and safety of the local community are affected by the construction of dairy processing plants, along with the impacts that occur during the construction of other industrial facilities. During the facility planning phase, the processing facility should be located at a suitable distance from the

neighborhood population, and access routes should be assessed. (Guidelines on the Environment, Health and Safety of Dairy Processing, 30 April 2007).

A balance must be taken into account between milk production and the surrounding farm environment, by adopting a system that Environmentally Sustainable Agriculture.

9.3. Environmental Management of the Dairy Industry in the Kingdom of Saudi Arabia

Human health and well-being are linked to the quality of the environment in which they live. They breathe its air, eat its bounty, and drink its water. Environmental scientists call the living organisms present in the environment the "biological component," while the air, soil, and water are called the "non-living component." These components are linked to each other in a network of interconnected and interactive relationships in the form of a chain of ecological chains, forming the ecosystem.

Humans are distinguished by their ability to think, research, and invent. The greater their technological wealth, the greater their ability to bring about change in their environment. The significant increase in agricultural production has not only led to a positive impact on the environment but has also led to significant depletion of resources.

Industrial pollution has become an integral part of the environment. The ecosystem, as any change it causes to its environment has a repercussive impact on humans. Considering humans as an integral part of the ecosystem, the environmental impact of industrial projects is assessed, and laws are put in place to determine whether the impact is positive or negative. In most countries, project owners are required to conduct a study on the impacts of their projects. This study is known as an Environmental Impact Assessment (EIA). This study contributes to making these projects less impactful on the environment and more beneficial to local communities.

Environmental Impact Assessment Process

The laws of each country specify the detailed procedures that the environmental impact assessment process must go through. In general, there are several basic steps or stages of this process:

9.3.1. Sorting

The assessment process begins with the first stage, sorting. In this stage, projects are classified according to the degree of their expected impact on the environment. Projects are usually classified into three categories:

- 1) Projects that have a direct impact on the environment, and therefore require an in-depth study of these impacts.
- 2) Projects exempt from the environmental impact assessment process, which are projects that are expected to have negative impacts.
- 3) Projects falling within the aforementioned groups

require a targeted assessment of certain important and limited points. [15].

The goal of sorting is to increase the effectiveness of the assessment process, so that efforts and resources are focused on projects that are expected to have significant environmental impacts. And important.

The sorting is carried out by the public institution entrusted with managing the environmental impact assessment process. Screening is usually done by issuing a list of projects that require a full environmental assessment, and another list of projects that are exempt. The third group of projects may be placed on a special list and presented to the arbitrators to determine the level of assessment required for each project individually.

9.3.2. Scoping

The step required for an environmental impact assessment of projects is called scoping (scope of the study). It involves identifying the most important aspects and those required for study. Priorities must be set in consultation with practical and technical specialists, local communities, civil society organizations, and project owners.

As for assessment studies that overlook important impacts, such as encyclopedic studies that cover both important and unimportant matters, they are of poor quality.

9.3.3. Impact Prediction and Evaluation

In this section, we identify the environmental impacts expected to occur in a project, as well as the magnitude and significance of these impacts. The magnitude or size of the impact must be distinguished here. The expected impacts may be small in magnitude and size, but they are nevertheless extremely important. The significance of environmental impacts varies from one place to another and from one community to another. In addition to direct impacts, the assessment must include both indirect and cumulative impacts. An example of direct impacts is the emission of particulate matter into the air resulting from the operation of a new power plant. Indirect impacts, also called secondary impacts, refer to changes that result from the construction or operation of a project. These changes occur quickly or within the confines of the project, as is the case with direct impacts. An example of this type of indirect impact is the increased incidence of schistosomiasis in agricultural fields after the construction of the High Dam. Cumulative impacts refer to changes caused by the project. These may not, in and of themselves, be dangerous to human health or the environment, but they become dangerous when added to the changes already caused. Other nearby projects are newly constructed, or those expected to occur from projects under construction.

9.3.4. Impact Mitigation

Following the impact assessment, the measures that will be taken to mitigate the negative environmental impacts expected from the project are identified. This may be through

some modifications to the project design or through its operation. Therefore, it is best to conduct an environmental assessment at an early stage. From project planning, we help reduce the negatives and increase the project's positives.

For example: increasing employment opportunities for residents through a project in areas affected by its construction.

9.3.5. Documentation and Documentation

The results of the environmental impact assessment study are presented to relevant parties in various forms: reports, drawings, presentations, etc.

The report is what the project owner is legally required to submit to the decision-making authority. It is commonly known as the Environmental Impact Statement (EIS).

The purpose of this report is to clarify the environmental impact and potential impacts of this project and to attempt to reduce negative impacts. The EIS must contain the information needed by several parties:

1. The project owner to implement his project socially responsibly.
2. To achieve this goal, the project owner must submit the EIS to the decision-making authority.
3. The responsible parties are required to make the right decision regarding the proposed project, including the conditions required for the general public to understand the proposed project, its potential impacts on people and the environment, and a useful environmental impact statement (EIS). This statement meets the following criteria:
 - a. The project owner must be able to adhere to the procedures recommended in the report in order for the project to be environmentally sound.
 - b. The report must provide the information the decision-making party needs to make the right decision.
 - c. It must be easy to understand for the general public, communicating technical matters in a simple yet comprehensive manner.
 - d. The EIS must contain the following basic components: [16].

This summary is often the only part of the report read by the decision-maker and the general public. Therefore, the executive summary must briefly and simply explain the overall results of the EIS.

- 1) Executive Summary and Overview
- 2) Project Description
- 3) Description of the Environment Affected by the Project
- 4) Project Alternatives, and if the selected alternative is selected, what are the expected significant impacts of the project
- 5) Mitigation Measures to be Implemented to Reduce the Project's Negative Impacts
- 6) Review and Arbitration: - A plan for the environmental management of the project after its construction and

operation

9.3.6. Review and Arbitration

The purpose of the review (Environmental Impact Statement (EIS) review) is to ensure the quality and adequacy of the information obtained from the assessment study. This process provides public participation. A comprehensive review of the EIS addresses many of the following issues:

- 1) Does the report cover the items agreed upon in the scoping process?
- 2) Does each of the essential parts of the report provide the information necessary for decision-making?
- 3) Is the information in the report accurate, precise, and technically sound?
- 4) Are the views and interests of affected and interested parties considered?
- 5) Does the report provide a comprehensive and satisfactory overview of the necessary findings?
- 6) Does the report provide all the information required for the decision-making process? This is the most important aspect of the report. [15].

9.3.7. Decision-making Process

The primary goal of the entire EIA process is to integrate environmental considerations into the decision-making process.

It also supports public participation in decision-making, or what is known as participatory decision-making.

9.3.8. Implementation and Follow-up

The environmental assessment process ends with project approval, but it continues throughout the project's life. The stages following project approval are called (implementation, follow-up, and strategic environmental assessment).

9.3.9. Strategic Environmental Assessment

The concept of environmental assessment has begun to be applied at the project level, and the prevailing trend is toward applying the same concept at higher levels: program, plan, and policy levels. Dairy production and the waste it produces. [12].

In terms of the dairy industry's impact on the environment, cow manure released during the manufacturing and packaging process is the most significant, if not the primary, source of pollution. Looking at this and other industries, we see that they began in the Kingdom during the planning process for residential and industrial areas, which enabled most industries, especially new ones, to be isolated in areas far from residential areas.

The energy level and type of technology in these factories, namely electricity, reduces air pollution from smokestacks that typically occur in industries that use gas, coal, or petroleum derivatives. As for land pollution, the sewage treatment plants used in industrial cities, which now house 80%

of various industries, significantly reduce industrial waste and residues. Moreover, the sanitation workers employed in the factories, in addition to municipal workers, collect and transport the remaining waste and residues to designated locations for burning them away from residents, which greatly reduces the environmental pollution resulting from this industry. The dairy industry is considered one of the most important and successful food industries in the Kingdom, given its rapid expansion, the rapid spread of cow farms producing fresh milk as an alternative to imported dried milk or as a supplement to it, and the degree of demand for it. The milk, yogurt, and yoghurt industries have surpassed the barrier of foreign competition in terms of quality, and they can meet the growing demand for them. This bodes well for the future of this industry, especially if local fresh milk production continues to increase over the coming years, at the same rate as it has been increasing over the past few years.

9.4. Administrative Bodies Concerned with Environmental Protection in the Kingdom of Saudi Arabia

There are several administrative bodies specialized in environmental protection, including the General Presidency of Meteorology and Environmental Protection, which aims to protect the public interest and achieve national and possibly international objectives.

Among the administrative bodies are the Ministry of Industry and Electricity, along with the Department of Safety and Environment, which plans, coordinates, and monitors operations to reduce industrial pollution from solid, liquid, and gaseous waste from production processes. They also study the most appropriate methods for treating industrial waste or reusing it using clean technology. Environmental considerations are taken into account when licensing an industrial project or establishing an industrial city.

Among the most prominent environmental considerations taken into account when establishing an industrial city are:

- 1) Suitable geographical location.
- 2) Distance from populated areas and residential areas.
- 3) Establishing stations to monitor air pollution in coordination with the General Presidency of Meteorology and Environmental Protection.
- 4) Industrial licensing requires the use of advanced technology to combat any pollution.
- 5) Encouraging industries that utilize industrial waste from other factories is an integral part of comprehensive development planning in all areas: industrial, agricultural, urban, and others. [5].
- 6) An important role has been assigned to the Ministry of Planning, which is to make environmental planning an integral part of the overall development plan.

10. Research Conclusion

The research presented numerous recommendation and suggestion for achieving good environmental management and eliminating the phenomenon of dairy pollution in the Kingdom of Saudi Arabia, the research relied on numerous sources and references that helped her define and analyze the problem under study.

10.1. Recommendations

- 1) The study recommends that ministries and agencies update their data periodically and facilitate access to it for researchers through their official websites. This saves time and effort for students and researchers, supports them in completing their studies more effectively and quickly, and encourages manufacturers to publish their data for the purpose of utilizing it in scientific research. • The study recommends maintaining a balance between milk production and the surrounding environment, implementing good agricultural practices in dairy factories, adopting an environmentally sustainable agricultural system, preserving and promoting biodiversity on farms, implementing an appropriate waste management system, and ensuring that dairy farm practices do not have negative impacts on the surrounding environment.
- 2) The study encourages the implementation of effective herd health management programs, such as establishing an identification system that allows each animal to be individually identified from birth until death, and developing herd health programs to keep all animals healthy and productive. The animals are regularly examined for signs of disease, using accurate detection and diagnosis methods, and isolating and caring for sick animals.
- 3) The study recommends not using veterinary chemicals and medicines unless authorized, and caution should be exercised regarding chemicals that leave traces in milk. The study encourages attention to milking methods so as not to harm the animal and transmit contamination for milk, proper handling of milk after milking, ensuring the continuous cleanliness of the barns and the milking area, and ensuring that milking workers adhere to basic personal hygiene rules.
- 4) The study recommends ensuring water and feed supplies from sustainable sources, implementing sustainable feeding and irrigation practices, and pest control when growing milk, and ensuring that the water and feed provided to animals are adequate in quantity and quality.
- 5) The study encourages effective and responsible human resource management, such as implementing sustainable work practices and training workers based on national laws and practices, by adhering to international laws and conventions, and ensuring compliance with

occupational health and safety requirements in the work environment.

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Abbreviations

TOC	Device for Measuring Organic Pollutants in Water
TDS-3	Water Salinity Meter
PH.	Hydrogen Ion Concentration in Solution
UHST	Rapid Temperature Pasteurized Milk Production
UHT	Production of Milk After Lactation Due to High Temperature
COD	Chemical Requirement for Oxygen
BOD5	Biological Need for Oxygen
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
AWS	Alliance for Water Stewardship
HACCP	Hazard Analysis Critical Control Point

Author Contributions

Fatimah Muqbil Naja Al-Mutairi is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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