EXPLORATORY DATA ANALYSIS ON VIRTUAL WATER FOR ANIMAL PRODUCTS

A MINI PROJECT REPORT SUBMITTED TO THE BHARATHIAR UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

MASTER OF COMPUTER APPLICATIONS

Submitted by

JEEVANANTHAN M

(Reg. No: 22CSEA09)

Under the guidance of

Dr. V. BHUVANESWARI., M.C.A., M.Phil., Ph.D.,

Professor

DEPARTMENT OF COMPUTER APPLICATIONS

BHARATHIAR UNIVERSITY

COIMBATORE-641046.

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CERTIFICATE

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This is to certify that, this mini project work entitled "**EXPLORATORY DATA ANALYSIS ON VIRTUAL WATER FOR ANIMAL PRODUCTS"** was submitted to the Department of Computer Applications, Bharathiar University in partial fulfillment of the requirements for the award of the degree of **MASTER OF COMPUTER APPLICATIONS**, is a record of original work done by **JEEVANANTHAN M (22CSEA09),** during his period of study in the Department of Computer Applications, Bharathiar University, Coimbatore, under my supervision and guidance, and this project work has not formed the basis for the award of any Degree/ Diploma /Associateship/ Fellowship or similar title to any candidate of any University.

Place: Coimbatore

Date:

Project Guide **Head of the Department**

Submitted for the University Viva-Voce Examination held on ____________

Internal Examiner **External Examiner**

DECLARATION

DECLARATION

I hereby declare that this mini project work titled, "**EXPLORATORY DATA ANALYSIS ON VIRTUAL WATER FOR ANIMAL PRODUCTS**" submitted to Department of Computer Applications, Bharathiar University, is a record of original work done by **JEEVANANTHAN M(22CSEA09)**, under the supervision and guidance of **Prof. Dr. V. BHUVANESWARI., M.C.A., M.Phil., Ph.D.,** Department of Computer Applications, Bharathiar University, and that this project work has not formed the basis for the award of any Degree/ Diploma/ Associateship/ Fellowship or similar title to any candidate of any University.

Place: Coimbatore — Signature of the candidate

Date: — (JEEVANANTHAN M)

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ACKNOWLEDGEMENT

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JEEVANANATHAN M

ABSTRACT

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This project explores the idea of virtual water, which is sometimes referred to as embedded water or indirect water. Virtual water is the term for the concealed water that is used in the manufacturing of products at different points in their value chains.

In the context of global water distribution, the importance of virtual water, particularly for water-stressed nations looking to manage their water resources effectively. The interchange of water-intensive goods and services between countries, known as virtual water trade, influences regional water supplies and consumption trends.

In this project various virtual water usage to produce Animal products through detailed exploratory data analytics is implemented. Analyze the association and relationship of Animal products produced using different water resources using the Water footprint of animal products (m3/ton) Period 1996-2005 dataset collected from www.waterfootprint.org, emphasizing the latter's deep study and its comprehensive measure, which includes components like blue, green, and grey water footprints.

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INTRODUCTION

CHAPTER – I

1.INTRODUCTION

In a time when environmental sustainability and global resource management are of utmost importance, the idea of virtual water becomes a vital lens through which to view the complex web of water usage ingrained in our everyday lives. Virtual water, sometimes referred to as embedded water or indirect water, is the term used to describe the hidden water that is woven into the production processes of commodities and services at various points along their value chains. It is sometimes veiled in mystery. The virtual water paradigm revolves around this hidden water, which is necessary to produce things.

This guide sets out to clarify the differences between virtual water content and direct water use by delving into the intricacies of virtual water. Although end consumers' actual, palpable water intake is known as "direct water use," virtual water content encompasses more, covering every stage of a product's lifespan, from extraction of raw materials through production, delivery, and consumption.

The worldwide ramifications of virtual water and its commerce are examined, particularly because some countries are experiencing a shortage of water. The dynamics of virtual water commerce, an exchange of water-intensive goods and services between nations that has a significant impact on regional water supplies and consumption patterns, are navigated by water-stressed countries seeking effective management of their water resources.

Examining the relationship between virtual water and water footprint, this project highlights the breadth of research that virtual water can provide, offering a complete measurement that incorporates fine-grained elements like blue, green, and grey water footprints. Green water, which comes from soil moisture and rainfall, is essential to the continuation of agricultural operations, while blue water, which comes from surface and groundwater, is important to many different sectors.

The acknowledgement of grey water as a residue of domestic tasks, underscoring the significance of conscientious water resource management, is intricately linked to the whole story.

This project intends to contribute to a nuanced understanding of virtual water as we traverse the complex interactions of water in our products and services, supporting informed decision-making for sustainable water management.[1]

1.1. VIRTUAL WATER

Virtual water, also known as "embedded water" or "indirect water," refers to the water that is hidden or not readily apparent in the products, services, and processes that people consume daily. This hidden water has been utilized at various stages throughout the entire value chain of a particular product or service, and it is essential for the creation of that product or service. The concept of virtual water is often used interchangeably with indirect water. In contrast, direct water use is the water that is visibly used and felt at a specific time and location to produce a particular item or service, such as the water that flows from a tap. Direct water use is the water directly employed in a specific activity or operation. For instance, in the production of microchips, highly distilled water is directly used in the manufacturing process, and a beverage bottling company directly uses water to clean bottles. The total direct water use across all the steps in a product's or service's production process adds up to the overall water required to bring the finished product to consumers. This total can be considered the virtual water content of the product or service.[1]

The difference between direct water uses and virtual water in the context of everyday products is given below.

1. WATER FOR PASTA:

- **Direct Water Use:** When we boil dry pasta at home, the water we use for cooking is an example of direct water use. This is the water we see and feel in your immediate consumption of the product.
- **Virtual Water Content:** To produce the pasta we cooked, water is needed at various stages along the value chain. This includes water to grow the wheat used in pasta production, water for fuel to run machines during wheat harvesting and pasta transportation, and water for electricity to process the wheat into flour and pasta. The combined water use at these different stages constitutes the virtual water content of the pasta. This water is "hidden" from the end consumer but is essential for the creation of the product.[1]

2. WATER FOR JACKETS:

- **Direct Water Use:** When we wash a nylon jacket in a washing machine, the water we use for cleaning it is an example of direct water use. This is the water we directly employ to maintain and use the product.
- **Virtual Water Content**: In the production of the jacket, water is required at various points in the value chain. This includes water for drilling, producing, and refining the oil and natural gas used to make nylon fabric, water for generating electricity during the manufacturing process, and water for producing fuel to power vehicles that transport the jacket to the store. The cumulative water usage in these various stages constitutes the virtual water content of the jacket, which is not readily visible to the end user but is necessary for the creation of the product.

In both examples, direct water use is the water consumption that the end user is directly aware of and responsible for, such as cooking or washing. Virtual water content, on the other hand, encompasses all the water used throughout the product's entire lifecycle, from raw material extraction and production to transportation and manufacturing. Understanding virtual water is crucial for assessing the environmental impact of products and services and for making more informed choices regarding water-efficient consumption.[1]

1.1.1. VIRTUAL WATER AND VIRTUAL WATER TRADE

Virtual water and virtual water trade are concepts that have evolved to address the global distribution of water-intensive goods and services. These concepts have become especially important for water-stressed countries in meeting their population's needs.

- **Virtual Water:** Virtual water refers to the hidden or indirect water used in the production of goods and services. It helps us understand how much water is embedded in various products, even though this water is not immediately apparent to the end consumer. The concept was initially developed to assist water-stressed countries in managing their water resources more effectively by addressing their consumption patterns.

- **Virtual Water Trade:** Due to the global nature of trade, water-scarce countries have increasingly relied on importing water-intensive products rather than producing them locally, which could be detrimental to their local water resources. Virtual water trade involves the exchange of water-intensive goods and services between countries. For example, a water-scarce country might import cotton textiles rather than growing cotton, which is a highly water-intensive crop, locally.

The Water Footprint Network summarizes the relationship between virtual water and water footprint as follows:

"As food and other products are traded internationally, their water footprint follows them in the form of virtual water. This allows us to link the water footprint of production to the water footprint of consumption, wherever they occur. Virtual water flows help us see how the water resources in one country are used to support consumption in another country."

While there are overlaps between virtual water and water footprint concepts, they are not equivalent: Virtual Water typically focuses on the total water used in the entire value chain of a product, providing a single, comprehensive measure of water use for that product. Water Footprint can be a more detailed analysis, breaking down a product's water footprint into different components, including blue, green, and grey water footprints. These components help distinguish between different types of water use (e.g., blue for surface and groundwater, green for rainwater, and grey for water polluted during production) and assess the environmental impact of the product within its local water and ecological conditions.[1]

1.1.2. GREEN WATER, BLUE WATER, AND GREY WATER IN THE CONTEXT OF VIRTUAL WATER

- **GREEN WATER**

  Virtual Water Source: Green virtual water refers to the water embedded in agricultural products that comes from rainwater and soil moisture. It represents the water used by crops during their growth.

  Use in Virtual Water Trade: Green virtual water is a significant component of the virtual water content of agricultural products. When a country exports crops to another nation, it is essentially exporting the green virtual water associated with those crops.

Importance in Virtual Water Trade: Understanding green virtual water is crucial in the context of virtual water trade, as it shows the water needed for producing agricultural goods. Importing nations often rely on the green virtual water of imported crops to supplement their domestic water resources.[2]

- **BLUE WATER**

Virtual Water Source: Blue virtual water represents the water embedded in products and services derived from surface and groundwater sources, such as rivers, lakes, and aquifers.

Use in Virtual Water Trade: Blue virtual water plays a significant role in the virtual water content of products that require freshwater resources, such as industrial processes, municipal water supply, and certain agricultural practices.

Importance in Virtual Water Trade: In virtual water trade, the exchange of products or services with high blue virtual water content can impact water-scarce regions that may rely on imports to meet their water-intensive needs. [2]

- **GREY WATER (VIRTUAL WATER)**

Virtual Water Source: Grey virtual water pertains to the water embedded in products and services that is generated as wastewater from household activities, like bathing, laundry, and dishwashing.

Use in Virtual Water Trade: Grey virtual water is not typically a direct focus of virtual water trade, but it has implications for water sustainability. It underscores the importance of responsible water management and wastewater treatment to reduce the environmental impact.

Importance in Virtual Water Trade: While grey virtual water is not directly traded, it indirectly impacts water conservation and resource management in regions by highlighting the need for recycling and treating grey water to reduce the overall water footprint. Understanding green, blue, and grey virtual water helps nations and industries make more informed decisions about water-efficient consumption and trade. [2]

1.2. TECHNICAL STACK

Programming Language

- Python: Widely used for data analysis, Python has a rich ecosystem of libraries and tools that are well-suited for tasks such as data cleaning, exploration, and visualization.

Data Analysis and Visualization

- Jupyter Notebooks: Interactive notebooks facilitate exploratory data analysis and visualization.
- Pandas: A powerful data manipulation library for cleaning and processing structured data.
- Matplotlib and Seaborn: Libraries for creating static, interactive, and aesthetically pleasing visualizations.

Statistical Analysis

- NumPy: Fundamental package for scientific computing with support for large, multi-dimensional arrays and matrices.
- SciPy: A library for scientific and technical computing that builds on NumPy and provides additional functionality.

Text Editor/IDE

- VSCode editor or integrated development environment (IDE) for Jupyter notebook

LITERATURE REVIEW

CHAPTER- II

2. LITERATURE REVIEW

A) Virtual Water

In the realm of water sustainability research, several notable studies have contributed valuable insights.[VW 01] Shiv Narayan Nishad and Naresh Kumar (2021) delved into a quantitative analysis of virtual water trade, focusing on the implications for water sustainability. Their study, published in Water Science & Technology Water Supply, concentrated on the rice crop, renowned for its significant water consumption and exportation from India. In a separate work ,[VW 02] Hedieh Ahmadpari, Elnaz Namdari Ghareghani, et al. (2022), presented a solution-oriented approach in their research on Virtual Water for Water Resources Management, showcased at the Second International Conference on Applied Research in Agricultural Sciences, Natural Resources, and the Environment in Hamedan.Another noteworthy contribution comes from [VW 03] Alaa El-Sadek, who explored the practical value of the virtual water concept for integrated water resources management. The outcomes of this exploration were documented in a paper published in Scientific Research. In an earlier study, [VW 04] H. Yang, L. Wang, K. C. Abbaspour, et al. (2005), scrutinized the efficiency of water use in the international food trade, assessing perspectives at both global and country levels, as published in Hydrol. Earth Syst. Sci.

B) Machine Learning

Machine learning's role in understanding virtual water networks was investigated by [ML 01] Fiorella Oreggioni et al., who developed a model using Random Forest to predict annual commodity and virtual water flow networks in the US. Their findings were shared in a publication on Science Direct. Similarly, [ML 02] Ali Mokhtar, Ahmed Elbeltagi, et al. (2021), employed machine learning algorithms to estimate the rice water footprint, contributing to water footprint prediction for sustainable water use and food security, as presented in Science Direct.A novel application of machine learning algorithms was also undertaken by [ML 03] Amal Mohamed, Mohamed Abuarab, et al. (2023), in estimating the potato water footprint in arid regions. Their models, yielding superior outcomes, offer potential contributions to decision-making processes in water management, as documented in Research Square. [ML 04] Hatem Chouchane, Maarten S. Krol, et al. (2017), delved into the virtual water trade patterns of Tunisia, employing regression models to analyze dynamics in relation to environmental and socio-economic factors. Their work was published in Elsevier.

C)Virtual Water Assessment

Further enriching the literature, [VWA 01] J.X. Sun, Y.L. Yin, et al. (2021), conducted a comprehensive review of virtual water research, focusing on accounting methods, impact assessment, and limitations. Additionally, [VWA 02] D. Vildan Fiçici, A. Keita, et al. (2014), explored the environmental effects of water footprint, providing insights into the water use behind consumption, as disseminated through their publication on ResearchGate.[VWA 03] Arjen Hoekstr, Ashok Chapagain, et al. (2011), made significant contributions with the Water Footprint Assessment Manual, emphasizing the freshwater perspective on animal products from grazing and industrial systems. [VWA 04] The importance of understanding water footprint and virtual water was underscored by Dipti Mathur and Priti Kaushik (2018) in their research, shared in IJERT. Finally, Lixing Lin, Xuerui Gao, et al. (2021), evaluated water consumption of animal products and virtual water flow patterns associated with interprovincial trade in China. Their study, published in Elsevier, proposed countermeasures for improving water use efficiency and addressing the integrated management of physical and virtual water.

METHODOLGY

CHAPTER-III

3. METHODOLOGY

3.1. OBJECTIVE

- The specific objective of the project is to perform EDA to analyze the usage of virtual water on different water sources by different Animal products across specific location in Asia.
- Identify and evaluate the major influence on usage of virtual water related to the foot print animal products.
- various Describe the story boarding of Inference and Insight with respect to the Dataset.
- Analyze the global distribution of virtual water usage, for the animal products with respect to production and consumption in fields as well as industry. this entails investigating both production and consumption patterns.

3.2 FRAMEWORK OF THE PROJECT

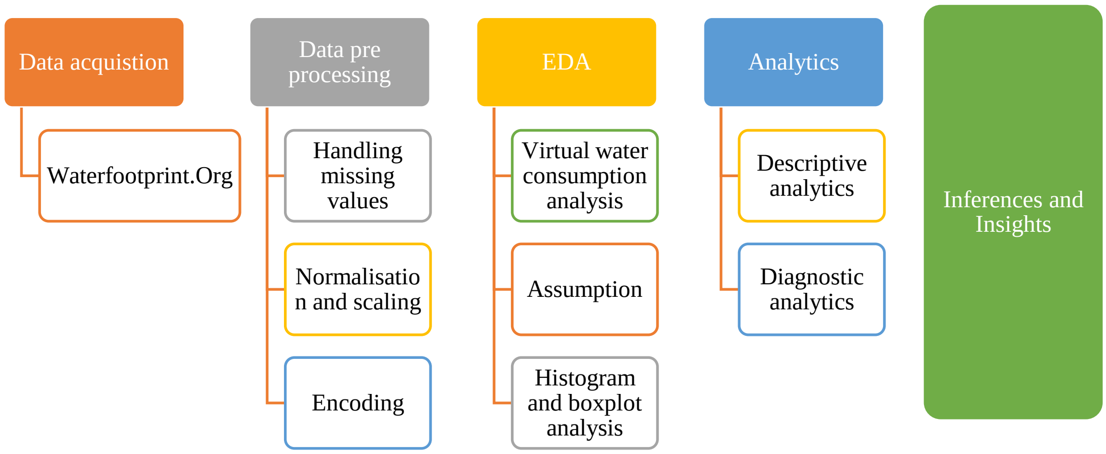


Fig.1: Framework of the project

3.3. DATA COLLECTION:

Data Collection

The dataset utilized in this project was obtained from the Water Footprint Network (WFN) website **(https://waterfootprint.org/).** The Water Footprint Network is a reputable source that provides comprehensive data on the virtual water content of various products, including animal-based goods.

Source

The data retrieval process involved accessing the Water Footprint Network website, navigating to the Water Footprint Assessment database section, and specifically extracting the relevant datasets related to animal product virtual water content. The datasets were accessed and downloaded in a structured format, ensuring compatibility with data analysis tools and techniques. The dataset covers a span of [1995-2005] and captures variations in virtual water usage over time, providing the opportunity for temporal analysis.

The animal product virtual water dataset was specifically sourced from the Water Footprint Assessment (WFA) database, which is maintained and regularly updated by the Water Footprint Network. The WFA database incorporates extensive information on the water footprint of diverse products, offering insights into the direct and indirect water use associated with their production.

Master Dataset Overview

The master dataset encompasses a comprehensive collection of data related to various Animal products, classified through HS (PC-TAS) and SITC Rev 3 (SITA) codes. These codes serve as key identifiers for international trade and product categorization.

MASTER DATA SET OVERVIEW	
Descriptions	**Attributes**
Product Descriptions	HS Code: A globally recognized code system for product classification. SITC Code: Corresponding to the Standard International Trade Classification, Revision3.
Product Attributes	Root Product (HS/SITC): Fundamental classification of products. Product Fraction: Percentage of the total virtual water content within a specific category that is attributed to a particular product. Value Fraction: Percentage of the total virtual water value within a specific category that is associated with a particular product.
Geographical Information	Country: The origin or destination country for each product.
Production System	Green Water: Water consumption associated with agricultural processes. Blue Water: Water consumption related to industrial processes. Grey Water: Water usage in mixed processes.
Virtual Water Consumption (Numerical Values)	Grazing: Numerical value indicating virtual water consumption in grazing systems.

	Mixed: Numerical value indicating virtual water consumption in mixed production systems. Industrial: Numerical value representing virtual water consumption in industrial processes. Weighted Average: Calculated average of virtual water consumption across different production systems.

Table.1. Master Dataset Overview

This dataset is valuable for understanding the virtual water consumption patterns across various products and production systems, providing insights into the environmental impact associated with water usage in different sectors.

Data Cleaning

To ensure data quality and consistency, a comprehensive data cleaning process was undertaken. This involved handling missing values, standardizing units, and addressing any anomalies or inconsistencies within the dataset.

Limitations

It's essential to acknowledge that the dataset, while comprehensive, may have inherent limitations. These limitations could include variations in data reporting standards across countries, potential inaccuracies in estimations, or a lack of granularity in certain aspects of the data.

By utilizing this dataset from the Water Footprint Network, this project aims to contribute valuable insights into the global virtual water footprint associated with animal products, fostering a deeper understanding of the environmental implications of our consumption patterns.

3.4. DATA PREPROCESSING

The raw dataset obtained from the Water Footprint Network underwent a series of pre-processing steps to ensure its suitability for meaningful analysis.

The pre-processing steps included:

A) Missing Value Imputation:

An assessment of missing values was conducted, and appropriate strategies were employed to handle them. This included imputation or removal of rows/columns with missing data, depending on the nature and extent of the missing values.

B) Normalization And Scaling

Reshaping Data Structure: The original dataset was in a wide format, with each column representing a specific country and different animal products. To enhance the analyzability and facilitate a clearer representation of the data, the dataset was transformed into a long format, where each row corresponds to a unique combination of country, product, and associated virtual water content.

C) Encoding

Product Categorization: To simplify the analysis and provide a more generalized perspective, the various animal products were categorized into broader product categories. This involved grouping specific items such as sheep, poultry, dairy, swine, horses, cattle, and eggs into overarching categories like “Bovine”, “Dairy”, “Poultry”, "Egg”, "Swine”,” Horses”, "Sheep and Goat”. A new column 'Product Category,' was introduced to capture these classifications.

Country Categorization Based on Continents: A new column, 'Continent,' was added to the dataset to categorize countries based on their geographical location. This categorization by continents enables a broader analysis, allowing for insights into regional trends and variations in virtual water utilization.

The resulting pre-processed dataset is now more amenable to exploratory data analysis, enabling a more focused investigation into the virtual water footprint of animal products across countries and continents.

D)Feature Engineering

Column Reduction: Unnecessary columns that did not contribute to the primary objectives of the analysis were removed. This streamlined the dataset, making it more focused and efficient for subsequent exploration.

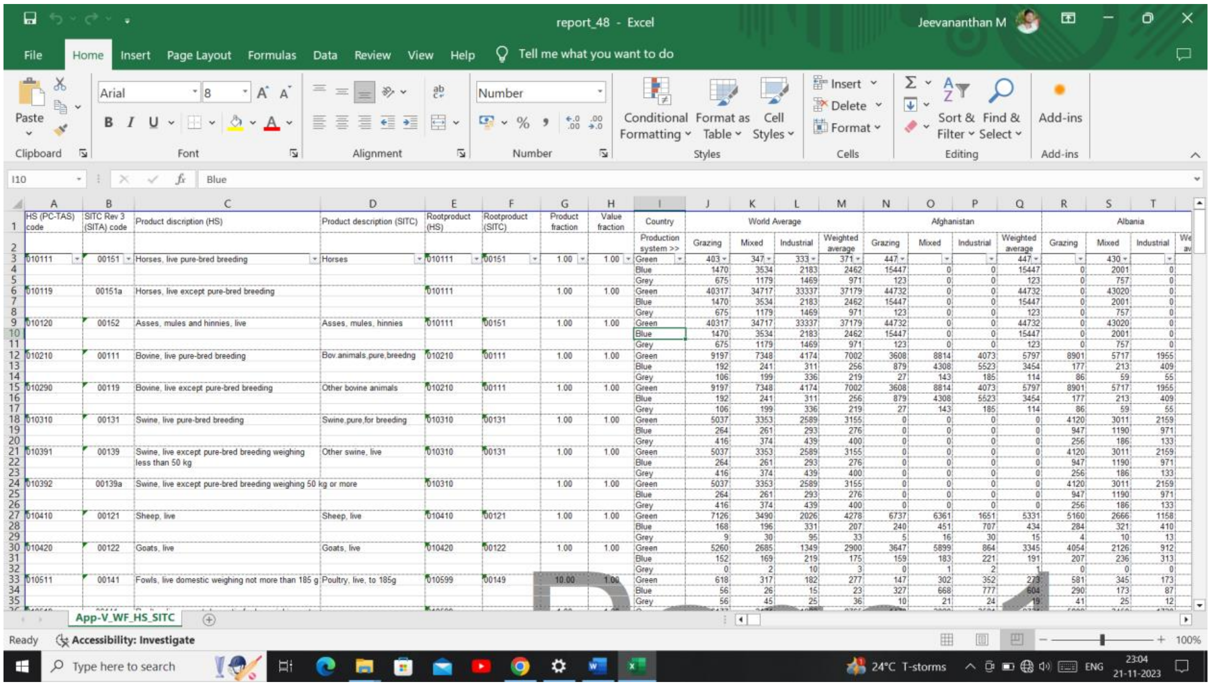
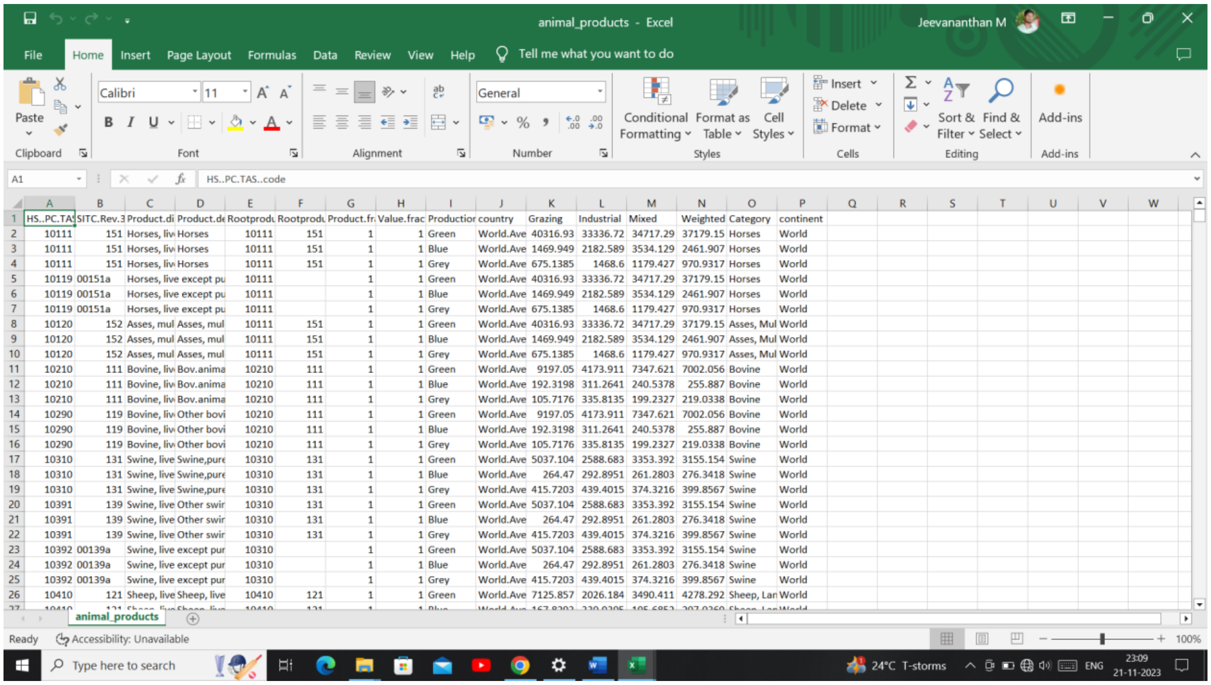


Fig.2: Before Data Preprocessing



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	HS..PC.TA!	SITC.Rev.3	Product.di	Product.de	Rootprodu	Rootprodu	Product.fr	Value.frac	Productior	country	Grazing	Industrial	Mixed	Weighted	Category	continent
2	10111	151	Horses, liv	Horses	10111	151	1	1	Green	World.Ave	40316.93	33336.72	34717.29	37179.15	Horses	World
3	10111	151	Horses, liv	Horses	10111	151	1	1	Blue	World.Ave	1469.949	2182.589	3534.129	2461.907	Horses	World
4	10111	151	Horses, liv	Horses	10111	151	1	1	Grey	World.Ave	675.1385	1468.6	1179.427	970.9317	Horses	World
5	10119	00151a	Horses, live except pu		10111		1	1	Green	World.Ave	40316.93	33336.72	34717.29	37179.15	Horses	World
6	10119	00151a	Horses, live except pu		10111		1	1	Blue	World.Ave	1469.949	2182.589	3534.129	2461.907	Horses	World
7	10119	00151a	Horses, live except pu		10111		1	1	Grey	World.Ave	675.1385	1468.6	1179.427	970.9317	Horses	World
8	10120	152	Asses, mul	Asses, mul	10111	151	1	1	Green	World.Ave	40316.93	33336.72	34717.29	37179.15	Asses, Mul	World
9	10120	152	Asses, mul	Asses, mul	10111	151	1	1	Blue	World.Ave	1469.949	2182.589	3534.129	2461.907	Asses, Mul	World
10	10120	152	Asses, mul	Asses, mul	10111	151	1	1	Grey	World.Ave	675.1385	1468.6	1179.427	970.9317	Asses, Mul	World
11	10210	111	Bovine, liv	Bov.anima	10210	111	1	1	Green	World.Ave	9197.05	4173.911	7347.621	7002.056	Bovine	World
12	10210	111	Bovine, liv	Bov.anima	10210	111	1	1	Blue	World.Ave	192.3198	311.2641	240.5378	255.887	Bovine	World
13	10210	111	Bovine, liv	Bov.anima	10210	111	1	1	Grey	World.Ave	105.7176	335.8135	199.2327	219.0338	Bovine	World
14	10290	119	Bovine, liv	Other bovi	10210	111	1	1	Green	World.Ave	9197.05	4173.911	7347.621	7002.056	Bovine	World
15	10290	119	Bovine, liv	Other bovi	10210	111	1	1	Blue	World.Ave	192.3198	311.2641	240.5378	255.887	Bovine	World
16	10290	119	Bovine, liv	Other bovi	10210	111	1	1	Grey	World.Ave	105.7176	335.8135	199.2327	219.0338	Bovine	World
17	10310	131	Swine, live	Swine,pure	10310	131	1	1	Green	World.Ave	5037.104	2588.683	3353.392	3155.154	Swine	World
18	10310	131	Swine, live	Swine,pure	10310	131	1	1	Blue	World.Ave	264.47	292.8951	261.2803	276.3418	Swine	World
19	10310	131	Swine, live	Swine,pure	10310	131	1	1	Grey	World.Ave	415.7203	439.4015	374.3216	399.8567	Swine	World
20	10391	139	Swine, live	Other swir	10310	131	1	1	Green	World.Ave	5037.104	2588.683	3353.392	3155.154	Swine	World
21	10391	139	Swine, live	Other swir	10310	131	1	1	Blue	World.Ave	264.47	292.8951	261.2803	276.3418	Swine	World
22	10391	139	Swine, live	Other swir	10310	131	1	1	Grey	World.Ave	415.7203	439.4015	374.3216	399.8567	Swine	World
23	10392	00139a	Swine, live except pur		10310		1	1	Green	World.Ave	5037.104	2588.683	3353.392	3155.154	Swine	World
24	10392	00139a	Swine, live except pur		10310		1	1	Blue	World.Ave	264.47	292.8951	261.2803	276.3418	Swine	World
25	10392	00139a	Swine, live except pur		10310		1	1	Grey	World.Ave	415.7203	439.4015	374.3216	399.8567	Swine	World
26	10410	121	Sheep, live	Sheep, live	10410	121	1	1	Green	World.Ave	7125.857	2026.184	3490.411	4278.292	Sheep, Lan	World

Fig.3: After Data Preprocessing

3.5. EXPLORATORY DATA ANALYSIS

The overall green water, blue water, grey water usage and production in different continents based on Grazing and Industry are

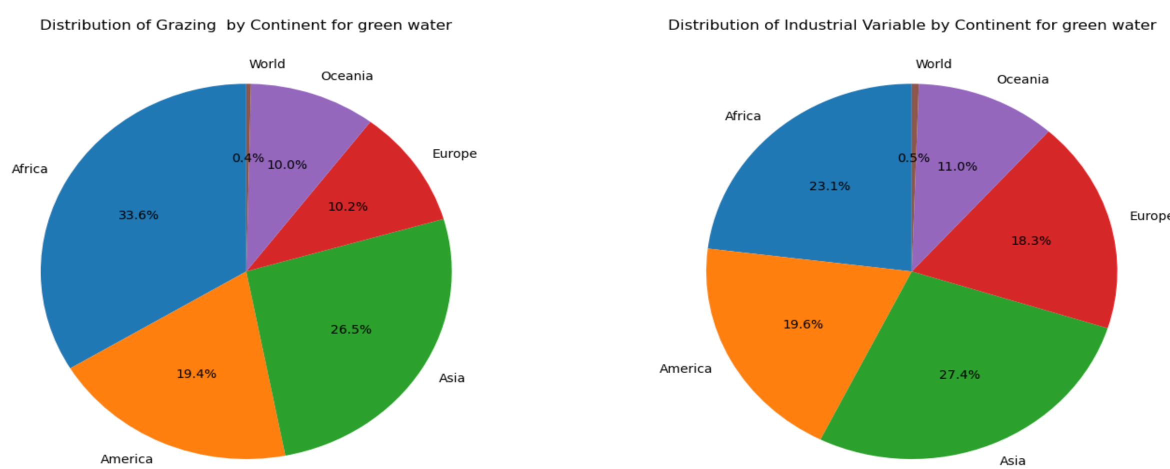


Fig. 4: Distribution of green water for continents in Grazing and Industry

Fig.4 shows the distribution of green water usage and production across continents, focusing on two key sectors: Grazing and Industry

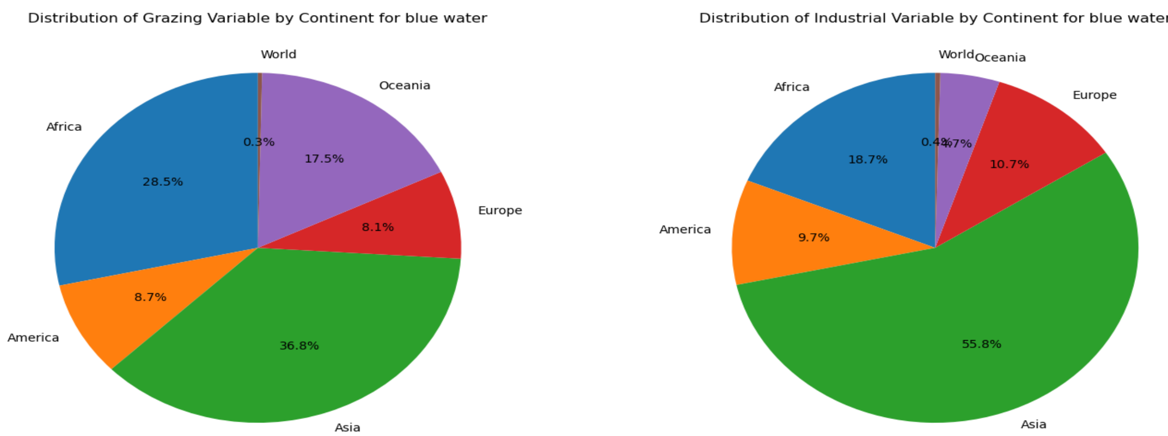


Fig.5: Distribution of blue water for continents in Grazing and Industry

Fig.5 shows the distribution of blue water usage and production across continents, focusing on two key sectors: Grazing and Industry

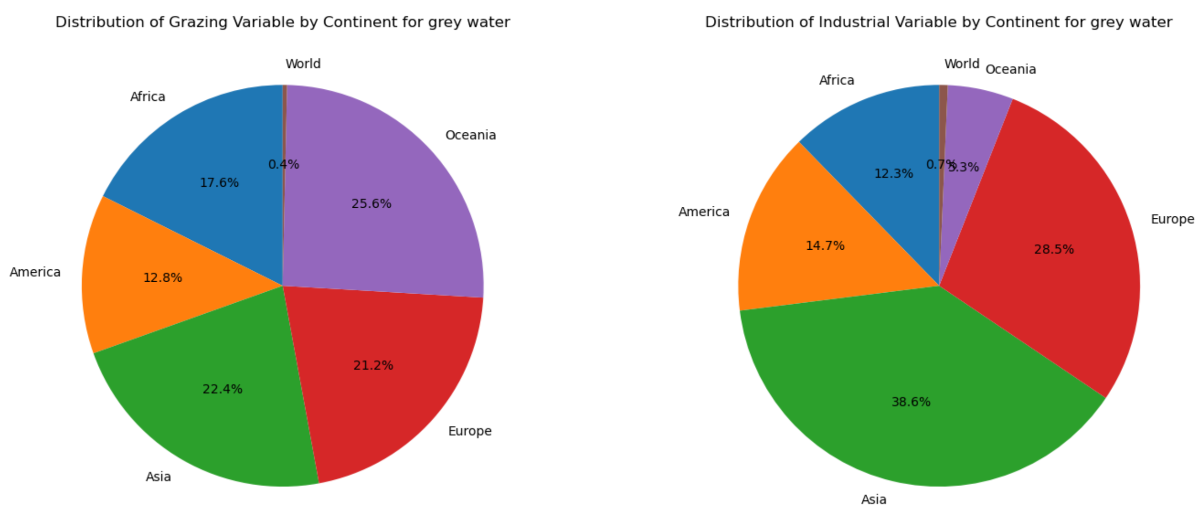


Fig.6:Distribution grey water for continents in Grazing and Industry

Fig.6 shows the distribution of grey water usage and production across continents, focusing on two key sectors: Grazing and Industry

The consumption distribution of virtual water by different products categories in different continents are

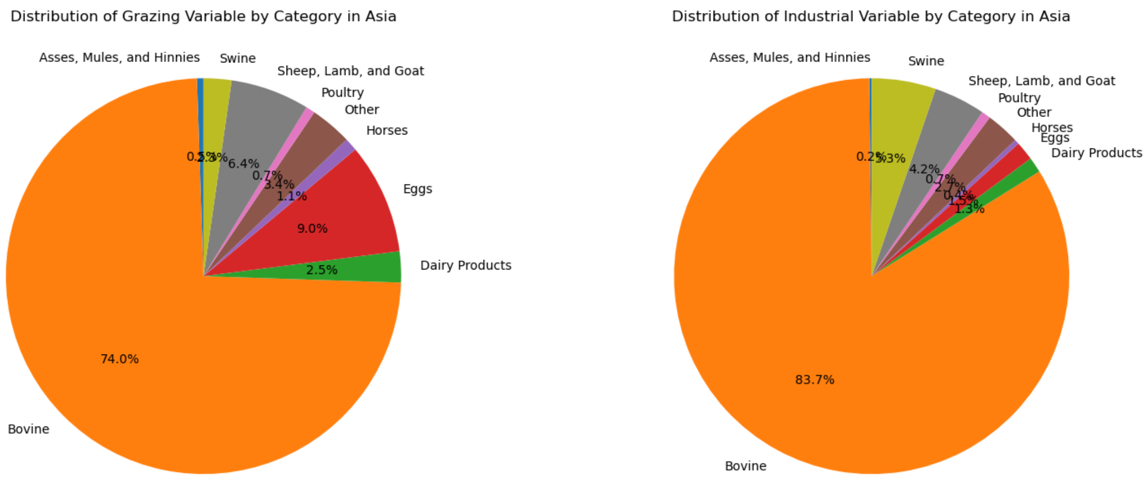


Fig.7: Consumption of virtual water by different product categories in Asia Continent

Fig.7 shows comprehensive overview of the distribution of virtual water consumption in Asia, categorized by different product types.

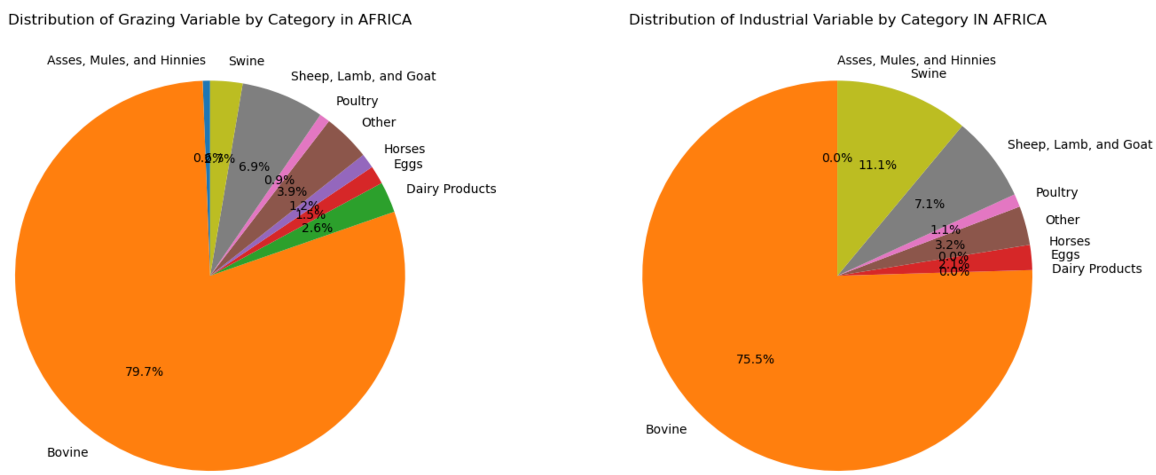


Fig.8: Consumption of virtual water by different product categories in Africa Continent

Fig.8 shows comprehensive overview of the distribution of virtual water consumption in Africa, categorized by different product types.

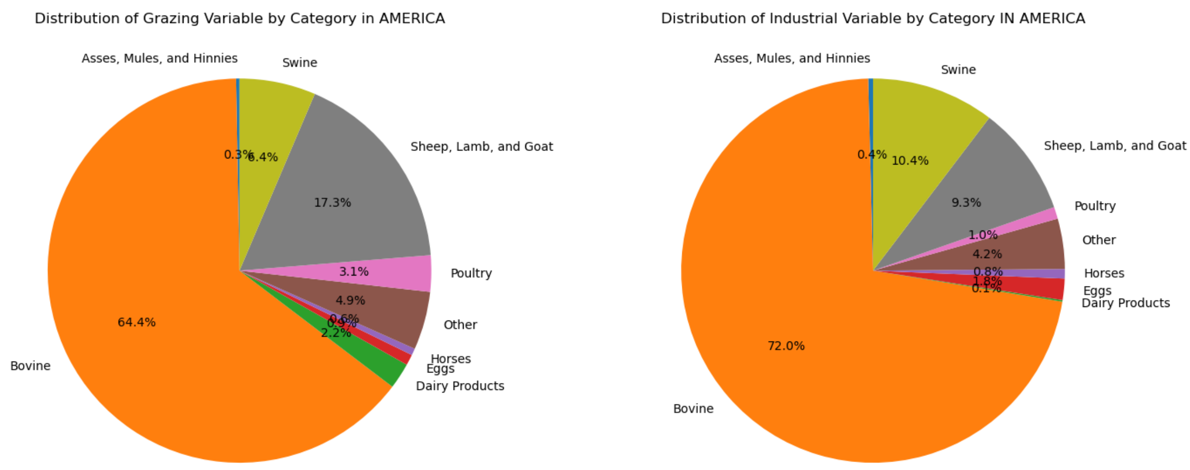


Fig.9: Consumption of virtual water by different product categories in America Continent

Fig.9 shows the comprehensive overview of the distribution of virtual water consumption in America, categorized by different product types.

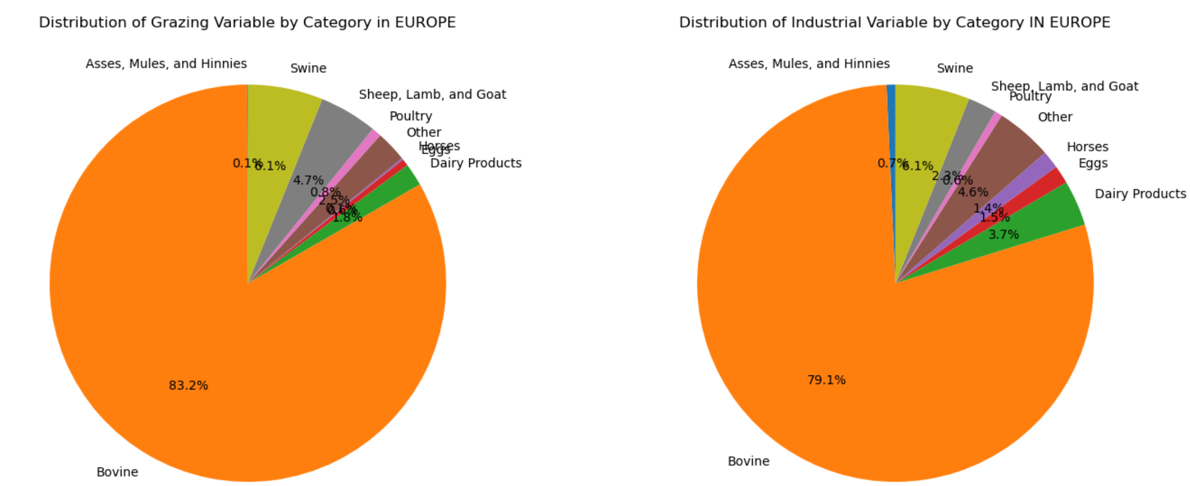


Fig.10: Consumption of virtual water by different product categories in Europe Continent

Fig.10 shows a comprehensive overview of the distribution of virtual water consumption in Europe, categorized by different product types.

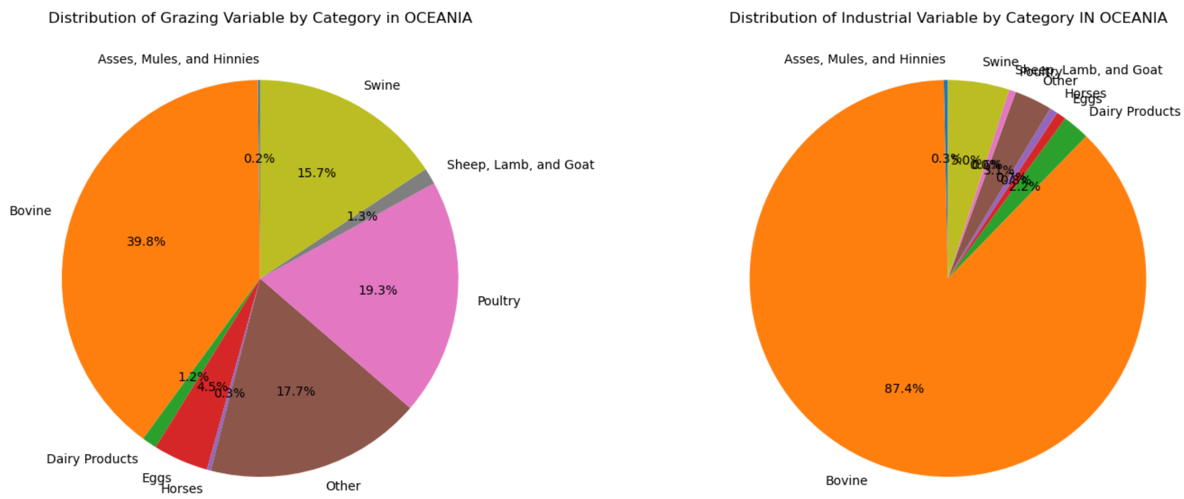


Fig.11: Consumption of virtual water by different product categories in Oceania Continent.

This chart provides a comprehensive overview of the distribution of virtual water consumption in Oceania, categorized by different product types.

Assumptions

A1: The categorization of green water usage levels, including minimum, maximum, above mean, and below mean, is presumed to accurately reflect data distribution. The selected countries are assumed to be representative of broader trends in green water usage for bovine product production in Asia, capturing diverse practices within the region. The analysis relies on central tendency measures (mean, median) to assess virtual water consumption, assuming these metrics effectively capture the central tendencies of the data. The data subset for this is analysis is obtained by splitting the dataset based on Product category Bovine and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional wise virtual green water usage for Bovine products in Asia.

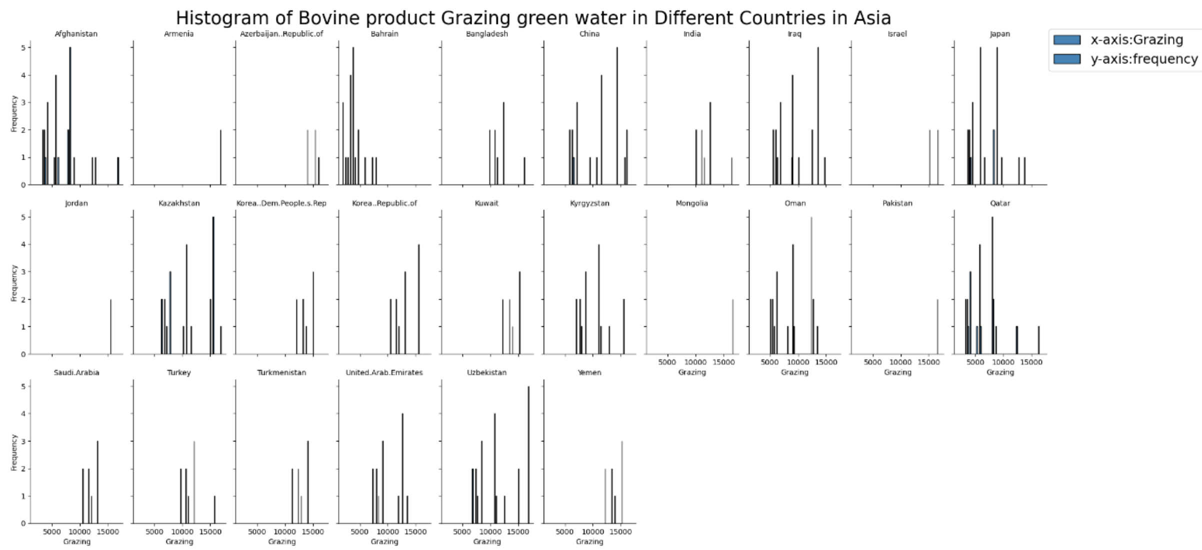


Fig.12: Grid histogram for Bovine products(Grazing).

Fig.12 provide a visual representation of the distribution of green water usage for Bovine products in the Grazing sectors for each country in Asia.

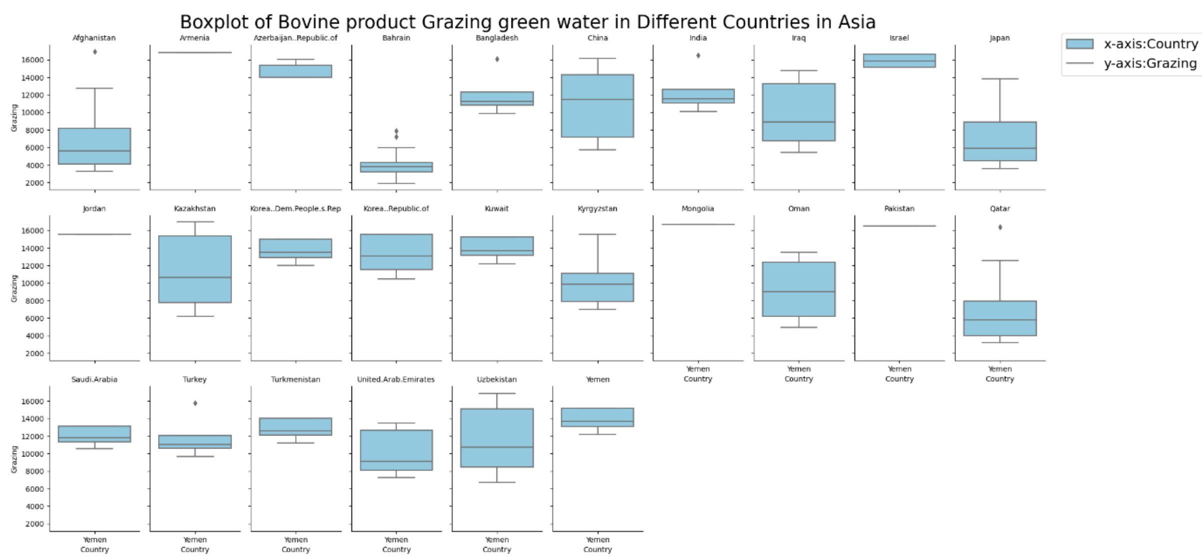


Fig.13: Grid Boxplot for Bovine products(Grazing).

Fig.13 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Bovine products in the Grazing sectors for each country in Asia.

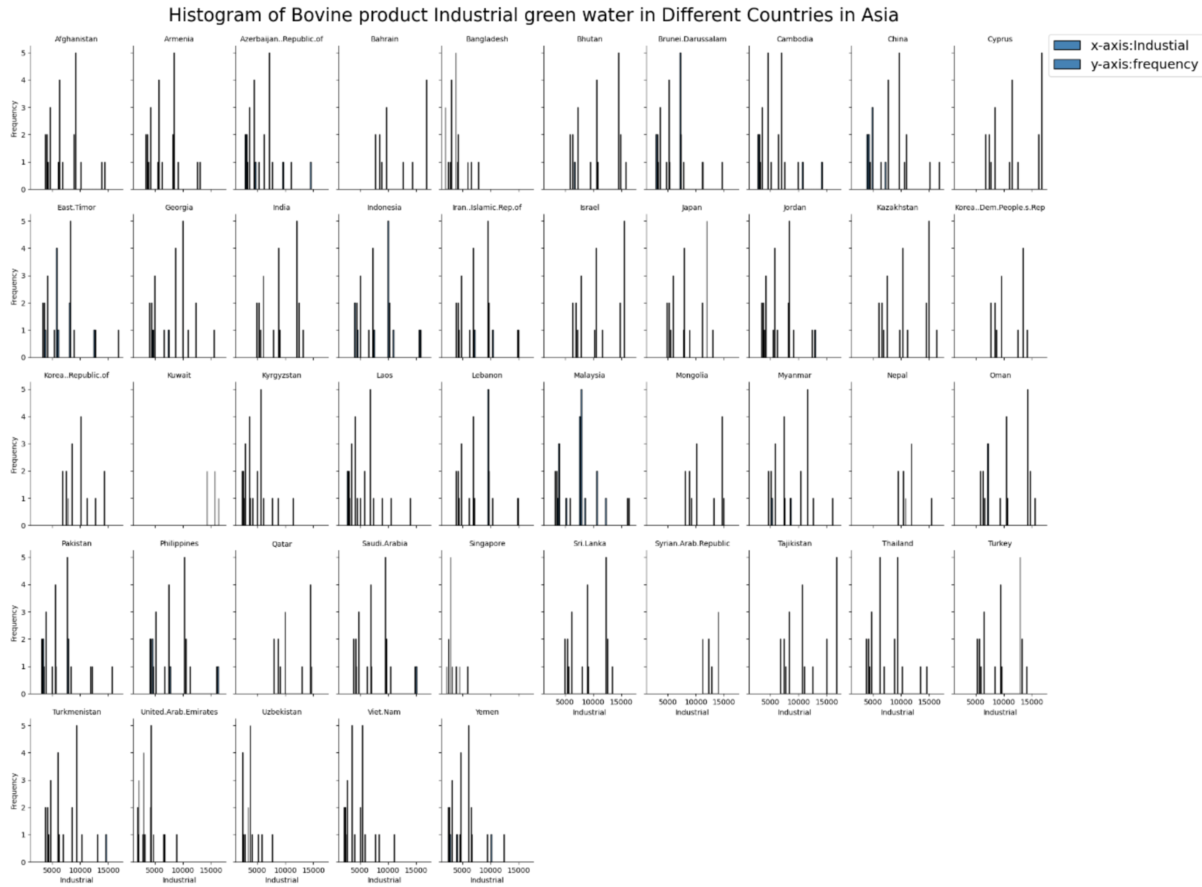


Fig.14: Grid histogram for Bovine products(Industrial).

Fig.14 shows provide a visual representation of the distribution of green water usage for Bovine products in the Industrial sectors for each country in Asia.

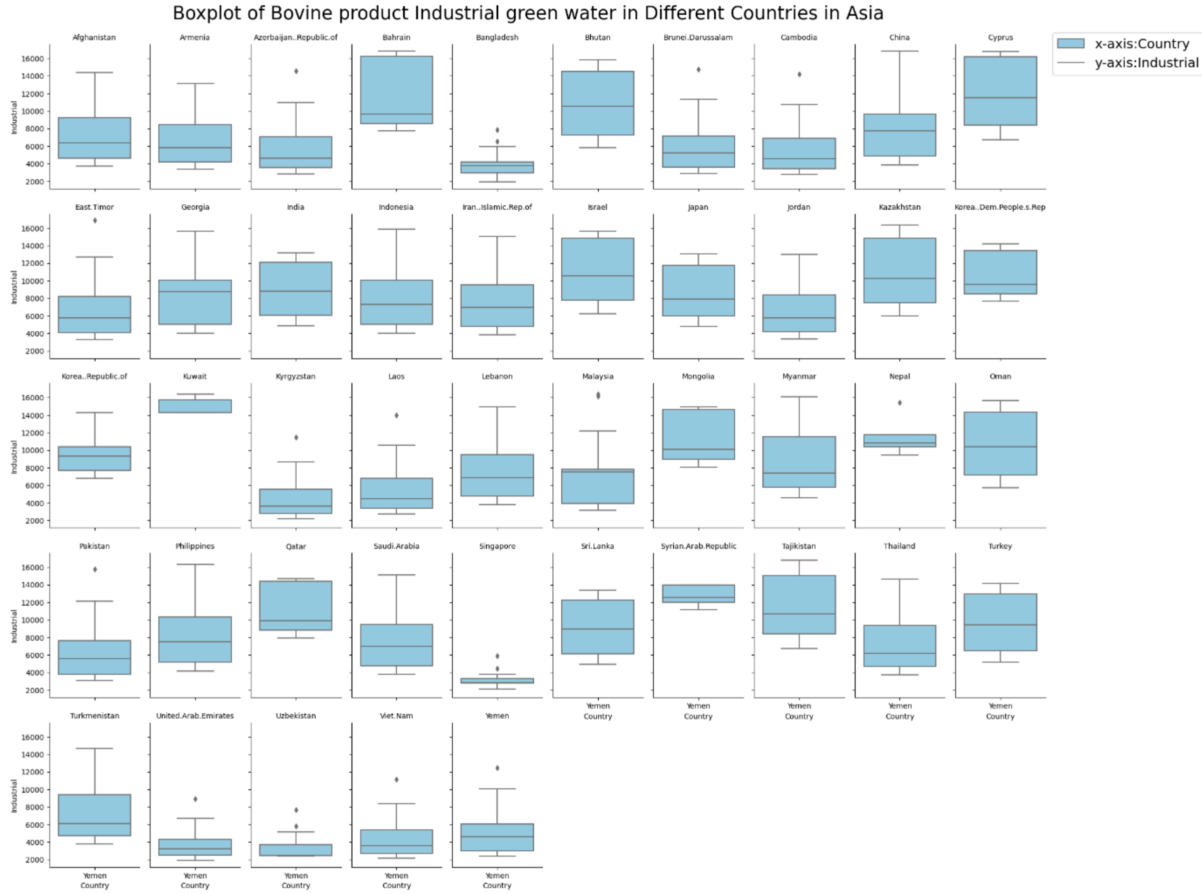


Fig.15: Grid Boxplot for Bovine products(Industrial).

Fig.15 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Bovine products in the Industrial sectors for each country in Asia.

INFERENCES:

- From the grid histogram, it is inferred that Afghanistan, Japan, Bahrain, and Qatar are showing minimum usage of green water at the grazing field.
- Countries like China, Iraq, Kazakhstan, Kyrgyzstan, Oman, Pakistan, and the United Arab Emirates are using green water at the grazing level, both in minimum and maximum levels.
- Azerbaijan, Bangladesh, India, Israel, Korea Dem , Korea Rep, Saudi Arabia, Turkmenistan, Turkey ,Yemen these countries using green water above the mean value in the production of bovine products at the field level.

- From the histogram, it is found that countries like Afghanistan, Armenia, Azerbaijan, Bangladesh, Brunei, Cambodia, East Timor, Georgia, Iran, Jordan, Kyrgyzstan, Laos, Lebanon, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Thailand, UAE, Turkmenistan, Uzbekistan, Vietnam and Yemen are utilizing green water less than the mean level for the production of bovine products at industries.
- Countries like Bhutan, Cyprus, India, Indonesia, Israel, Japan, Kazakhstan, Korea, Malaysia, Lebanon, Myanmar, Oman, Sri Lanka, Tajikistan and Turkey are producing bovine products with both minimum and maximum green water at the industry level.

DESCRIPTIVE ANALYTICS

Descriptive Insights:

- Minimum Green Water Usage at Grazing Field: Afghanistan, Japan, Bahrain, and Qatar exhibit the lowest usage of green water at the grazing field.
- Varied Green Water Usage at Grazing Field: China, Iraq, Kazakhstan, Kyrgyzstan, Oman, Pakistan, and the United Arab Emirates show a diverse range of green water usage at the grazing level, ranging from minimum to maximum.
- Above Mean Green Water Usage in Bovine Production at Field: Azerbaijan, Bangladesh, India, Israel, Korea Dem, Korea Rep, Saudi Arabia, Turkmenistan, Turkey, and Yemen are using green water above the mean value in the production of bovine products at the field level.
- Below Mean Green Water Usage in Bovine Production at Industries: Afghanistan, Armenia, Azerbaijan, Bangladesh, Brunei, Cambodia, East Timor, Georgia, Iran, Jordan, Kyrgyzstan, Laos, Lebanon, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Thailand, UAE, Turkmenistan, Uzbekistan, Vietnam, and Yemen are utilizing green water less than the mean level for bovine product production at industries.
- Varied Green Water Usage in Bovine Production at Industries: Bhutan, Cyprus, India, Indonesia, Israel, Japan, Kazakhstan, Korea, Malaysia, Lebanon, Myanmar, Oman, Sri Lanka, Tajikistan, and Turkey demonstrate varying levels of green water usage, encompassing both minimum and maximum values, in the production of bovine products at the industry level.

DESCRIPTIVE ANALYTICS

Diagnostic Insights:

- Identifying Regions with Minimal Green Water Usage: Afghanistan consistently shows minimal green water usage at both the grazing field and industry levels.
- Highlighting Countries with Diverse Grazing Practices: China, Iraq, Kazakhstan, Kyrgyzstan, Oman, Pakistan, and the United Arab Emirates demonstrate varied green water usage at the grazing level, indicating differences in grazing practices.
- Noting High Green Water Consumption in Specific Countries: Azerbaijan, Bangladesh, India, Israel, Korea Dem, Korea Rep, Saudi Arabia, Turkmenistan, Turkey, and Yemen are highlighted for their above-average green water consumption in bovine production at the field level.
- Comparing Grazing and Industry Green Water Usage: Discrepancies between grazing and industry-level green water usage are evident in various countries, such as Afghanistan, Armenia, Azerbaijan, Bangladesh, and others, suggesting potential areas for improvement or intervention.
- Identifying Varied Industry Practices: Bhutan, Cyprus, India, Indonesia, Israel, Japan, Kazakhstan, Korea, Malaysia, Lebanon, Myanmar, Oman, Sri Lanka, Tajikistan, and Turkey display variability in green water usage at the industry level, indicating diverse industrial practices.

Assumptions

A2: The categorization of countries based on their green water usage levels for sheep product production is assumed to accurately reflect the distribution of data. The identified categories (e.g., using less than mean, both minimum and maximum, maximum) accurately represent the diversity of green water usage patterns within each country group. The data subset for this is analysis is obtained by splitting the dataset based on Product category Sheep and Goat and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional trend of virtual green water usage for Sheep and Goat products in Asia.

The grid histogram analysis and box plot of green water usage in the grazing and industry for the production of the Sheep, Goat product for different countries in the continent Asia .

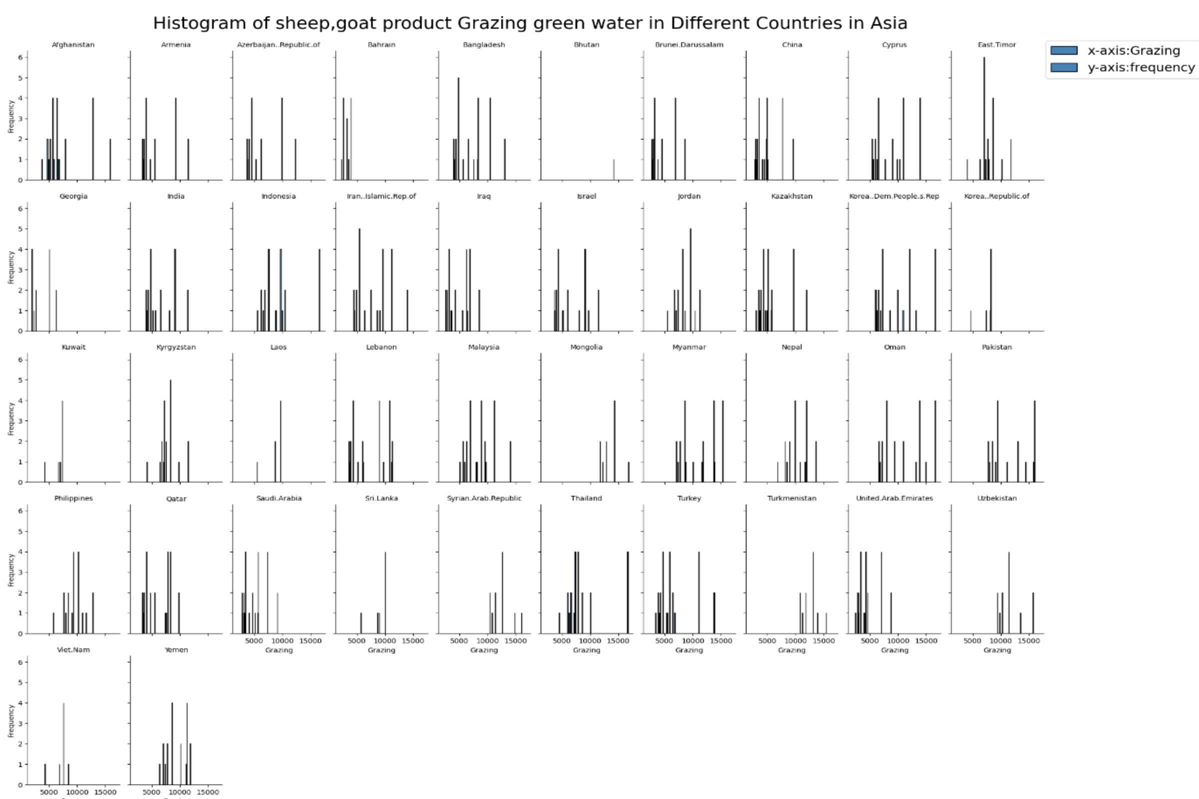


Fig.16: Grid Histogram for sheep, goat products(Grazing).

Fig.16 shows a visual representation of the distribution of green water usage for sheep, goat products in the Grazing sectors for each country in Asia.

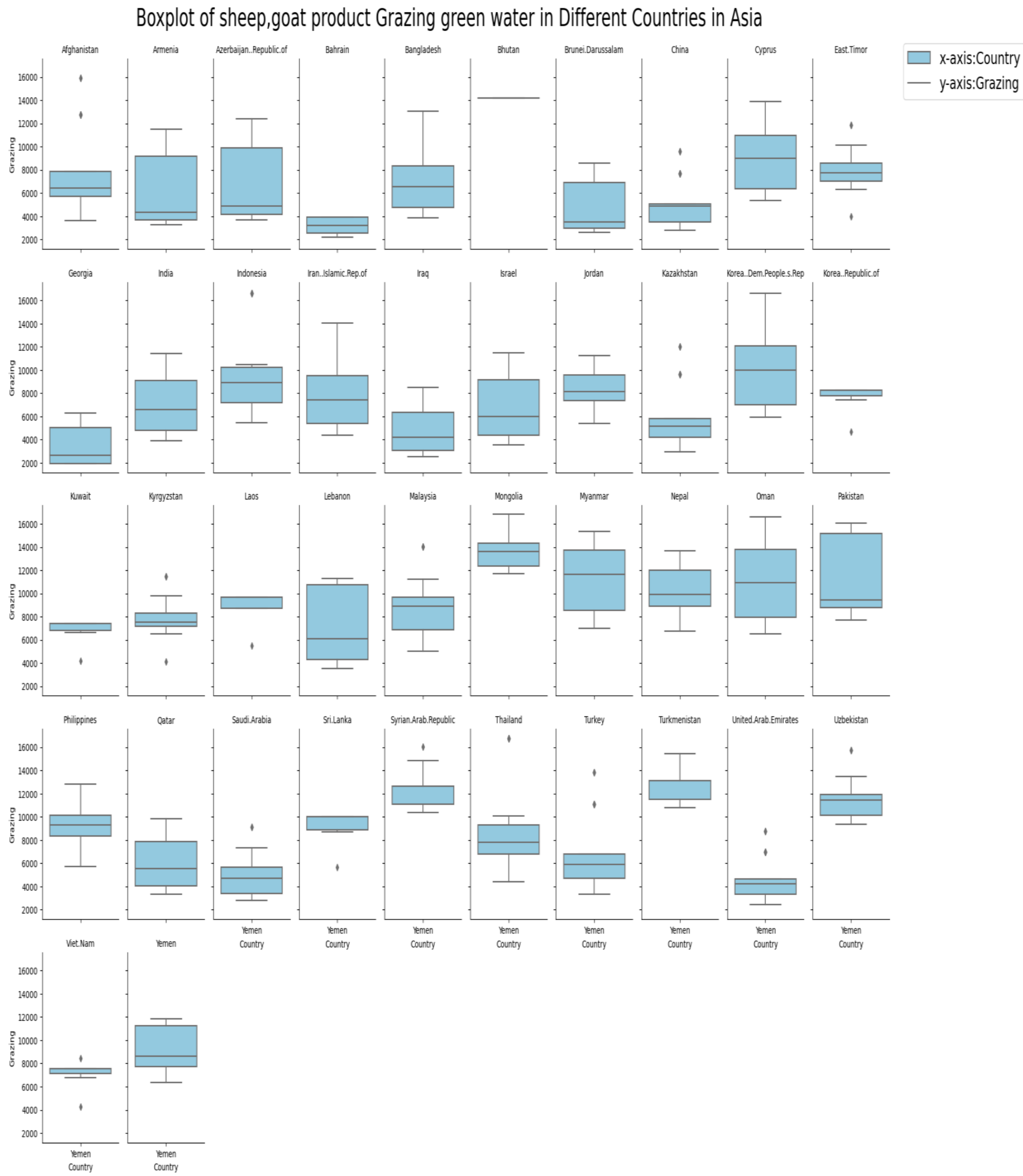


Fig.17: Grid Boxplot for sheep, goat products(Grazing).

Fig.17 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for sheep, goat products in the Grazing sectors for each country in Asia.

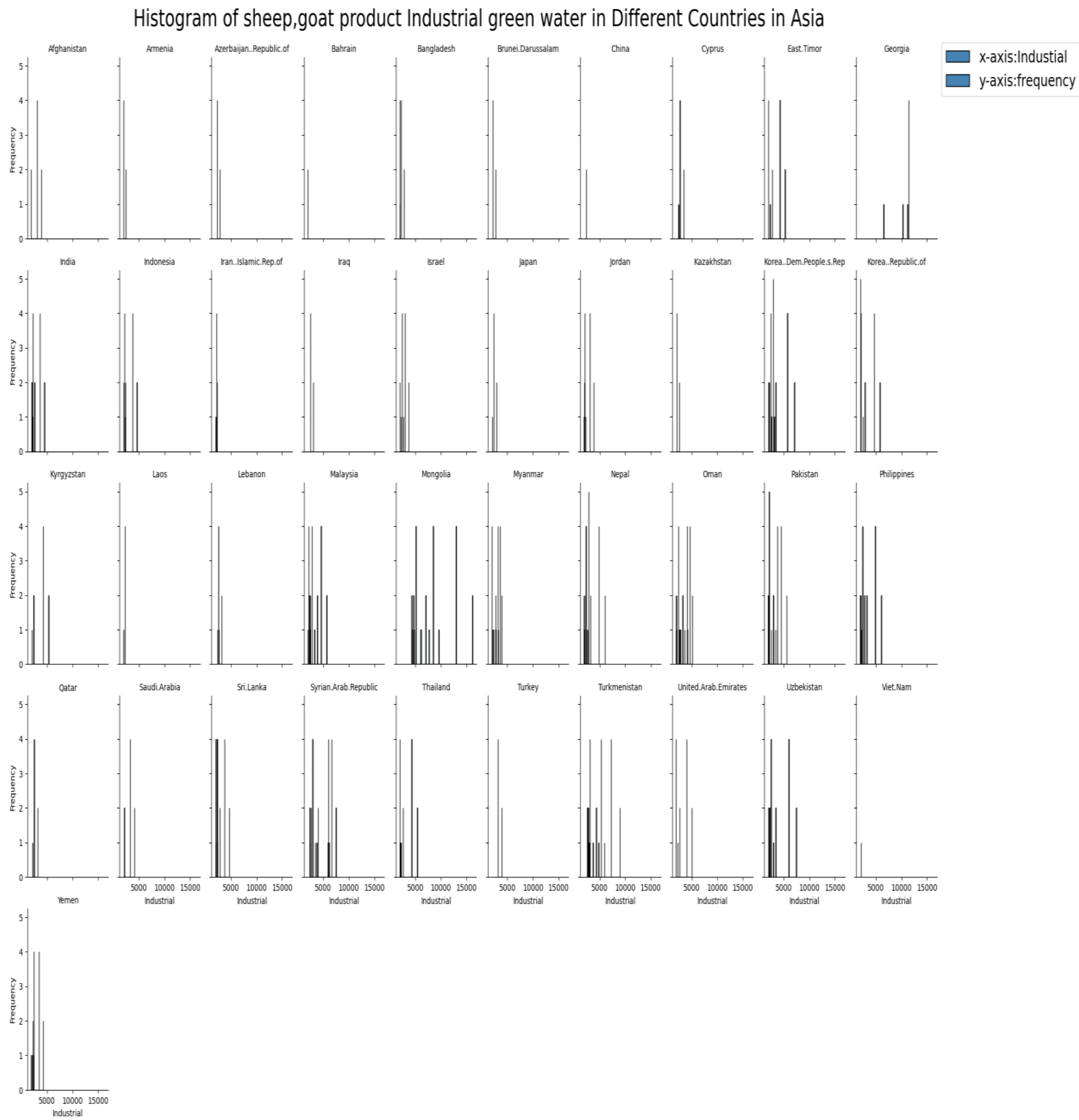


Fig.18: Grid Histogram for sheep, goat products(Industrial).

Fig.18 shows a visual representation of the distribution of green water usage for sheep, goat products in the Industrial sectors for each country in Asia.

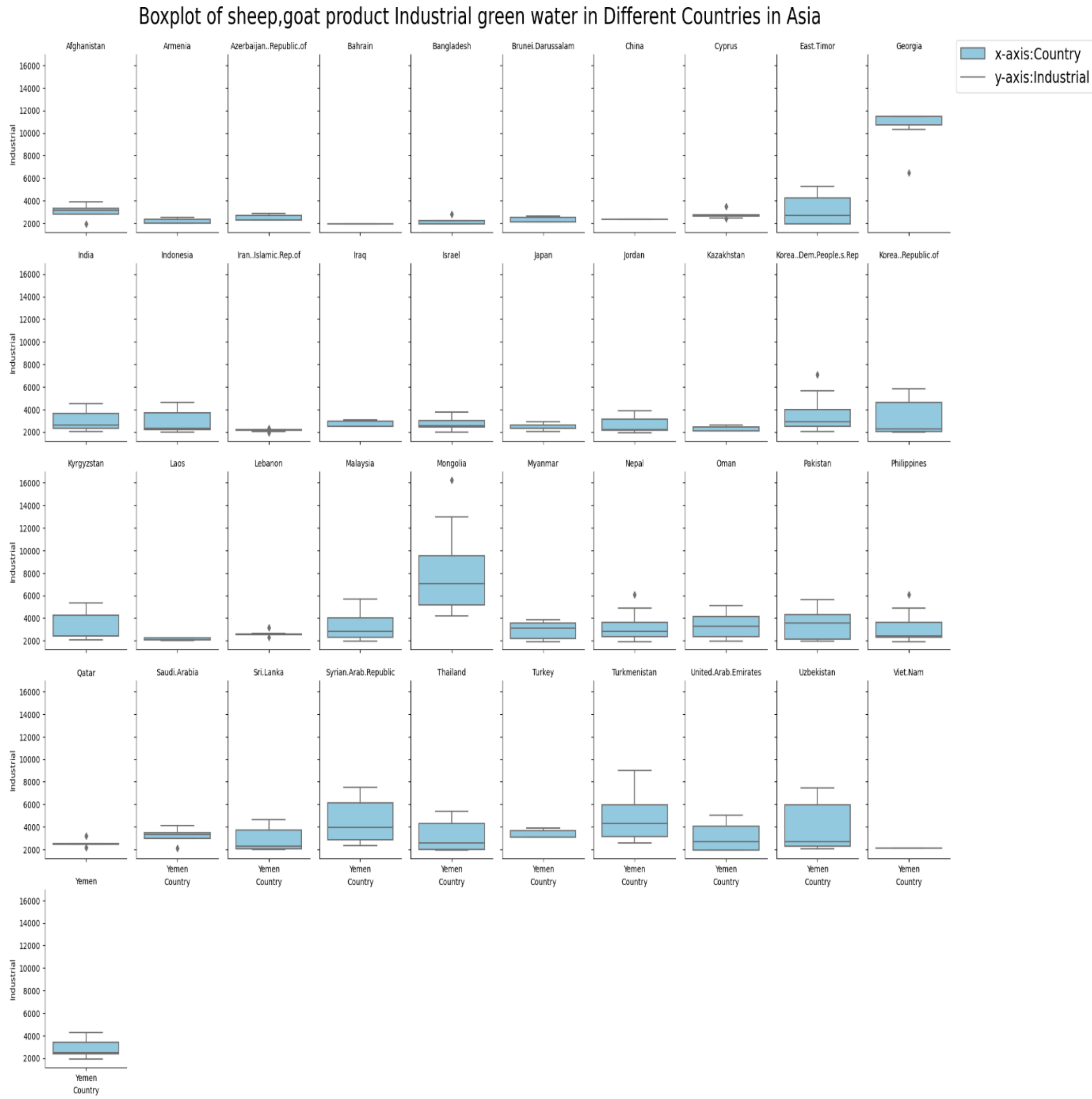


Fig.19: Grid Boxplot for sheep, goat products(Industrial).

Fig.19 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for sheep, goat products in the Industrial sectors for each country in Asia.

INFERENCES:

- Armenia, Azerbaijan, Bahrain, Bangladesh, Brunei, China, East Timor, Korea, Georgia, India, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Qatar, Saudi Arabia, Sri Lanka, Thailand, UAE, Vietnam all these countries use less than the mean green water level for the production of sheep products.
- Afghanistan, Cyprus, Indonesia, Korea, Malaysia, Myanmar, Nepal, Oman, Pakistan , Philippines, Turkey and Yemen use both minimum and maximum levels of green water for the purpose of production of sheep products at the grazing level.
- Mongolia, the Syrian Arab Republic, Turkmenistan, and Uzbekistan use the maximum amount of green water for the production of sheep products at the grazing level.
- Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Brunei, China, Cyprus, East Timor, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Republic of Korea, Laos, Lebanon, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syrian, Thailand, Turkey, Turkmenistan, UAE, Uzbekistan, Vietnam, Yemen all these countries are below the average value of green water for the production of products at industries.
- Mongolia and Georgia use the maximum amount of green water for the production of sheep products.

DESCRIPTIVE ANALYTICS

Descriptive Insights

- Below Mean Green Water Usage in Sheep Production: Armenia, Azerbaijan, Bahrain, Bangladesh, Brunei, China, East Timor, Korea, Georgia, India, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Qatar, Saudi Arabia, Sri Lanka, Thailand, UAE, Vietnam, and others utilize less than the mean green water level for sheep product production.
- Varied Grazing Level Green Water Usage: Afghanistan, Cyprus, Indonesia, Korea, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Turkey, and Yemen exhibit both minimum and maximum levels of green water usage for sheep product production at the grazing level.

- Maximum Grazing Level Green Water Usage: Mongolia, the Syrian Arab Republic, Turkmenistan, and Uzbekistan use the maximum amount of green water for sheep product production at the grazing level.
- Below Average Green Water Usage in Industries: Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Brunei, China, Cyprus, East Timor, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Republic of Korea, Laos, Lebanon, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syrian, Thailand, Turkey, Turkmenistan, UAE, Uzbekistan, Vietnam, Yemen—all these countries are below the average value of green water for sheep product production at industries.
- Maximum Industrial Level Green Water Usage: Mongolia and Georgia use the maximum amount of green water for the production of sheep products at the industrial level.

DIAGNOSTIC ANALYTICS

Diagnostic Insights

- Identifying Efficient Water Use in Sheep Grazing: Armenia, Azerbaijan, Bahrain, Bangladesh, Brunei, China, East Timor, Korea, Georgia, India, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Qatar, Saudi Arabia, Sri Lanka, Thailand, UAE, Vietnam, and others are identified as using less than the mean green water level for sheep production, suggesting potentially efficient water management practices.
- Highlighting Varied Grazing Practices: Afghanistan, Cyprus, Indonesia, Korea, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Turkey, and Yemen exhibit diverse grazing practices, utilizing both minimum and maximum levels of green water for sheep production.
- Concerns about High Grazing Level Water Usage: Mongolia, the Syrian Arab Republic, Turkmenistan, and Uzbekistan raise concerns due to their utilization of the maximum amount of green water for sheep production at the grazing level, indicating potential environmental impact or inefficiency.
- Efficient Water Use in Industrial Production: Countries below the average value of green water for sheep product production at industries may be considered as employing more efficient water use practices in industrial settings.

- Monitoring Industrial Level Water Usage: Mongolia and Georgia, with the maximum industrial level green water usage, may warrant closer monitoring and potential interventions to ensure sustainable water practices in sheep product industries**.**

Assumptions

A3: The identified countries that utilize minimum, both maximum and minimum, or maximum levels from the mean value of green water usage for egg production are assumed to be accurately classified, forming the basis for meaningful comparisons. Additionally, it is assumed that the identified categories effectively capture the diversity of green water usage patterns within each group of countries, enabling valid cross-country comparisons. The data subset for this is analysis is obtained by splitting the dataset based on Product category Egg and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional trend of virtual green water usage for Egg products in Asia.

The grid histogram analysis and box plot of green water usage in the grazing and industry for the production of the Egg product for different countries in the continent Asia .

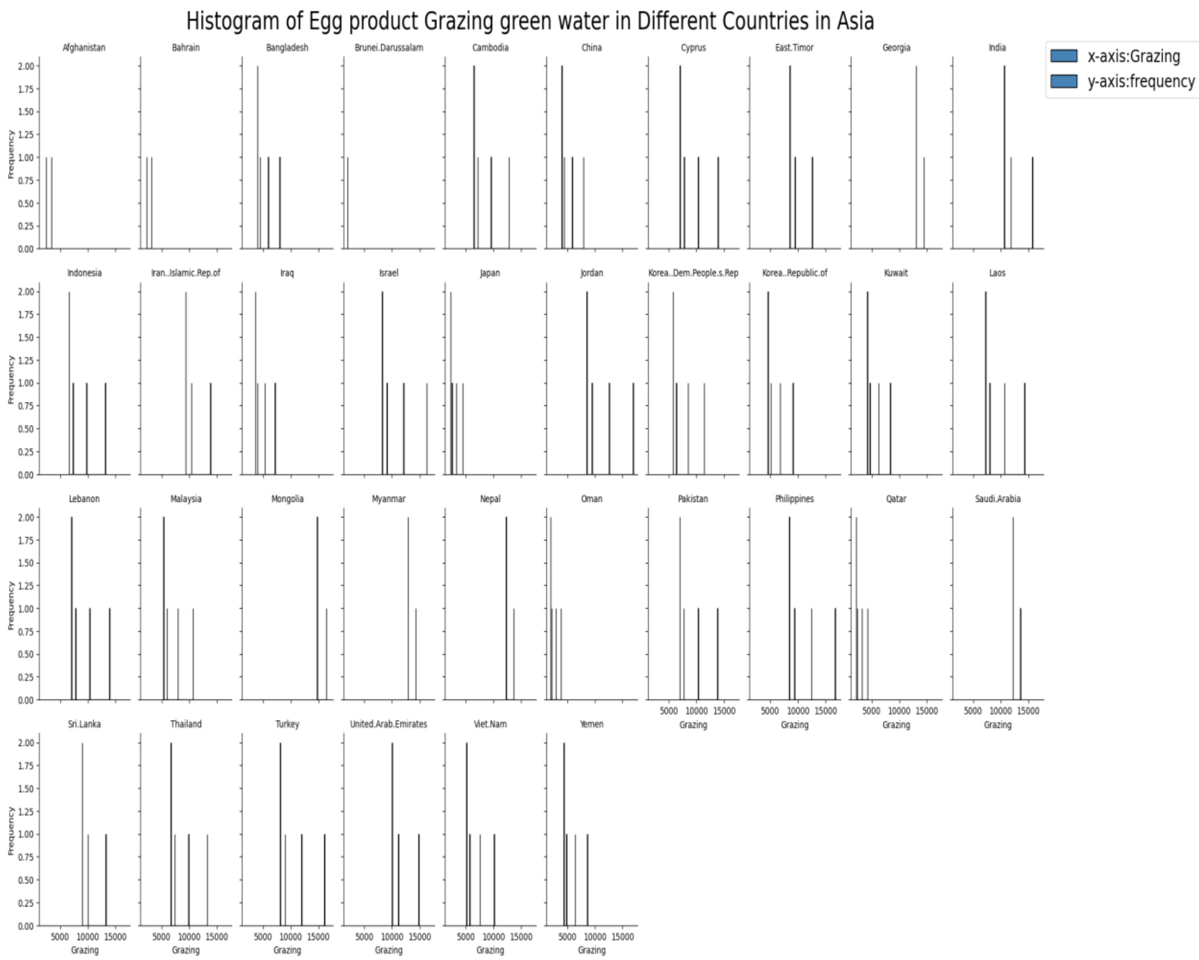


Fig.20: Grid histogram for Egg products(Grazing).

Fig.20 shows a visual representation of the distribution of green water usage for Egg products in the Grazing sectors for each country in Asia.

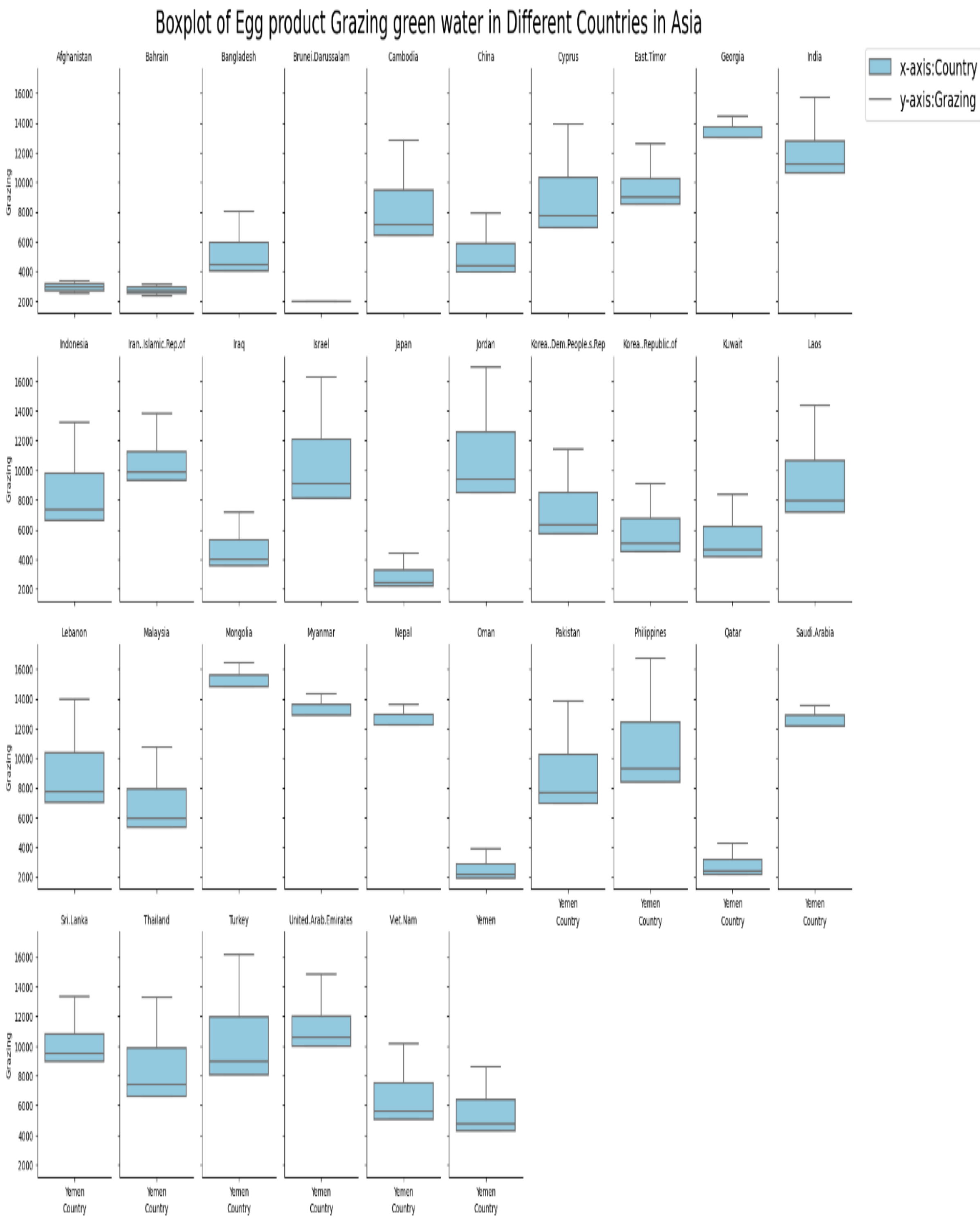


Fig.21: Grid Boxplot for Egg products(Grazing).

Fig.21 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Egg products in the Grazing sectors for each country in Asia.

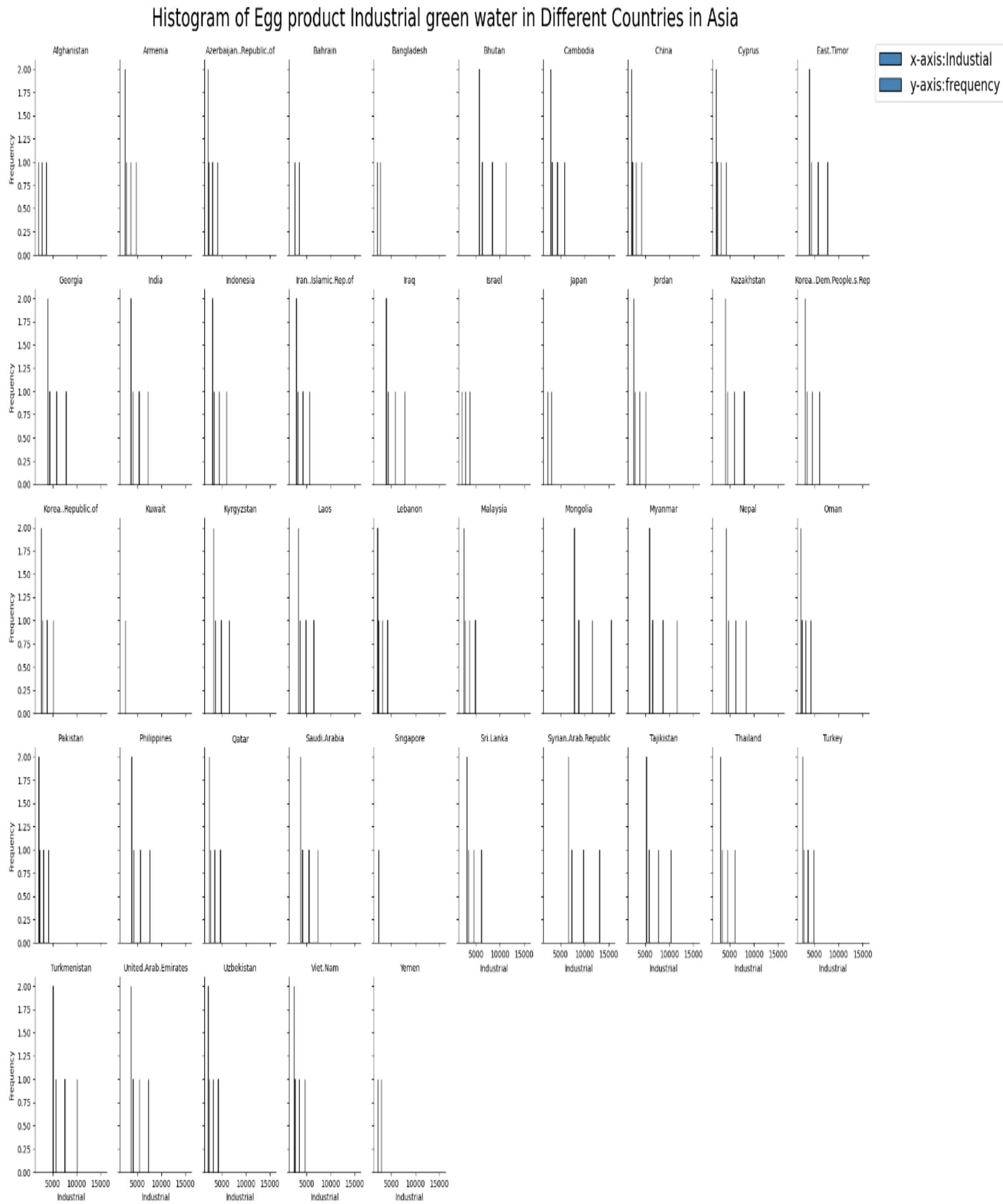


Fig.22: Grid histogram for Egg products(Industrial).

Fig.22 shows a visual representation of the distribution of green water usage for Egg products in the Industrial sectors for each country in Asia.

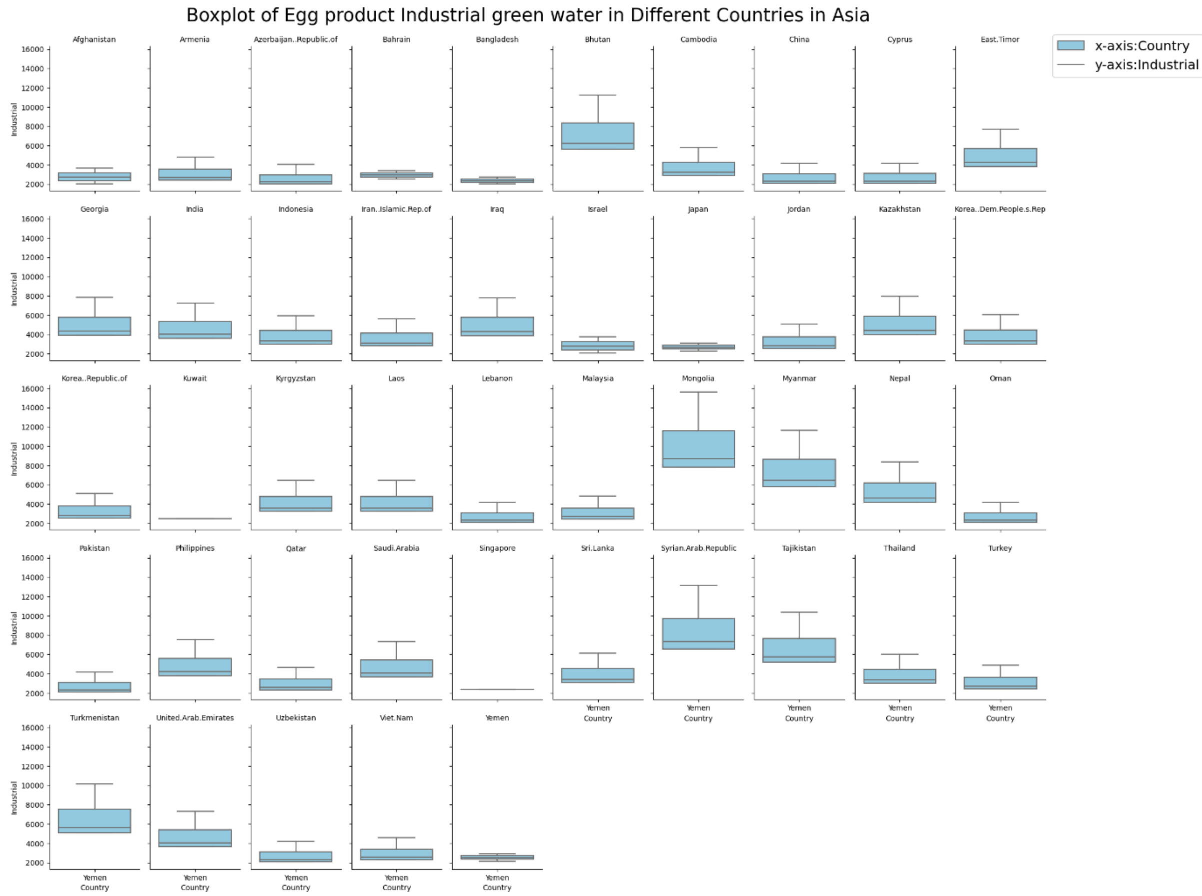


Fig.23: Grid Boxplot for Egg products(Industrial).

Fig.23 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Egg products in the Industrial sectors for each country in Asia.

INFERENCES:

- Afghanistan, Bahrain, Bangladesh, Brunei, China, Iraq, Japan, Korea, Korea Republic, Kuwait, Malaysia, Oman, Qatar, Vietnam, and Yemen use the minimum level of green water for the production of egg products.
- Cambodia, Cyprus, East Timor, Iran, Indonesia, Israel, Jordan, Laos, Lebanon, Pakistan, Sri Lanka, the Philippines, Thailand, Turkey, and the UAE use both the maximum and minimum amounts of green water for the production of egg products.
- Saudi Arabia, Mongolia, Myanmar, Nepal, Georgia, India—these countries use the maximum amount of green water for the production of egg products.

- Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Cambodia, China, Cyprus, East Timor, India, Iraq, Israel, Indonesia, Japan, Jordan, Kazakhstan, Korea Republic, Kuwait , Kyrgyzstan ,Laos, Lebanon, Malaysia, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Thailand, Turkey, the UAE, Uzbekistan, Vietnam, Yemen countries using a minimum amount of green water for the production of products in the industry.
- Bhutan and Myanmar use both maximum and minimum amounts of green water for the purpose of production of egg products in the industry.

DESCRIPTIVE ANALYTICS

Descriptive Insights

- Minimum Green Water Usage for Egg Production: Afghanistan, Bahrain, Bangladesh, Brunei, China, Iraq, Japan, Korea, Korea Republic, Kuwait, Malaysia, Oman, Qatar, Vietnam, and Yemen utilize the minimum level of green water for egg product production.
- Varied Green Water Usage at the Egg Production Level: Cambodia, Cyprus, East Timor, Iran, Indonesia, Israel, Jordan, Laos, Lebanon, Pakistan, Sri Lanka, the Philippines, Thailand, Turkey, and the UAE show a range of green water usage, utilizing both maximum and minimum amounts for egg product production.
- Maximum Green Water Usage for Egg Production: Saudi Arabia, Mongolia, Myanmar, Nepal, Georgia, India—these countries use the maximum amount of green water for egg product production.
- Minimum Green Water Usage in Industrial Egg Production: Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Cambodia, China, Cyprus, East Timor, India, Iraq, Israel, Indonesia, Japan, Jordan, Kazakhstan, Korea Republic, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Thailand, Turkey, the UAE, Uzbekistan, Vietnam, Yemen—all these countries are using a minimum amount of green water for egg product production in the industry.
- Varied Industrial Level Green Water Usage: Bhutan and Myanmar use both maximum and minimum amounts of green water for industrial egg product production.

DIAGNOSTIC ANALYTICS

Diagnostic Insights

- Efficient Water Use in Egg Production: Afghanistan, Bahrain, Bangladesh, Brunei, China, Iraq, Japan, Korea, Korea Republic, Kuwait, Malaysia, Oman, Qatar, Vietnam, and Yemen are identified as efficiently using the minimum level of green water for egg production, suggesting potentially sustainable practices.
- Concerns about Varied Green Water Usage: Countries such as Cambodia, Cyprus, East Timor, Iran, Indonesia, Israel, Jordan, Laos, Lebanon, Pakistan, Sri Lanka, the Philippines, Thailand, Turkey, and the UAE, exhibiting both maximum and minimum green water usage, may require further investigation to understand the reasons behind the variability and to ensure sustainability.
- Environmental Impact of High Water Usage: Saudi Arabia, Mongolia, Myanmar, Nepal, Georgia, and India may raise concerns due to their use of the maximum amount of green water for egg production, indicating potential environmental impact or inefficiency.
- Efficient Water Use in Industrial Egg Production: Countries using the minimum amount of green water for industrial egg production may be considered as implementing more efficient water practices in the industry.
- Monitoring Varied Industrial Practices: Bhutan and Myanmar, with both maximum and minimum industrial level green water usage, may need closer monitoring and potential interventions to ensure sustainable water practices in industrial egg production.

Assumptions

A4: It is assumed that distinctions between the countries using a minimum quantity of green water below the mean, the countries using both maximum and minimum levels from the mean value, and the countries using less amount of green water in industrial production, signifying the importance of accurately capturing relevant differences in water usage practices. The data subset for this is analysis is obtained by splitting the dataset based on Product category dairy and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional trend of virtual green water usage for dairy products in Asia.

The grid histogram analysis and box plot of green water usage in the grazing and industry for the production of the dairy product for different countries in the continent Asia.

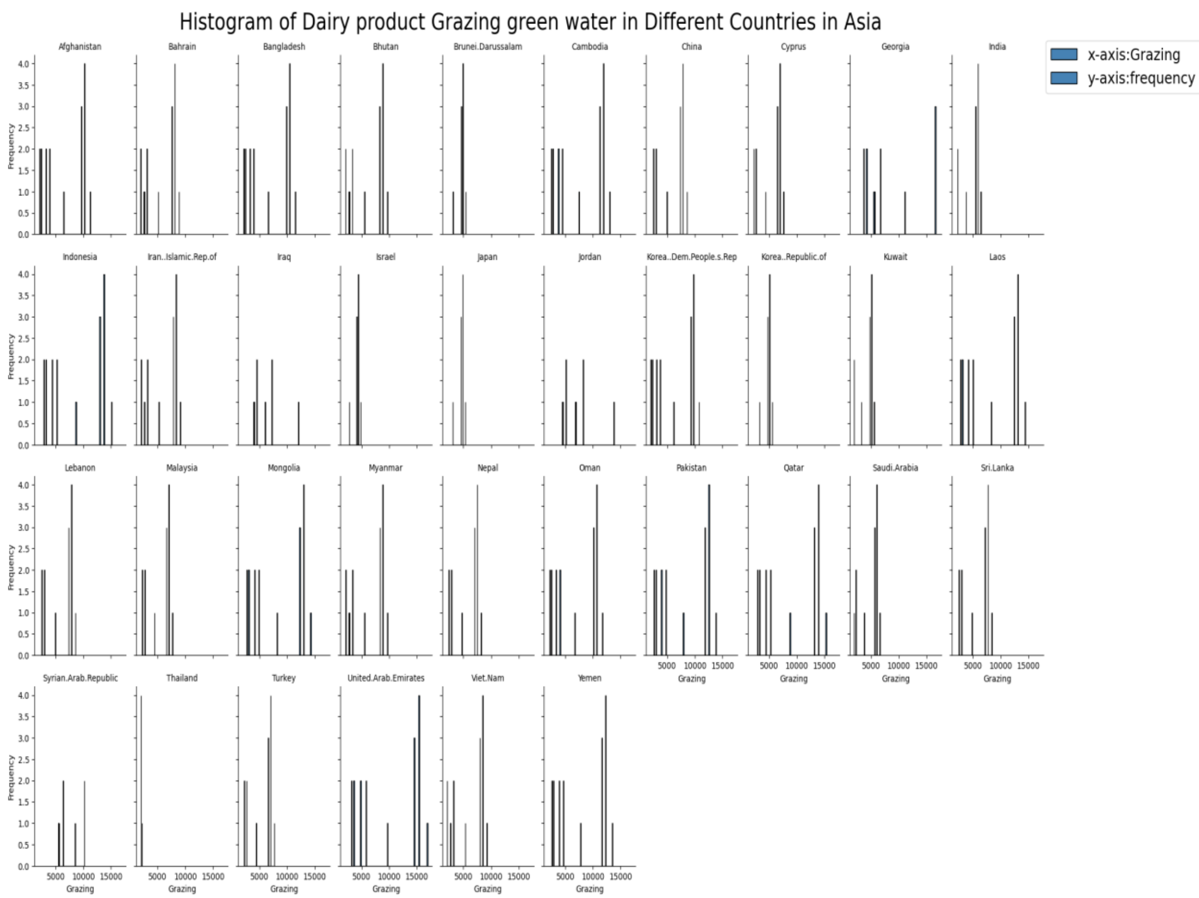


Fig.24: Grid histogram for Dairy products(Grazing).

Fig.24 shows a visual representation of the distribution of green water usage for Dairy products in the Grazing sectors for each country in Asia.

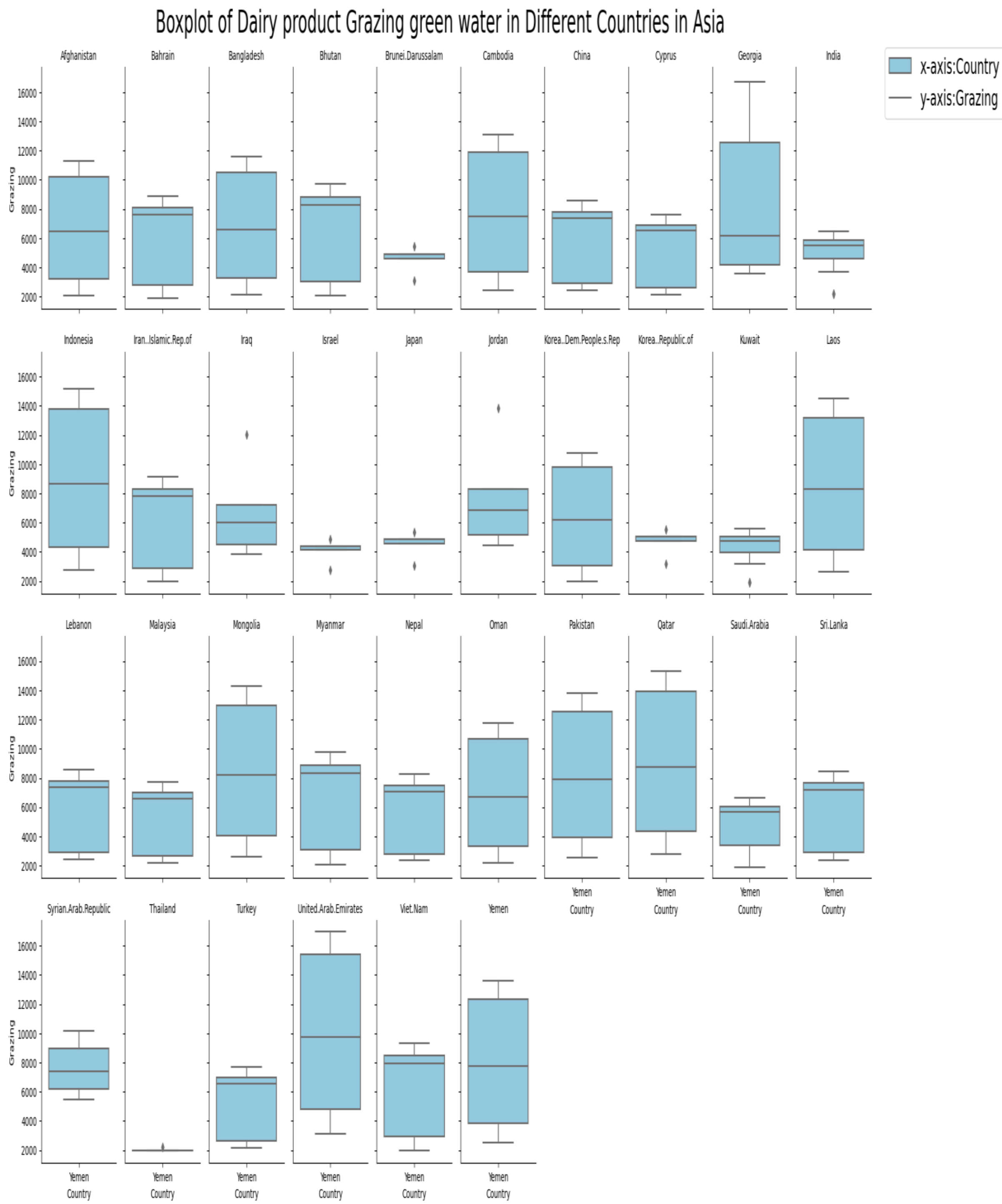


Fig.25: Grid Boxplot for Dairy products(Grazing).

Fig.25 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Dairy products in the Grazing sectors for each country in Asia.

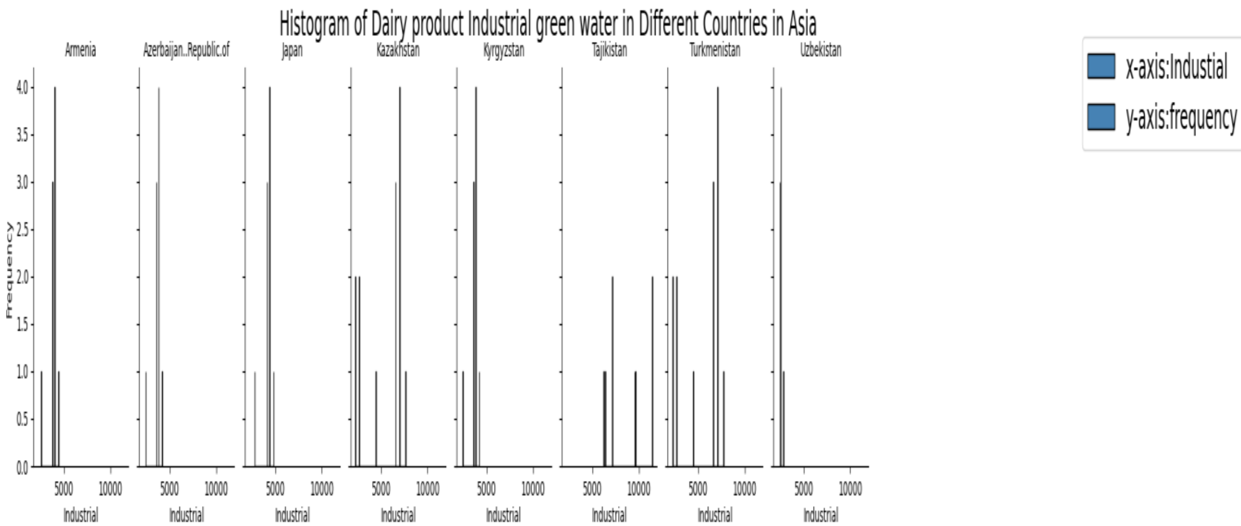


Fig.26: Grid histogram for Dairy products(Industrial).

Fig.26 shows a visual representation of the distribution of green water usage for Dairy products in the Industrial sectors for each country in Asia.

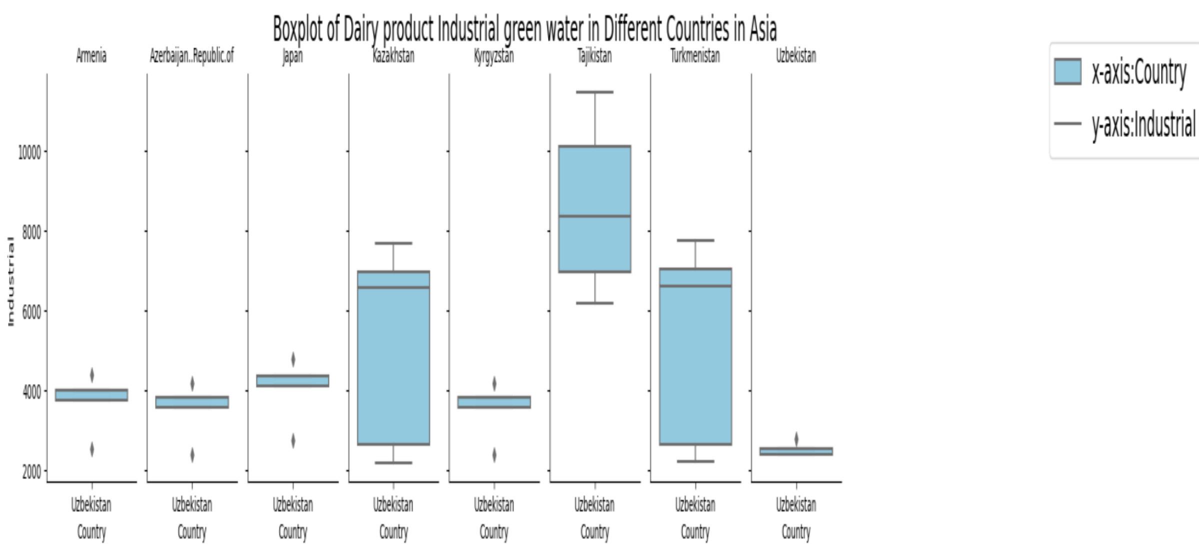


Fig.27: Grid Boxplot for Dairy products(Industrial).

Fig.27 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Dairy products in the Industrial sectors for each country in Asia.

INFERENCES:

- Afghanistan, Bahrain, Bhutan, Brunei, China, Cyprus, India, Iran, Israel, Japan, Korea, Korean Republic, Kuwait, Lebanon, Malaysia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Syrian, Thailand, Turkey, and Vietnam these countries use a minimum quantity of green water below the mean value for the production of dairy products.
- Bangladesh, Cambodia, Georgia, Indonesia, Laos, Mongolia, Oman, Pakistan, Qatar, UAE, and Yemen these countries use both maximum and minimum levels of green water for the production of dairy products in grazing.
- Armenia, Azerbaijan, Japan, Kyrgyzstan, and Uzbekistan use less amount of green water in industrial production.
- Kazakhstan, Tajikistan, and Turkmenistan use a level of green water near the mean value in industrial production.

DESCRIPTIVE ANALYTICS

Descriptive Insights

- Minimum Green Water Usage for Dairy Production: Afghanistan, Bahrain, Bhutan, Brunei, China, Cyprus, India, Iran, Israel, Japan, Korea, Korean Republic, Kuwait, Lebanon, Malaysia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Syrian, Thailand, Turkey, and Vietnam utilize a minimum quantity of green water below the mean value for dairy product production.
- Varied Grazing Level Green Water Usage: Bangladesh, Cambodia, Georgia, Indonesia, Laos, Mongolia, Oman, Pakistan, Qatar, UAE, and Yemen show a range of green water usage, utilizing both maximum and minimum levels for dairy product production in grazing.
- Less Green Water Usage in Industrial Production: Armenia, Azerbaijan, Japan, Kyrgyzstan, and Uzbekistan use a smaller amount of green water in industrial dairy production.
- Near Mean Green Water Usage in Industrial Production: Kazakhstan, Tajikistan, and Turkmenistan use a level of green water near the mean value in industrial dairy production.

DIAGNOSTIC ANALYTICS

Diagnostic Insights

- Efficient Water Use for Dairy Production: Countries using a minimum quantity of green water below the mean value for dairy production, such as Afghanistan, Bahrain, Bhutan, Brunei, China, Cyprus, India, Iran, Israel, Japan, Korea, Korean Republic, Kuwait, Lebanon, Malaysia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Syrian, Thailand, Turkey, and Vietnam, are identified as potentially implementing efficient and sustainable water practices.
- Monitoring Varied Grazing Practices: Bangladesh, Cambodia, Georgia, Indonesia, Laos, Mongolia, Oman, Pakistan, Qatar, UAE, and Yemen, with both maximum and minimum grazing level green water usage, may require further investigation to understand the reasons behind the variability and to ensure sustainable practices.
- Efficient Water Use in Industrial Dairy Production: Armenia, Azerbaijan, Japan, Kyrgyzstan, and Uzbekistan, with less green water usage in industrial production, are potentially implementing more efficient water practices in the dairy industry.
- Balanced Water Use in Industrial Dairy Production: Kazakhstan, Tajikistan, and Turkmenistan, with green water usage near the mean value in industrial production, may be considered to have a balanced approach, neither excessive nor insufficient.

Assumptions

A5: It is assumed that categorizing countries into minimum, both maximum and minimum, and maximum green water usage for grazing and Industrial gives the meaningfulness of distinctions between countries using varying amounts of green water, implying that accurate interpretations of differences in water usage patterns during poultry production can be made. The mean green water level is assumed to be representative of the average green water usage for each country group in poultry production. The data subset for this is analysis is obtained by splitting the dataset based on Product category Poultry and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional trend of virtual green water usage for Poultry products in Asia.

The grid histogram analysis and box plot of green water usage in the grazing and industry for the production of the poultry product for different countries in the continent Asia.

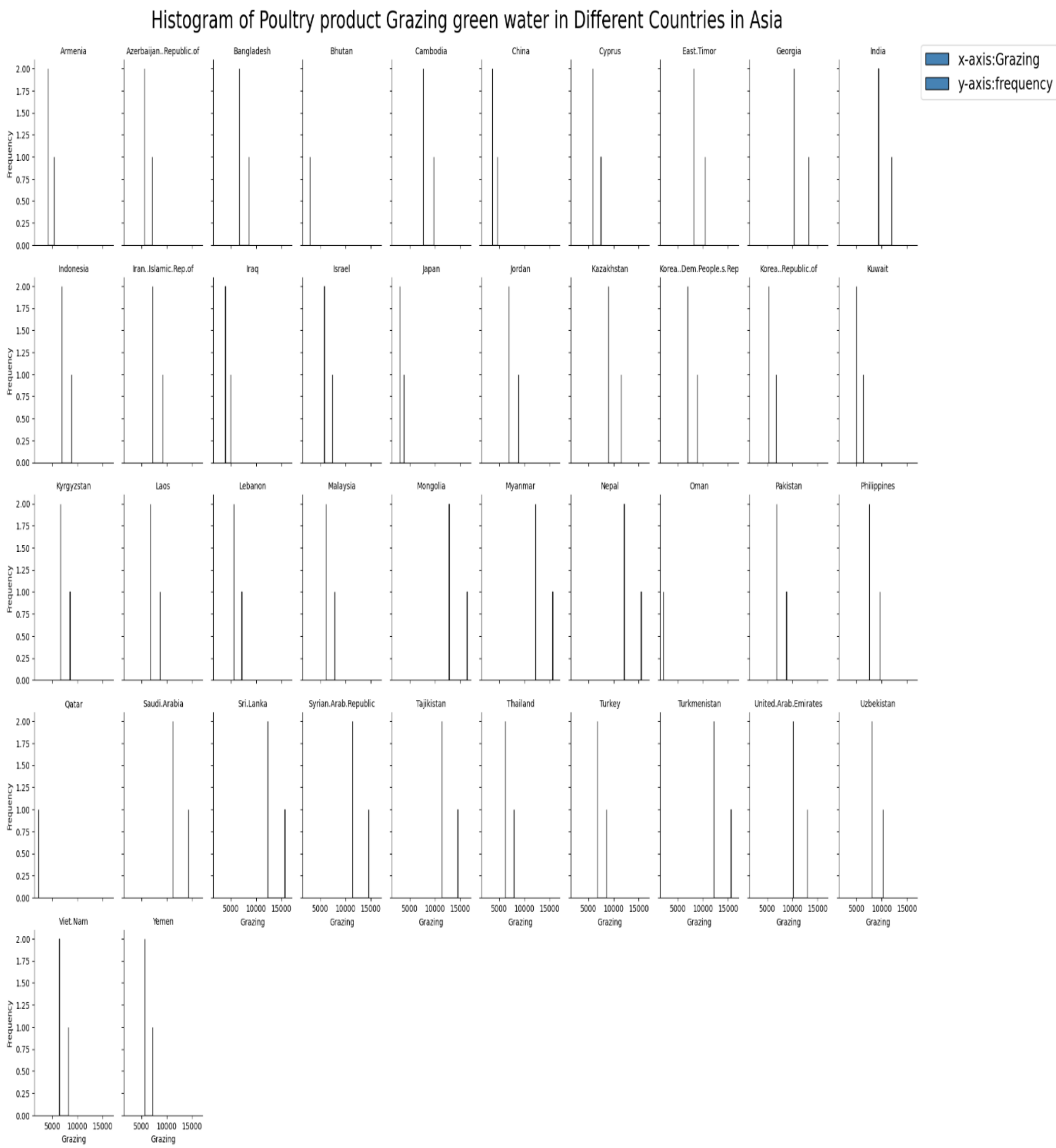


Fig.28: Grid histogram for poultry products(Grazing).

Fig.28 shows a visual representation of the distribution of green water usage for Poultry products in the Grazing sectors for each country in Asia.

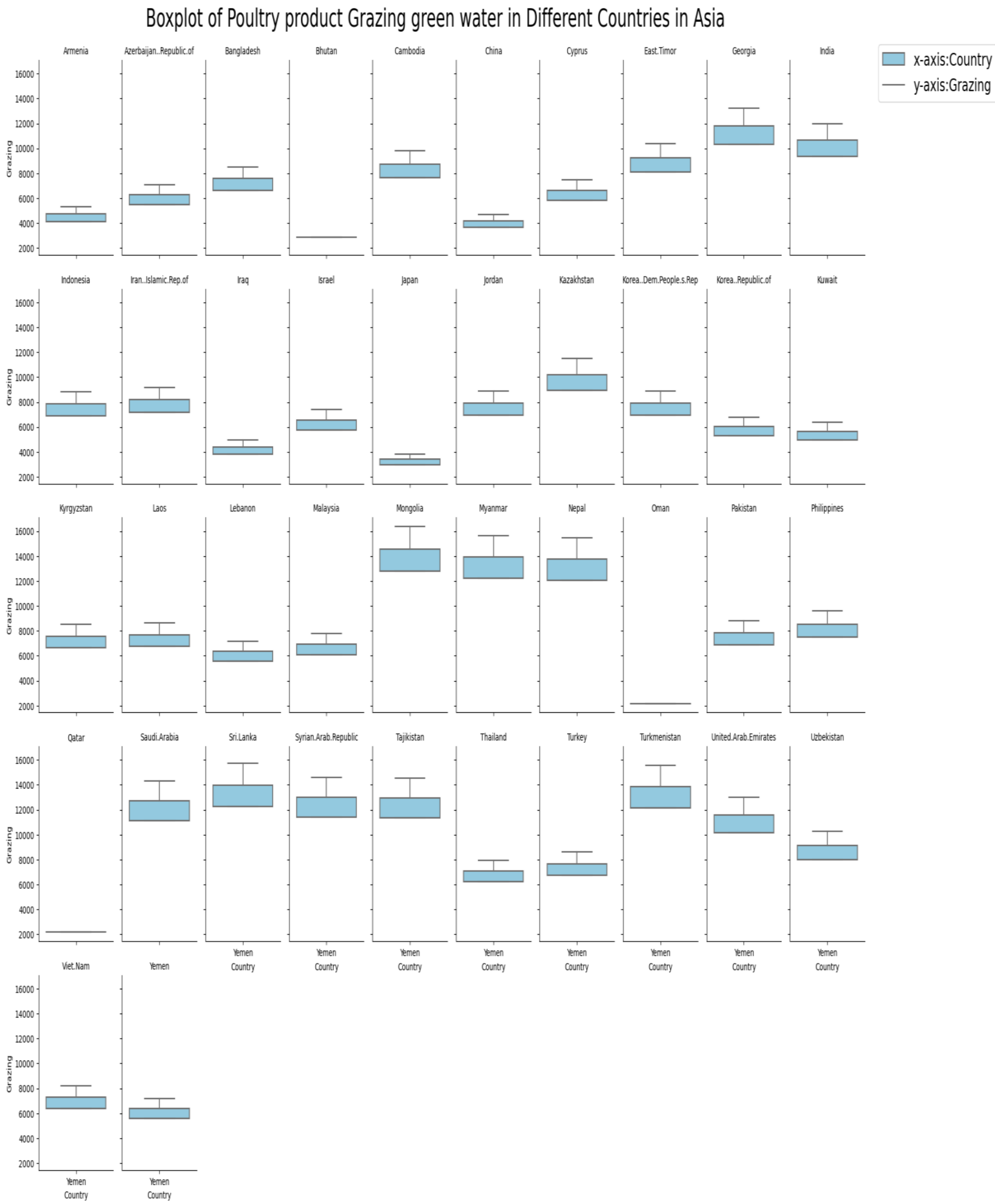


Fig.29: Grid Boxplot for Poultry products(Grazing).

Fig.29 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Poultry products in the Grazing sectors for each country in Asia.

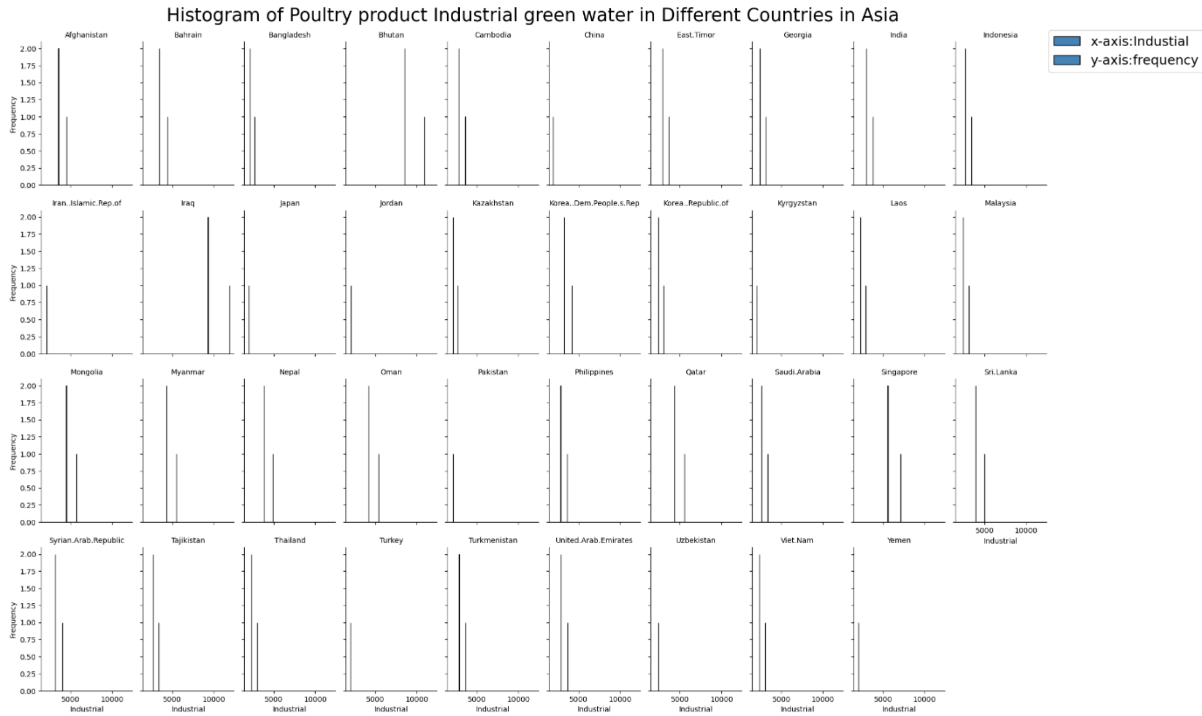


Fig.30:Grid histogram for Poultry products(Industrial).

Fig.30 shows a visual representation of the distribution of green water usage for Poultry products in the Industrial sectors for each country in Asia.

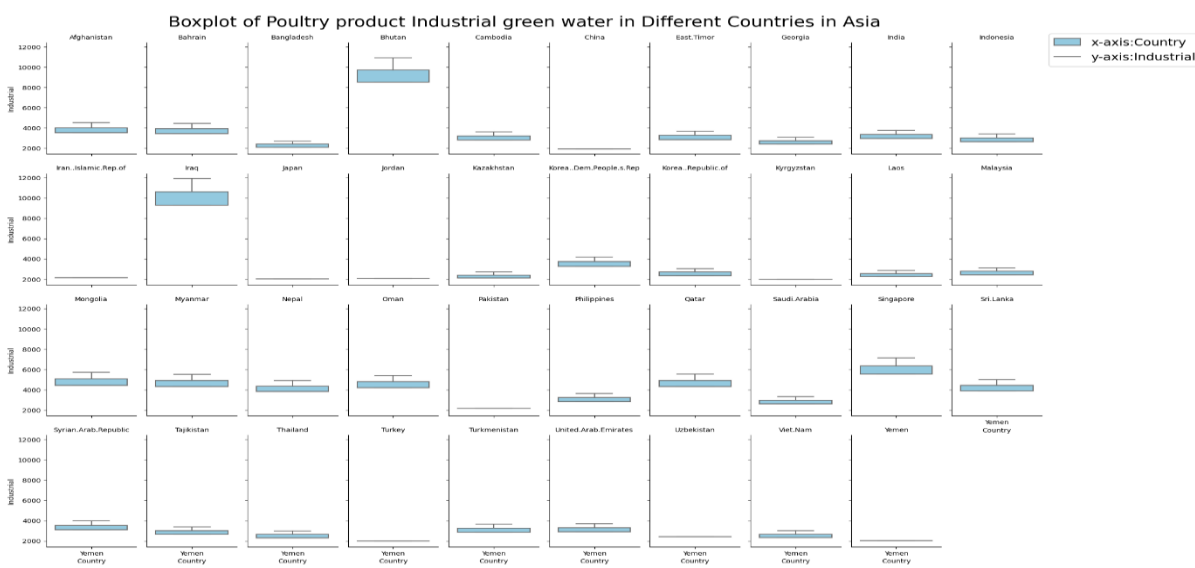


Fig.31: Grid Boxplot for Poultry products(Industrial).

Fig.31 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Poultry products in the Industrial sectors for each country in Asia.

INFERENCES:

- Armenia, Azerbaijan, Bangladesh, Cambodia, China, Cyprus, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Korea, Korea Republic, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Oman, Pakistan, Philippines, Qatar, Thailand, Turkey, Vietnam, and Yemen all these countries use a minimum amount of green water for grazing.
- Georgia, India, and Kazakhstan use both maximum and minimum amounts of green water for grazing.
- Mongolia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Tajikistan, Turkmenistan, and UAE use the maximum amount of green water for grazing.
- Iran and Bhutan use a major amount of green water for industrial purposes in poultry products. Other countries in Asia use water nearer to the mean level for industrial purpose in poultry production.

DESCRIPTIVE ANALYTICS

Descriptive Insights

- Minimum Green Water Usage for Grazing: Armenia, Azerbaijan, Bangladesh, Cambodia, China, Cyprus, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Korea, Korea Republic, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Oman, Pakistan, Philippines, Qatar, Thailand, Turkey, Vietnam, and Yemen all use a minimum amount of green water for grazing.
- Varied Grazing Level Green Water Usage: Georgia, India, and Kazakhstan use both maximum and minimum amounts of green water for grazing.
- Maximum Grazing Level Green Water Usage: Mongolia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Tajikistan, Turkmenistan, and UAE use the maximum amount of green water for grazing.
- High Industrial Water Usage in Poultry Production: Iran and Bhutan use a major amount of green water for industrial purposes in poultry products.
- Balanced Industrial Water Usage in Poultry Production: Other countries in Asia use water nearer to the mean level for industrial purposes in poultry production.

DIAGNOSTIC ANALYTICS

Diagnostic Insights

- Efficient Water Use for Grazing: Countries using a minimum amount of green water for grazing are likely implementing efficient and sustainable water practices in their grazing systems.
- Monitoring Varied Grazing Practices: Georgia, India, and Kazakhstan, with both maximum and minimum grazing level green water usage, may require further investigation to understand the reasons behind the variability and ensure sustainable grazing practices.
- Concerns about High Grazing Level Water Usage: Mongolia, Myanmar, Nepal, Saudi Arabia, Sri Lanka, Tajikistan, Turkmenistan, and UAE raise concerns due to their utilization of the maximum amount of green water for grazing, indicating potential environmental impact or inefficiency.
- Assessing Industrial Water Practices in Poultry Production: Iran and Bhutan, with high green water usage in industrial poultry production, may need closer monitoring and potential interventions to ensure sustainable water practices.
- Balanced Industrial Water Practices in Poultry Production: Other countries in Asia, with water usage nearer to the mean level in industrial poultry production, may be considered to have a balanced approach, neither excessive nor insufficient.

Assumptions

A6:Assuming that the mean, calculated for each country in the Swine category, is a representative measure of the average green water usage in Swine production. Assuming that Swine farming practices related to green water usage are relatively homogeneous within each country, allowing for meaningful comparisons. Assuming that, with the mean used as the central tendency measure, the use of box plots remains statistically valid for visually representing the spread and distribution of green water usage within and between countries in the Swine subset. The data subset for this is analysis is obtained by splitting the dataset based on Product category Swine and the production System Green water and the countries of Continent Asia. Assuming that this splitting of dataset helps to understand the regional trend of virtual green water usage for Swine products in Asia.

The grid histogram analysis and box plot of green water usage in the grazing and industry for the production of the Swine product for different countries in the continent Asia.

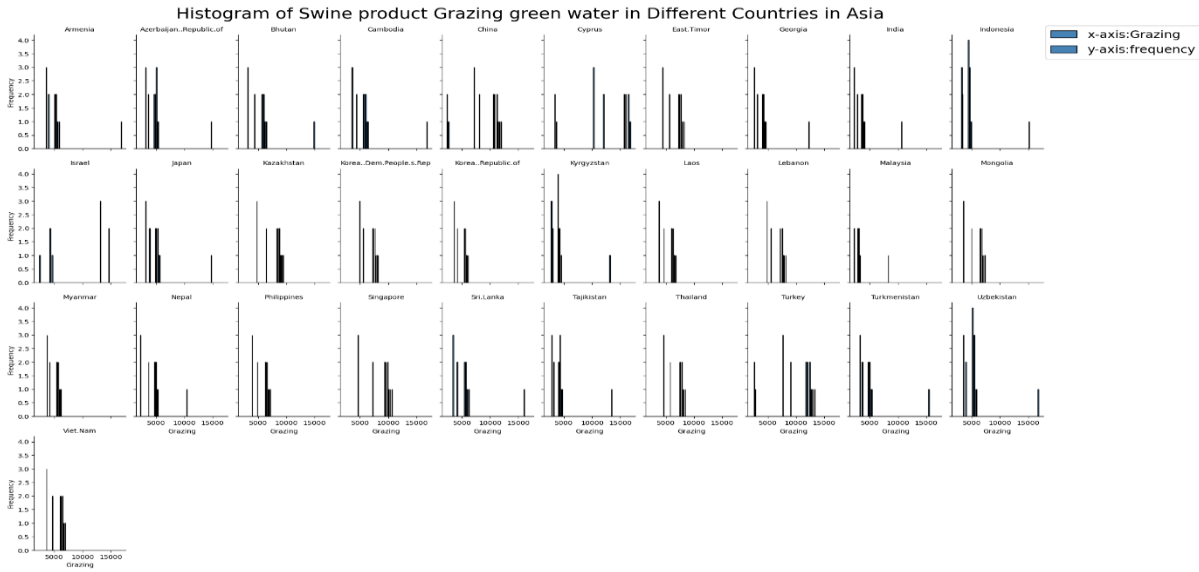


Fig.32: Grid histogram for Swine products(Grazing).

Fig.32 shows a visual representation of the distribution of green water usage for Swine products in the Grazing sectors for each country in Asia.

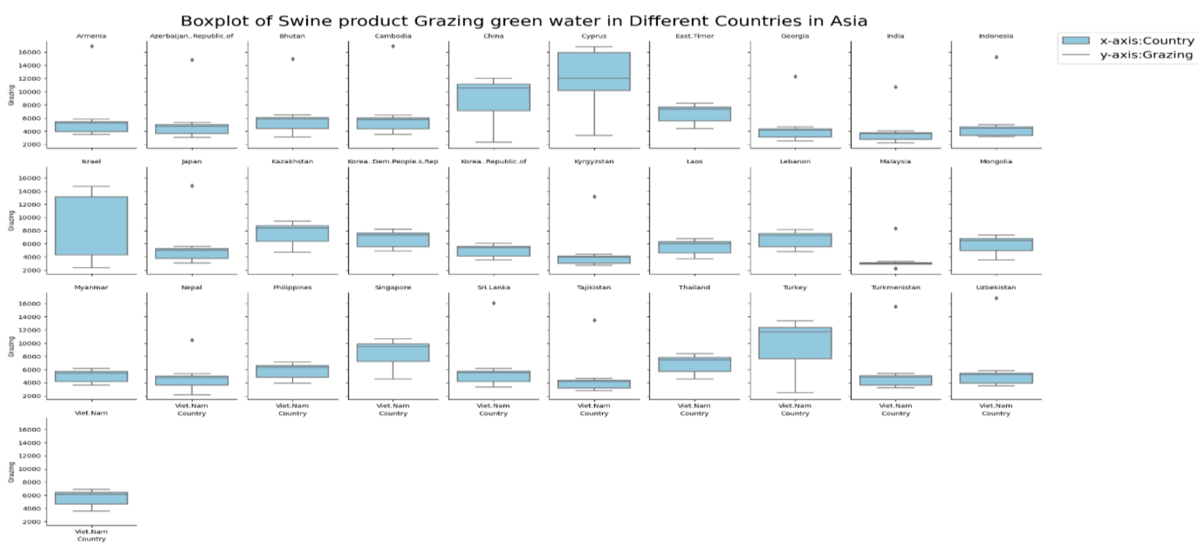


Fig.33: Grid Boxplot for Swine products(Grazing).

Fig.33 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Swine products in the Grazing sectors for each country in Asia.

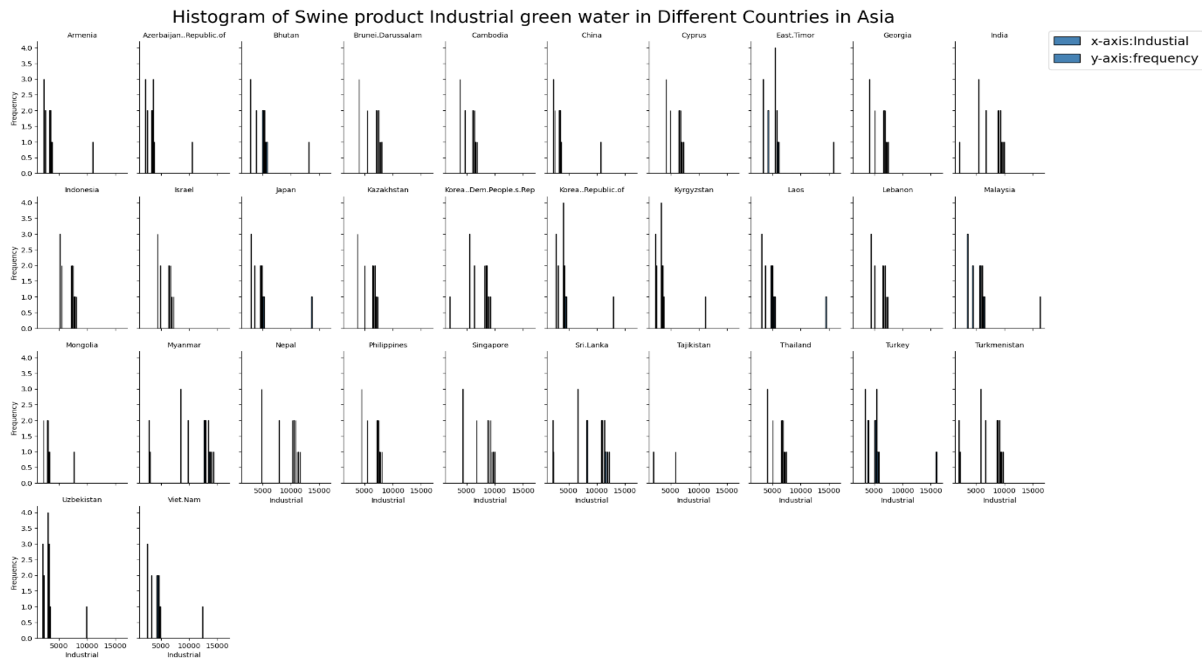


Fig.34: Grid histogram for Swine products(Industrial).

Fig.34 shows a visual representation of the distribution of green water usage for Swine products in the Industrial sectors for each country in Asia.

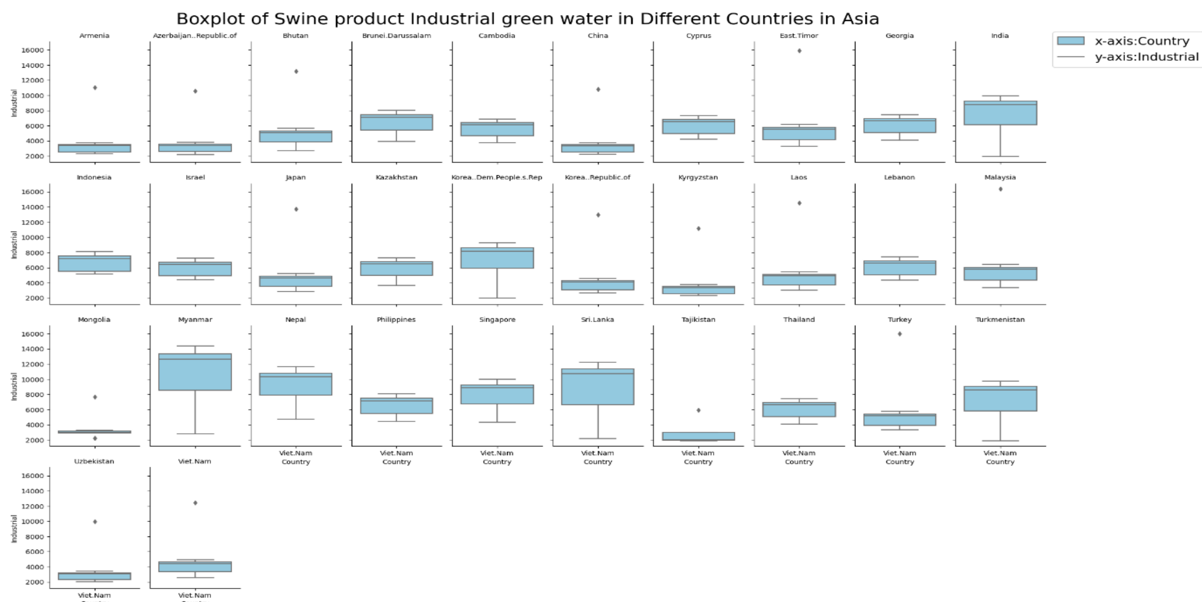


Fig.35: Grid Boxplot for Swine products(Industrial).

Fig.35 shows a deeper understanding of the central tendency, dispersion, and potential outliers in green water usage for Swine products in the Industrial sectors for each country in Asia.

INFERENCES:

- Armenia, Azerbaijan, Bhutan, Cambodia, East Timor ,Georgia, India, Indonesia, Japan, Kazakhstan, Korea, Korea Republic, Kyrgyzstan, Lebanon, Laos, Mongolia, Myanmar, Nepal, Philippines, Sri Lanka, Tajikistan, Thailand, Turkmenistan, Uzbekistan and Vietnam use minimum and near to the mean level of green water in the production of swine products at grazing.
- China, Cyprus, Israel, Singapore, and Turkey use green water above the mean level for the production of swine products at grazing.
- Armenia, Azerbaijan, Bhutan, Cambodia, China, Cyprus, East Timor, Georgia, Japan, Israel, Kazakhstan, Korea Republic, Kyrgyzstan, Laos, Lebanon, Malaysia, Tajikistan, Thailand, Turkey, Uzbekistan, and Vietnam use minimum and near the mean value of green water for the production of swine products at the industry level.
- Brunei, India, Indonesia, Korea Democratic, Myanmar, Nepal, Singapore, Sri Lanka, and Turkmenistan use above the mean level of green water for the production of swine products at the industry.

DESCRIPTIVE ANALYTICS

Descriptive Insights

- Minimum and Near Mean Green Water Usage in Grazing for Swine Production: Armenia, Azerbaijan, Bhutan, Cambodia, East Timor, Georgia, India, Indonesia, Japan, Kazakhstan, Korea, Korea Republic, Kyrgyzstan, Lebanon, Laos, Mongolia, Myanmar, Nepal, Philippines, Sri Lanka, Tajikistan, Thailand, Turkmenistan, Uzbekistan, and Vietnam use a minimum and near to the mean level of green water in the production of swine products at grazing.
- Above Mean Green Water Usage in Grazing for Swine Production: China, Cyprus, Israel, Singapore, and Turkey use green water above the mean level for the production of swine products at grazing.
- Minimum and Near Mean Green Water Usage in Industrial Swine Production: Armenia, Azerbaijan, Bhutan, Cambodia, China, Cyprus, East Timor, Georgia, Japan, Israel, Kazakhstan, Korea Republic, Kyrgyzstan, Laos, Lebanon, Malaysia, Tajikistan, Thailand,

Turkey, Uzbekistan, and Vietnam use minimum and near the mean value of green water for the production of swine products at the industry level.

- Above Mean Green Water Usage in Industrial Swine Production: Brunei, India, Indonesia, Korea Democratic, Myanmar, Nepal, Singapore, Sri Lanka, and Turkmenistan use above the mean level of green water for the production of swine products at the industry level.

DESCRIPTIVE ANALYTICS

Diagnostic Insights

- Efficient Water Use in Grazing for Swine Production: Countries utilizing minimum and near to the mean level of green water in grazing for swine production are likely implementing efficient and sustainable water practices in their grazing systems.
- Concerns about High Grazing Level Water Usage: China, Cyprus, Israel, Singapore, and Turkey raise concerns due to their usage of green water above the mean level for swine production at the grazing level, indicating potential environmental impact or inefficiency.
- Efficient Water Use in Industrial Swine Production: Countries using minimum and near to the mean value of green water for industrial swine production are potentially implementing efficient water practices in the swine industry.
- Concerns about High Industrial Water Usage: Brunei, India, Indonesia, Korea Democratic, Myanmar, Nepal, Singapore, Sri Lanka, and Turkmenistan, with above the mean level of green water usage in industrial swine production, may need closer monitoring and potential interventions to ensure sustainable water practices.

RESULTS AND DISCUSSIONS

CHAPTER-IV

4.RESULTS AND DISCUSSIONS

4.1 RESULTS

Bovine Product Production:

- Minimum Grazing Water Usage: Afghanistan, Japan, Bahrain, and Qatar exhibit minimal green water usage at the grazing field, suggesting efficient water management or alternative water sources for grazing.
- Varied Grazing Practices: China, Iraq, Kazakhstan, Kyrgyzstan, Oman, Pakistan, and the United Arab Emirates show diverse green water usage at the grazing level, indicating factors such as agricultural practices, climate, or water availability influence variability.
- Above-Mean Field-Level Usage: Azerbaijan, Bangladesh, India, Israel, Korea Dem, Korea Rep, Saudi Arabia, Turkmenistan, Turkey, and Yemen rely on green water above the mean for bovine product production at the field level.
- Efficient Industrial Water Use: Afghanistan, Armenia, Azerbaijan, and several other countries utilize green water below the mean for industrial bovine product production, suggesting efficient and diverse water use strategies.
- Mixed Industrial Water Usage: Bhutan, Cyprus, India, Indonesia, Japan, and others demonstrate both minimum and maximum green water usage in industrial bovine product production, indicating varying regional reliance or different approaches to industrial production.

Sheep Product Production:

- Efficient Grazing Practices: Armenia, Azerbaijan, Bahrain, Bangladesh, and others use less than the mean green water level for sheep product production at grazing, presenting opportunities for efficient water management practices.
- Varied Grazing Practices: Afghanistan, Cyprus, Indonesia, and others exhibit both minimum and maximum green water usage at the grazing level for sheep production, necessitating exploration of factors contributing to this variability.

- Maximized Grazing Water Use: Mongolia, Turkmenistan, and others use the maximum amount of green water for sheep product production at grazing, prompting further study into the sustainability of such intensive water use.
- Below Average Industrial Water Use: Afghanistan, Armenia, Azerbaijan, and others demonstrate below-average green water usage for industrial sheep product production, offering potential insights for sustainable industrial water management.
- Maximized Industrial Water Use: Mongolia and Georgia utilize the maximum amount of green water for industrial sheep product production, indicating the need for careful consideration of the environmental impact and sustainability of such practices.

Egg Product Production:

- Efficient Water Use: Afghanistan, Bahrain, Bangladesh, and others use the minimum level of green water for egg production, providing a benchmark for efficient water management practices.
- Varied Water Use: Cambodia, Cyprus, East Timor, and others demonstrate both maximum and minimum green water usage for egg production, requiring investigation into factors contributing to this variability.
- Maximized Water Use: Saudi Arabia, Mongolia, and others use the maximum amount of green water for egg production, necessitating a closer examination of the impact and sustainability of such practices.
- Efficient Industrial Water Use: Afghanistan, Armenia, Azerbaijan, and others utilize a minimum amount of green water for industrial egg production, suggesting potential strategies for efficient industrial water management.
- Varied Industrial Water Use: Bhutan and Myanmar show both maximum and minimum green water usage in industrial egg production, prompting exploration of regional factors influencing this variability.

Dairy Product Production:

- Efficient Water Use: Afghanistan, Bahrain, Bhutan, and others use a minimum quantity of green water below the mean for dairy product production, indicating potential efficiency in water management.

- Varied Grazing Practices: Bangladesh, Cambodia, Georgia, and others exhibit both maximum and minimum green water usage in grazing-based dairy production, requiring investigation into factors contributing to variability.
- Low Industrial Water Use: Armenia, Azerbaijan, Japan, and others use less green water in industrial dairy production, offering insights into optimizing industrial water usage.
- Moderate Industrial Water Use: Kazakhstan, Tajikistan, and Turkmenistan use a level of green water near the mean in industrial dairy production, providing a potential balance between industrial production and sustainable water use.

Swine Product Production:

- Efficient Grazing Practices: Armenia, Azerbaijan, Bhutan, and others utilize minimum and near-mean levels of green water in swine product production at grazing, showcasing potential efficient and sustainable grazing practices.
- Above Mean Grazing Water Use: China, Cyprus, Israel, and others use green water above the mean for swine product production at grazing, necessitating evaluation for sustainability.
- Efficient Industrial Water Use: Armenia, Azerbaijan, Bhutan, and others use minimum and near-mean values of green water for swine product production at the industry level, indicating potential efficiency in industrial water management.
- Above Mean Industrial Water Use: Brunei, India, Indonesia, and others use above the mean level of green water for industrial swine product production, prompting assessment of factors contributing to higher water usage and sustainability considerations.

4.2.DISCUSSIONS

Diverse Water Usage Patterns: The exploratory data analysis reveals a diverse range of water usage patterns across different countries and livestock categories in Asia. Each livestock category, including bovine, sheep, egg, dairy products, poultry, and swine, presents distinct nuances in how countries manage and utilize green water resources.

Grazing vs. Industrial Practices: A noticeable distinction emerges between grazing based and industrial practices in livestock production. Countries like China, Iraq, Kazakhstan, and

Kyrgyzstan show efficient green water usage in grazing based production, while others, such as Afghanistan and Armenia, prioritize sustainability in industrial settings.

Sustainable Practices: Certain countries, like Afghanistan, Bahrain, and Brunei, consistently employ minimal green water in various livestock categories, suggesting a commitment to sustainable and water efficient farming practices.

The utilization of both maximum and minimum green water levels in grazing based farming by countries like Bangladesh and Cambodia indicates a balanced and adaptive approach to resource management.

Intensive Farming Practices: Some nations exhibit a propensity for intensive farming practices, especially in poultry and swine production. Iran and Bhutan, for instance, showcase major green water usage in industrial poultry farming, indicating a focus on high intensity production.

Regional Trends: The observed variations in water usage patterns across countries suggest potential regional or cultural trends influencing agricultural practices. Regions like Central Asia, including countries like Turkmenistan and Uzbekistan, show distinct reliance on extensive grazing practices, impacting water usage in sheep production.

Potential Areas for Improvement: Countries with consistent patterns of efficient or resource intensive water usage across multiple livestock categories may highlight specific national strategies or challenges in livestock farming. Identifying and understanding these patterns can provide valuable insights for policymakers and stakeholders aiming to enhance water sustainability in the livestock industry.

Need for Context Specific Interventions: The insights underscore the importance of tailoring interventions and strategies based on specific country contexts and the unique challenges each nation faces in livestock production. Understanding the factors influencing water usage patterns can inform targeted approaches to improve efficiency and reduce environmental impact.

CONCLUSION

CHAPTER-V

5.CONCLUSION

In summary, the exploratory data analysis (EDA) on water usage in livestock production provides a nuanced perspective on the diverse strategies employed by different countries. The insights gained from examining bovine, sheep, egg, dairy products, poultry, and swine production reveal distinctive patterns and trends that warrant careful consideration. Here are the key takeaways:

Efficient Resource Utilization: Countries such as China, Iraq, Kazakhstan, and Kyrgyzstan demonstrate efficient green water usage in grazing based bovine production, suggesting a potential model for optimizing resource utilization in extensive farming practices.

Sustainability in Agriculture: Nations like Afghanistan, Bahrain, and Brunei showcase a commitment to sustainable agriculture by consistently employing minimal green water in various livestock categories. This underscores the importance of balancing production goals with environmental stewardship.

Regional and Cultural Influences: Regional and cultural factors play a significant role in shaping water usage patterns. The observed variations across countries highlight the need for context specific interventions that consider unique challenges and opportunities in each region

Intensive Farming Practices: Some countries, notably Iran and Bhutan, exhibit intensive water usage in industrial poultry farming. Understanding these intensive practices is crucial for addressing environmental concerns and promoting sustainable alternatives.

Balanced Grazing Practices: Countries like Bangladesh and Cambodia showcase a balanced and adaptive approach to resource management in grazing-based farming. This flexibility indicates a capacity to adjust strategies based on environmental conditions and evolving agricultural needs.

5.1. FUTURE SCOPE AND RESEARCH:

Call for Further Investigation: The provided insights offer a foundation for further investigation into the specific practices, policies, and conditions that contribute to observed patterns in water usage across different livestock categories. Continued research in this area can contribute to the development of more effective and targeted solutions for sustainable livestock farming globally. These overall insights contribute to a comprehensive understanding of water usage in livestock production, offering valuable information for stakeholders involved in agriculture, environmental conservation, and policymaking.

Call to Action for Further Research: The findings provide a solid foundation for further research into the specific practices, policies, and conditions influencing water usage patterns. Continued investigation in this field can contribute to the development of more effective and targeted solutions for sustainable livestock farming globally .In conclusion, the EDA on water usage in livestock production offers valuable insights that contribute to our understanding of the complex interplay between agriculture, environmental conservation, and resource management. These insights pave the way for informed decision making, policy formulation, and collaborative efforts aimed at fostering a more sustainable and resilient future for global livestock production.

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