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Trend and Instability Analysis of Milk Production and Consumption in the South Asia Region

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ABSTRACT

This study examined the trend and variability in milk production and consumption in different countries of the South Asian region from the year 2000 to the year 2017. An exponential growth function was fitted to estimate compound annual growth rates (CAGR) in milk production and consumption. Cuddy-Della Valle indices were constructed to examine the extent of instability. The study reveals that the growth rate of milk consumption in Afghanistan and Nepal was higher than that of milk production, indicating an increasing trend of net imports in these countries. In Bhutan, milk growth (CAGR) was negative for both production (-0.69 percent) and consumption (-0.67 percent), indicating a weak performance in the livestock sector during the study period. However, in this South Asian region, the positive CAGR in milk production varied from 1.38 percent in Iran to 5.20 percent in Sri Lanka, with total consumption growing at almost the same rate as production in these two countries. In the South Asian region, all countries showed low milk production and consumption variability, except Sri Lanka, where medium instability was observed in both milk production and consumption during this period. In Afghanistan, milk production grew at an annual compound rate of 1.86 percent, slightly less than milk consumption, which grew by 2 percent compound annual growth rate.

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Introduction

Livestock plays a major role in global food systems and contributes to the livelihoods and nourishment of millions of people in low- and middle-income countries (Salmon et al., 2020). In 2021, global milk production was 879.90 million tons. India ranked first, contributing 23.75 percent, followed by the USA and Pakistan, with shares of 11.67 percent and 6.78 percent, respectively, while China ranked fourth, producing about 4.69 percent. Afghanistan ranked

53rd with a share of less than 1 percent of total world milk production (FAO, 2023). In Asia, milk production increased by 3.9 percent in 2018. Asian countries contributed 97.10 percent of buffalo milk, with 96 percent coming from South Asian countries, mainly India and Pakistan (Pasha and Hayat, 2012). Milk production in India increased by 5.6 percent from 2017 to 2018 due to the expansion of the dairy herd and higher productivity levels, while in Pakistan, milk production grew by 3 percent over the same period (FAO, 2018). In Afghanistan, milk production increased by about 28 percent due to a rise in the number of major milk-producing animals, namely cattle and buffalo, during this period (Abdul and Srivastava, 2020).

In 2007, Asian countries contributed 97.10 percent of buffalo milk, with 96 percent coming from South Asian countries, including India, Pakistan, and Nepal (Pasha and Hayat, 2012). India was the leading producer, contributing 13.1 percent of global milk production (Kumbhar, 2010). The livestock sector trend has been rising steadily, as it provides an important alternative source of employment and significantly contributes to food security, often surpassing crop growth. While the production and consumption of livestock products are increasing, they remain unbalanced. This variability in animal products affects animal production, farmers' income, and decisions to invest in livestock farming. Instability in livestock production also impacts consumers, price stability, the vulnerability of low-income households to market fluctuations, consumption, employment, the livestock sector's growth, and the countries' economic development (Sekaran et al., 2021). In South Asia, 1 in 8 children does not receive sufficient food, so increasing local food production is essential to address food security (Rasul et al., 2021).

Problem Statement

In South Asian countries like Afghanistan, livestock products, particularly milk, provide daily cash income and play an essential role in providing food for both rural and urban populations. Given the large population share of South Asia within Asia, many children suffer from malnutrition. Reducing malnutrition in Asia depends on reducing malnutrition in South Asia. India and Bangladesh have the highest rates of undernourishment and hunger in Asia, with undernourishment affecting 16 percent of the population. In Pakistan, about 30 percent of pregnant women were found to be vitamin A deficient in 2006. In Afghanistan, both women and children are the most vulnerable to chronic undernourishment, which is among the highest globally. More than 40.9 percent of Afghan children under the age of 5 are stunted, while about 2.5 million children are severely undernourished (FAO, 2020). Milk is considered an essential source of nutrients for various age groups, especially children. Given these concerns, the current study was conducted in various South Asian countries.

Research Objectives

1. To estimate the growth rate of milk production and consumption.
2. To examine the extent of instability in the growth of milk production and consumption.

Research Questions

1. Is production growth aligned with consumption?
2. Do production and consumption exhibit different levels of instability?

Methods and Materials

This study is based on secondary data collected from the FAO for the period from 2000 to 2017. An exponential growth function was fitted to estimate milk production trends and consumption trends in South Asian countries. Growth rates were calculated to examine the tendency of the variable to increase, decrease, or stagnate over time, indicating the rate of change in the variable per unit of time. In the current study, compound annual growth rates for milk production and consumption in South Asian countries were estimated by fitting the exponential growth function of the following form:

$$Y_t = a\, e^{bt} \ldots\ldots\ldots (1)$$

where

Y_t is the production/consumption of milk in the countries of the South Asian region.

Both a and b are constants parameters

t is noted as a time period from 2000 to 2017.

A natural log on both sides of equation (1) has been taken to change it into a linear equation.

$$Log\, Y = loga + bt \ldots\ldots\ldots (2)$$

and CAGR (%) was worked out by using the following formula:

$$CAGR\ (\%) = (antilog\ of\ b - 1) * 100 \ldots\ldots (3)$$

Milk production data was available from secondary sources, but consumption data was not. Therefore, the availability of milk in each country was considered total consumption. Total availability also considered each year's net import quantity (total import – total export). Total milk consumption was calculated as follows:

$C_{jt} = P_{jt} + I_{jt} - E_{jt}$

Where,

C_{jt} = Consumption of milk in j^{th} country in t^{th} year (tones)

P_{jt} = Production of milk in j^{th} country in t^{th} year (tones)

I_{jt} = Import of milk in j^{th} country in t^{th} year (tones)

E_{jt} = Export of milk in j^{th} country in t^{th} year (tones)

To generate consumption data for different years and countries in the region, data on the quantity of milk exports and imports, along with production data, was collected across South Asian countries.

To find the extent and level of variability in milk production and consumption across the countries, Cuddy-Della Valle instability indices (CDI) were constructed. The instability index is useful for measuring variability in time series data. The Cuddy-Della Valle index technique corrects the coefficient of variation if data is scattered around a trend line, reducing the risk of overestimation (Geetha and Srivastava, 2019). The formula for constructing the Cuddy-Della Valle index is as follows:

$$I_x = CV\sqrt{(1 - \bar{R}^2)}$$

Where,

I_x = Index value

Coefficient of variation (CV %) = $\left(\sigma/\bar{X}\right) \times 100$

$\bar{R}^2 =$ Adjusted coefficient of multiple determination

$\sigma =$ Standard deviation

$\bar{X}$ = Mean value

In this study, the CDI values are grouped into three classes, which represent the different levels of instability, as follows:

1. Low level of instability = value of instability index is from 0 to 15
2. Medium level of instability = value of instability index is more than 15 to 30
3. High-level instability = value of instability index is more than 30

Results and Discussion

Compound Annual Growth Rates of Production and Consumption of Milk in Different Countries of the South Asian Region (2000-2017)

The compound annual growth rates (CAGR) of milk production and consumption in various South Asian countries from 2000 to 2017 are presented in Table 1. The table shows that Sri Lanka recorded the highest CAGR in milk production (5.20 percent) and consumption (5.19 percent), followed by India, where both milk production and consumption grew at nearly the same rate (4.74 percent). Milk production and consumption increased by over 3 percent in Pakistan, followed by Nepal, while Bhutan registered negative growth. The growth rates of milk production and consumption were nearly identical in Iran, at 1.38 percent and 1.35 percent, respectively. The table shows that India and Bangladesh exhibited annual growth rates for milk production and consumption that supported a favorable trade balance and indicated almost self-sufficiency in milk production. In Afghanistan, however, the growth rate

of milk consumption exceeded that of milk production, suggesting a greater reliance on milk imports, negatively impacting the country's foreign exchange reserves. In Bhutan, milk production and consumption showed negative growth, indicating weak performance in the livestock sector. Figures 1 through 8 depict the changes in milk production and consumption across various South Asian countries over the study period.

Table 1: Compound annual growth rates in production and consumption of milk in the countries of South Asia region from 2000 to 2017

No.	Countries / Region	Production		Consumption	
		Trend coefficient	CAGR (%)	Trend coefficient	CAGR (%)
1	India	0.0463* (0.0009)	4.74	0.0463* (0.0009)	4.74
2	Pakistan	0.0331* (0.0003)	3.36	0.033* (0.0003)	3.36
3	Iran	0.0137* (0.0046)	1.38	0.0134** (0.0046)	1.35
4	Nepal	0.0314* (0.0004)	3.19	0.0317* (0.0004)	3.22
5	Afghanistan	0.0184* (0.005)	1.86	0.0198* (0.005)	2.00
6	Bangladesh	0.0204* (0.0022)	2.07	0.0205* (0.0022)	2.07
7	Sri Lanka	0.0507* (0.0051)	5.20	0.0506* (0.0051)	5.19
8	Bhutan	-0.0069* (0.0023)	-0.69	-0.0067** (0.0023)	-0.67

CAGR- compound annual growth rate
Figures in the parentheses indicate standard error
* and ** indicate significant at 1% and 5% probability level

Figures 1 through 8 below illustrate the trend in milk production and consumption over time for each South Asian country from 2000 to 2017, with both actual and estimated production and consumption data displayed simultaneously for comparison.

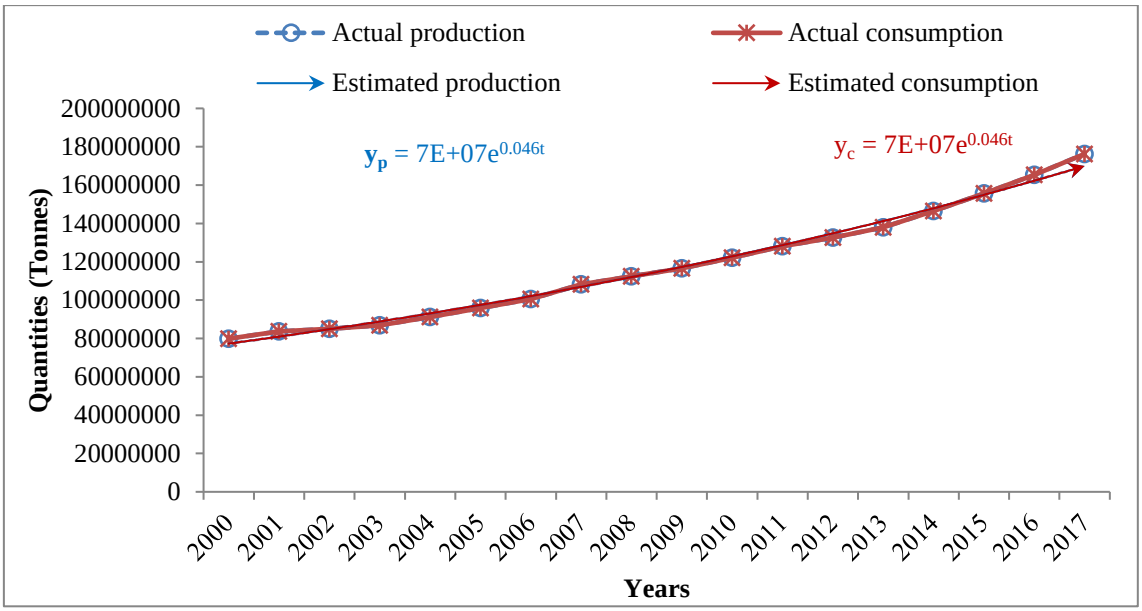

Fig 1: Estimated and actual production and consumption of milk in India

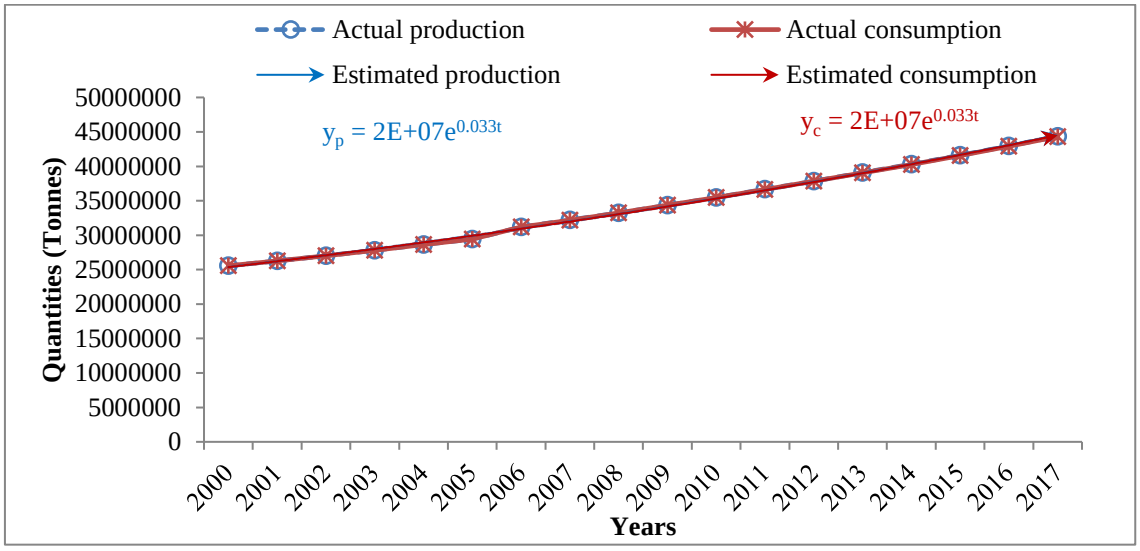

Fig 2: Estimated and actual production and consumption of milk in Pakistan

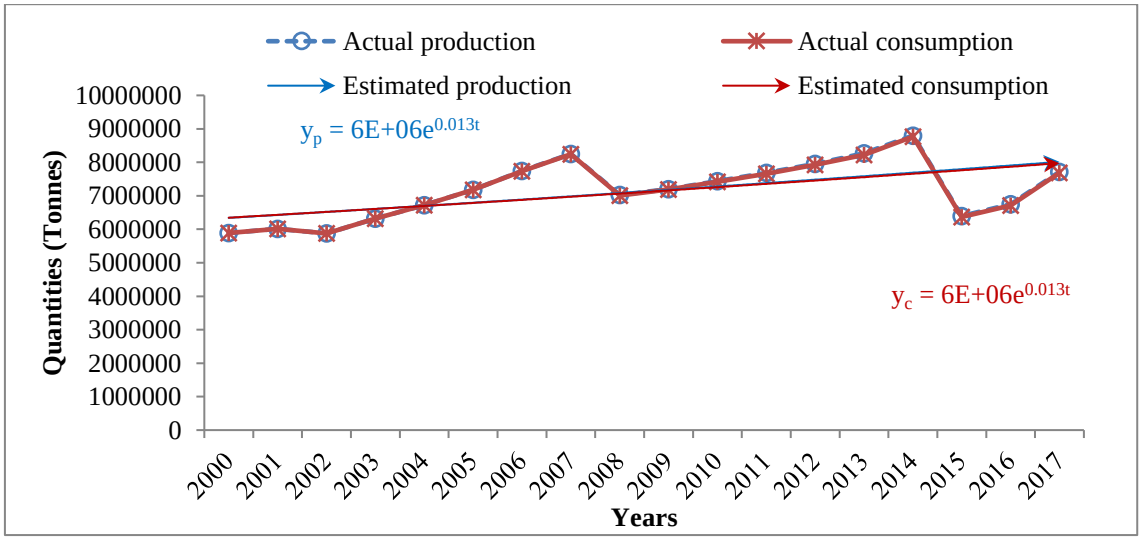

Fig 3: Estimated and actual production and consumption of milk in Iran

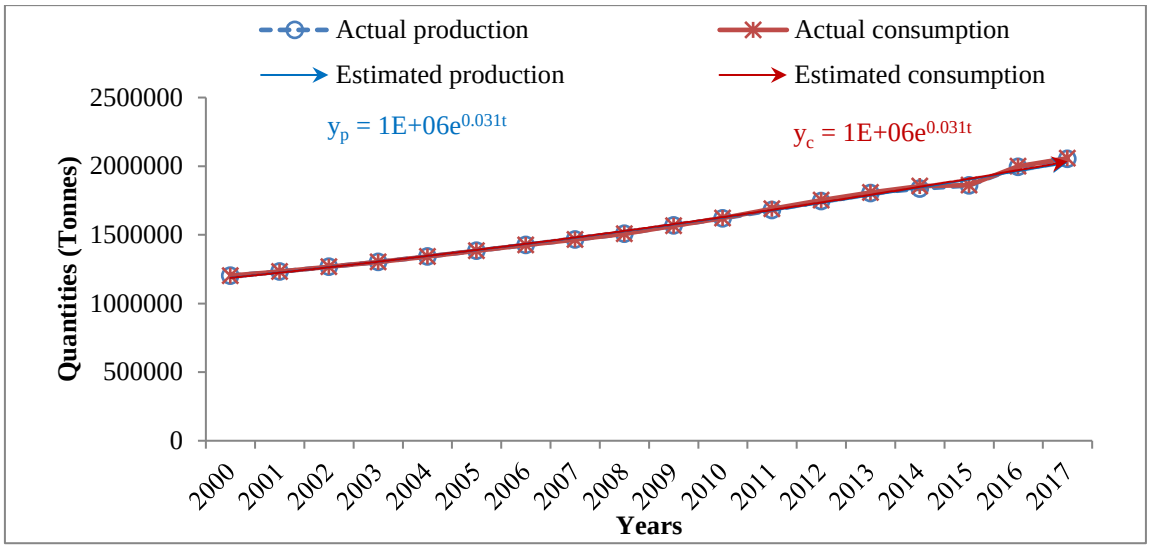

Fig 4: Estimated and actual production and consumption of milk in Nepal

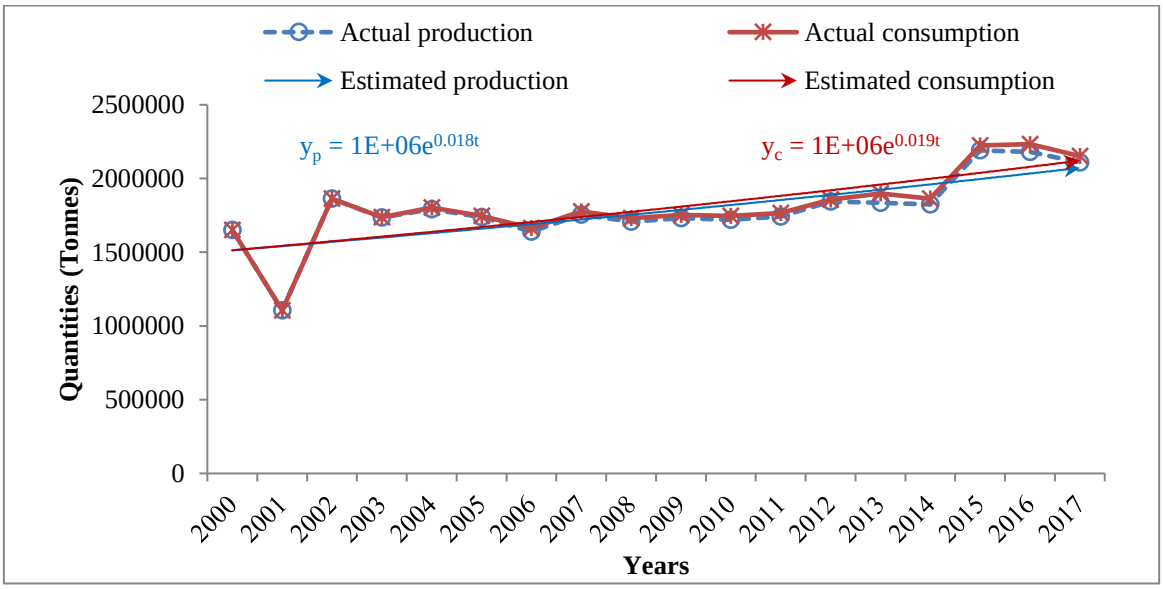

Fig 5: Estimated and actual production and consumption of milk in Afghanistan

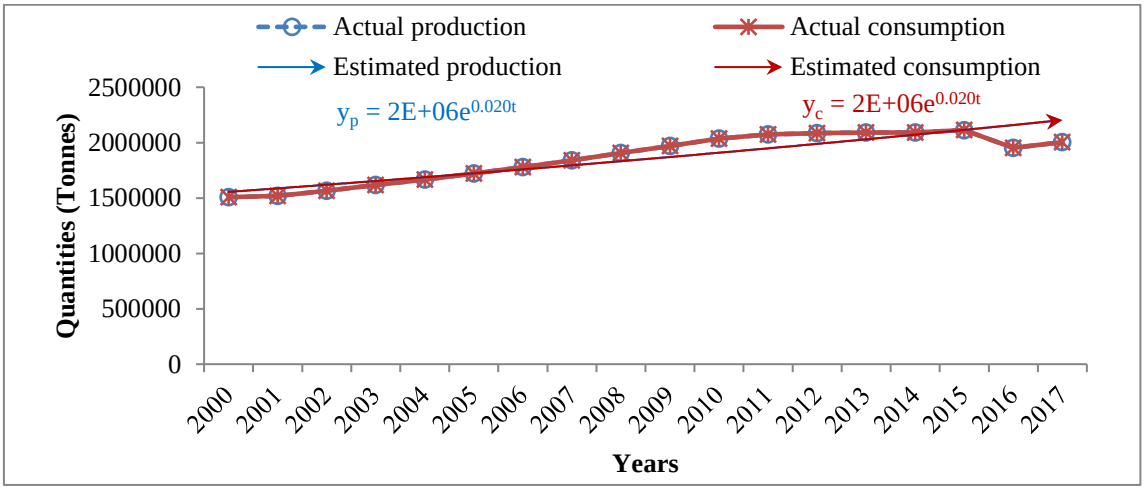

Fig 6: Estimated and actual production and consumption of milk in Bangladesh

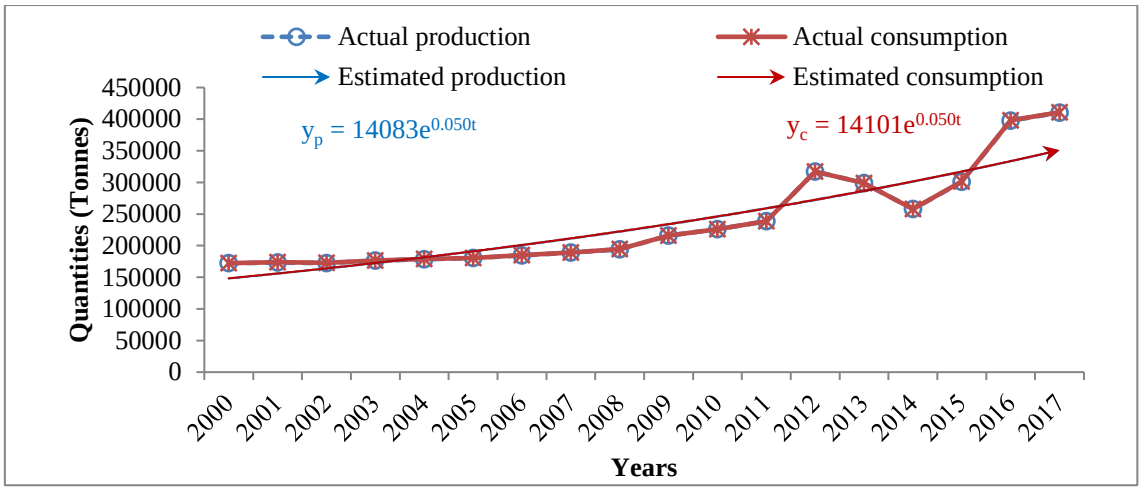

Fig 7: Estimated and actual production and consumption of milk in Sri Lanka

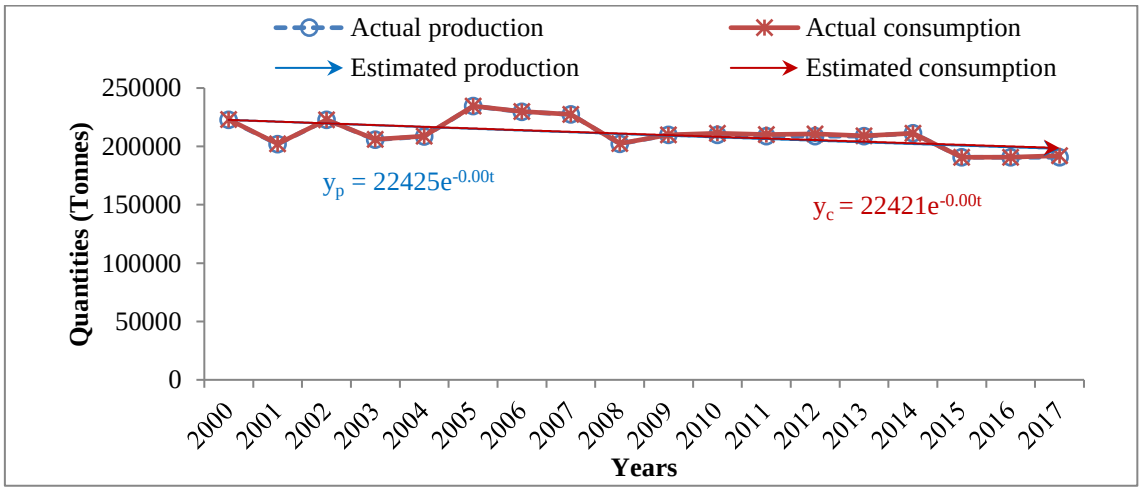

Fig 8: Estimated and actual production and consumption of milk in Bhutan

The Extent of Instability in Milk Production in Different Countries of the South Asian Region

The variability analysis of milk production across different South Asian countries is presented in Table 2. The table indicates that, except for Sri Lanka, which registered medium instability in milk production, all South Asian countries exhibited low instability in milk production from 2000 to 2017, with variability ranging from 1.32 to 10.15.

Table 2: the extent of instability in the production of milk in different countries of the South Asian region

Level of instability	Period 2000 – 2017 production	
	Countries	Instability value
Low instability	India	4.41
	Pakistan	1.32

	Iran	10.15
	Nepal	2.08
	Afghanistan	9.61
	Bangladesh	4.849
	Bhutan	5.13
Medium instability	Sri Lanka	15.26

The Extent of Instability in Milk Consumption in Different Countries of the South Asian Region

The instability indices for milk consumption across various South Asian countries are presented in Table 3. The table reveals that, except for Sri Lanka, which recorded medium instability in milk consumption, the remaining countries demonstrated low instability, with values ranging from 1.33 to 10.17 from 2000 to 2017.

Table 3: Level of instability in the consumption of milk in different countries of South Asia region

	Period 2000 - 2017	
Level of instability	Consumption	
	Countries	Instability value
	India	4.41
	Pakistan	1.33
	Iran	10.17
Low instability	Nepal	2.10
	Afghanistan	9.46
	Bangladesh	4.84
	Bhutan	5.14
Medium instability	Sri Lanka	15.28

Conclusion

Among South Asian countries, India and Bangladesh showed identical growth rates in milk output and availability, supporting a favorable trade balance and indicating near self-sufficiency in milk production. In Afghanistan, the growth rate of milk consumption surpassed that of milk production, suggesting a reliance on milk imports, adversely affecting the country's foreign exchange reserves. Conversely, milk production has increased due to a rising number of milk-producing animals, although productivity per animal remains low. In Bhutan, milk growth (CAGR) was negative for both production (-0.69 percent) and consumption (-0.67 percent), indicating weak performance in the livestock sector over the study period. All South Asian countries, except Sri Lanka, exhibited low milk production and consumption instability, while Sri Lanka showed medium instability in both.

This study recommends examining milk production at the individual livestock level across all South Asian countries to promote the adoption of new technologies for increased milk production, with a particular focus on Bhutan and Afghanistan. Milk consumption growth is

expected to continue due to its nutritional value, distinctive flavor, and the region's growing population. Supporting milk production growth through breeding programs focused on yield, fat and protein content, ecological adaptation, reproductive performance, growth rates, and optimal feeding and maintenance practices will enhance milk quality and quantity. Afghanistan has significant potential to increase the number of milking animals and their productivity, as 45 percent of its land is under permanent pasture. Local breeds can be improved through effective breeding programs, which could help Afghanistan reach self-sufficiency in milk and milk products, contributing to sustainable development in the country.

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