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Assessing Fruit and Vegetable Self-Sufficiency in Nepal: Historical Trends, Forecasts and Policy Implications

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ABSTRACT

Nepal's goal of achieving self-sufficiency in fruits and vegetables, as outlined in the Sixteenth Periodic Plan (2024-2029), conflicts with the country's growing imports, which exceeded USD 439 million in 2024 and have continued to climb. This paper analyzed 19 years of FAOSTAT and MoALD data (2004–2023) on production, consumption, cultivated area, yield, and trade, and used an ARIMA model to forecast the self sufficiency gap through 2030. We studied where growth comes from (more land vs. higher productivity) and assessed whether import prices are higher or lower than usual international market prices. Vegetables are imported at an average price of USD 343 per tonne, compared with the reported global benchmark range of USD 500–800 per tonne. This suggests that differences in agricultural support policies and informal cross-border trade may contribute to the observed price disparities. Fruit yields are growing at a statistically significant but very slow rate (0.42%) per year. However, because the cultivated area is increasing at a higher rate (4.01%) per year, production is increasing at 5.42% per year. As a result, fruit import dependence is expected to fall from 11.6% in 2024 to 5.9% in 2030, reducing annual import expenditure from USD 110 million in 2024 to USD 63 million in 2030. The vegetable sector shows a worsening situation, as the vegetable supply gap (Domestic supply - Production) is projected to reach 501,807 t by 2030, up from 388,730 t in 2024, and the import bill is expected to increase from 133.2 million USD in 2024 to 172.1 million USD in 2030. The findings indicate that while fruit self-sufficiency is expected to improve, vegetable supply deficits are expected to widen, highlighting the need to strengthen domestic vegetable production to improve long-term food security.

INTRODUCTION

Nepal, a small, landlocked country with a population of around 30 million, has high agroclimatic variation, ranging from the tropical Terai plains to the temperate mid-hills and alpine high-hills within a short distance (Pathak, 2026). Sixty percent of Nepal's workforce is employed in agriculture, which contributes only 23.9% of GDP (Yogi *et al.*, 2025). Due to Nepal's diverse agroecological regions, it has strong potential for year-round fruit and vegetable production, providing a comparative advantage for import substitution and potential export expansion (FAO, 2007; Timalisina *et al.*, 2025). However, this potential remains largely underutilized due to fragmented landholdings, traditional subsistence farming, inadequate irrigation and storage infrastructure, high post-harvest losses, and poor marketing systems. Due to those reasons, Nepal's productivity levels of fruits and vegetables remain the lowest among South Asian countries (Yogi *et al.*, 2025; Mishra, 2023). These constraints highlight the need for improved technology adoption, market development, and policy support to enhance production efficiency, environmental sustainability, and competitiveness.

In these situations, the country's horticulture sector can play an important role in nutrition security, income generation, and rural livelihoods (Shrestha *et al.*, 2022). Horticulture contributes about 30.94% to the national agricultural GDP, with vegetable production contributing

the largest share of horticultural output (13% AGDP), followed by fruits (6% AGDP) (Chapagain *et al.*, 2024). In 2023/24, Nepal produced 4,440,116 metric tons of vegetables, with a productivity of 14.24 tons per hectare (MoALD, 2024). The fruit sector is also important and growing in Nepal, with total production of about 1,508,701 metric tons and a productivity of 10.83 tons per hectare in year 2023/24 (MoALD, 2023).

Nepal's imports of fruits and vegetables have increased over time, with the total value of fruit and vegetable imports reaching USD 439.9 million in 2024, an increase of 2.32% from 2023 (FAOSTAT, 2026; FreshPlaza, 2025). Over the period 2004–2023, vegetable imports increased from 141,832 tons/year to 222,744 tons/year, and fruit imports increased from about 66,637.5 tons/year to 250,525.55 tons/year (FAO, 2026). During the same period, Nepal's per capita vegetable supply increased from 75.3 kg/year to 149.1 kg/year, and fruit supply increased from 39.9 kg/year to 51.3 kg/year (FAO, 2026). Nepal imported vegetables worth NPR 31.84 billion and fruits and nuts worth NPR 28.78 billion during the first ten months of FY 2025/26 (Nepal News, 2026). However, the same source indicates that exports remain negligible, indicating strong import dependence. Given these circumstances, it is very important to increase the production and productivity of fruits and vegetables in Nepal to achieve self-sufficiency.

Many studies have examined past import-export

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dynamics in Nepal's vegetable and fruit sector, but few have forecasted future trends in production, imports, exports, and self-sufficiency based on past trends. Filling this gap can help policymakers develop better strategies to achieve self-sufficiency in the vegetable and fruit sector. Based on these considerations, this paper provides a comprehensive, data-driven self-sufficiency analysis of fruits and vegetables for 2004–2023, along with projections through 2030 using an Autoregressive Integrated Moving Average (ARIMA) model. ARIMA models are widely used in agricultural forecasting because they analyze historical time series data to identify patterns and generate reliable predictions of future trends (Xia, 2024), which supports agricultural planning and decision-making (Xia, 2024). Studies have shown successful use of ARIMA in forecasting major crop yields such as rice, wheat, and maize (Alam *et al.*, 2018; Kumar *et al.*, 2022). This study used data from the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), the Ministry of Agriculture and Livestock Development, Nepal (MoALD), and the Department of Customs, Nepal (DoC), on Nepal's fruit and vegetable production, consumption, cultivated area, yield, and trade. The study focuses on three key research questions:

- (i) What has been the past import-export trend for Nepal's fruits and vegetables, and what is the current situation?
- (ii) How is Nepal's import dependence on fruits and vegetables likely to change by 2030 under current trends?
- (iii) What policy interventions are necessary to increase domestic production of fruits and vegetables, reduce dependence on imports, and move toward greater self-sufficiency by 2030?

LITERATURE REVIEW

Agricultural Trade and Food Self Sufficiency in South Asia

Achieving food self-sufficiency has long been a priority in South Asian countries, driven by concerns about economic stability and national sovereignty (Mittal & Sethi, 2009). Bangladesh has made significant progress in rice production, and India has achieved cereal self-sufficiency through the Green Revolution (Nandi *et al.*, 2024). However, despite its diverse agro-ecological zones, cheap labor, and abundant sources of irrigation, Nepal remains heavily dependent on imports to meet domestic demand for fruits and vegetables (Shrestha, 2025). Import substitution in vegetables and fruits can help create rural employment, increase farmer income, and strengthen food self-sufficiency.

Timilsina *et al.* (2025) analyzed the competitiveness of Nepali fruits and vegetables in domestic and export markets and concluded that high production costs and low productivity are the main factors limiting export potential. Nepal's open border with India allows an easy import of low-cost fruits and vegetables, increasing market competition for domestic producers (Gupta & Roy, 2023). Export potential remains underutilized due

to quality certification issues, regulatory barriers, limited access to international markets, and poor competitiveness (Khatri, 2023). Forecasting future imports and exports is essential for efficient planning to achieve self-sufficiency. Yet most existing studies focus only on the current import-export situation, with no attention to past trends or future forecasting in a single comprehensive study. This study addresses that gap by analyzing past import and export trends and using them to forecast future trends through an ARIMA model.

Yield Gaps in Nepal

Yield growth is a key driver of agricultural production quantity, particularly in land-limited countries where expansion of cultivated area is limited. Large yield gaps between research stations and farmers' fields persist in many developing countries due to limited adoption of advanced technologies, poor farm management, and low-quality and low-quantity input use (Hengsdijk & Langeveld, 2009; Lobell *et al.*, 2009). Vegetable and fruit productivity in

Table 1: Fruit and Vegetable Yield in SAARC Countries (2024)

Country	Vegetable Yield (kg/ha)	Fruit Yield (kg/ha)
Afghanistan	11,371.20	11,152.40
Bangladesh	12,199.70	12,195.20
Bhutan	5,214.40	8,473.30
India	15,946.30	16,024.80
Maldives	1,227.00	8,642.40
Nepal	13,915.30	11,188.40
Pakistan	14,927.20	12,594.60
Sri Lanka	11,346.70	10,183.10

Source: FAOSTAT (2026)

Table 2: Fruit and Vegetable Yield in Selected Highly Developed Countries (2024)

Country	Vegetable Yield (kg/ha)	Fruit Yield (kg/ha)
Australia	26,793.5	13,973.1
Israel	15,451.2	22,740.0
Netherlands	55,605.6	33,139.1
United States	35,968.8	20,856.8

Source: FAOSTAT (2026)

Nepal remains below its capacity due to limited use of high-quality planting materials, subsistence agriculture, inadequate irrigation infrastructure, low use of controlled environment agriculture, and poor access to modern technologies (Khatri-Chhetri *et al.*, 2017; National Agricultural Environment Research Center [NAERC], n.d.).

As shown in Table 1 & 2, Nepal's vegetable (13,915.3 kg/ha) and fruit (11,188.4 kg/ha) yields remain lower than those of several SAARC and highly developed countries. Higher productivity in developed countries such as the Netherlands

and the United States reflects the use of improved technologies, mechanization, efficient irrigation, and stronger market systems. In Nepal, limited mechanization and poor transport infrastructure due to steep terrain limit access to urban markets, increase marketing costs, and hinder large-scale commercial production.

High Dependence on Imports

The role of trade policies and subsidies in shaping import and export patterns is well documented in many studies (Jiang & Zhang, 2022). India, as Nepal's largest trading partner, provides substantial support to farmers through fertilizer subsidies, minimum support prices, and export incentives (Sharma *et al.*, 2017). These subsidies and incentives can lower international prices and distort global markets, creating an uneven playing field for neighboring countries like Nepal, which have limited capacity to respond (World Bank, 2023). The free and open border between India and Nepal further complicates the picture, as a large share of trade is untaxed and informal (Pohit & Taneja, 2004). Second, Nepal's per capita income growth has increased demand for processed vegetable products such as preserved tomatoes, sauces, and packaged goods (Sharma *et al.*, 2025). Nepal's domestic agro-processing industry remains in its nascent stage, and imports meet almost all demand for these higher-value products (Yadav *et al.*, 2023). Third, Nepal's rapid infrastructure development, particularly road expansion into previously remote areas, has opened new markets for domestic producers and also enabled imports to penetrate areas previously supplied by local agriculture (Murton, 2016). In this study, we calculate the distorted per-ton import price for fruits and vegetables and compare it with the standard international price to help us understand the reasons for high imports and inform recommendations for future policy. Furthermore, this study examines a commodity-specific case study of tomatoes, as they are among the most consumed and widely imported vegetables and serve as an important indicator of Nepal's self-sufficiency situations.

Forecasting Agricultural Production and Trade

Time series forecasting is important for agricultural policy formulation and analysis (Yoo & Oh, 2020). In this study, we used the Autoregressive Integrated Moving Average (ARIMA) model to forecast production and consumption of fruits and vegetables. ARIMA is widely recommended for univariate time series forecasting in agriculture as it captures patterns based on past values of the series (Badmus & Ariyo, 2011; Thapa *et al.*, 2022). Its popularity comes from its strong statistical properties and the well established Box Jenkins methodology (Mahapatra & Dash, 2020). Previous researchers have successfully used ARIMA to forecast area, production, and yield for various crops, including wheat in Pakistan (Saeed *et al.*, 2000), potato in Bangladesh (Hossain, 2016), cotton in India (Wali *et al.*, 2017), and groundnut in Turkey (Celik *et al.*, 2017). Such forecasts can guide policy decisions on price stabilization, import/export management, production decisions, and

food security (Zhao, 2026). In agriculture, future trade volumes are estimated based on past patterns, helping policymakers, traders, and farmers plan production, trade, and resource allocation. This study applies ARIMA models to historical data (2004–2023) to generate seven-year forecasts of fruit and vegetable production, consumption, and self-sufficiency through 2030.

MATERIALS AND METHODS

Data Sources

The FAOSTAT database is the primary data source. Another data source were the Ministry of Agriculture and Livestock Development, Nepal (MoALD), and the Department of Customs, Nepal (DoC) (Ministry of Agricultural Development, 2015; Ministry of Agriculture and Livestock Development, 2024; Department of Customs, n.d.).

The following variables were obtained from FAOSTAT covering the period 2004–2023:

- Population (thousands): from the Annual population domain, item “Population - Est. & Proj.” (2004–2023, including projections through 2030).
- Vegetable domestic supply (tonnes): from the Food Balances (2010–) and Food Balances (-2013, old methodology and population) domains, item “Vegetables + (Total)”.
- Vegetable food supply (kg/capita/year): from the Food Balances (2010–) and Food Balances (-2013, old methodology and population) domains, item “Vegetables + (Total)”.
- Vegetable import value (USD): from the Trade domain, item “-- Vegetables + (Total)”.
- Vegetable import quantity (t): from the Trade domain, item “-- Vegetables + (Total)”.

The following variables were obtained from MoALD, Nepal, covering the period 2004/5–2023/24

- Total vegetable production (tonnes)
- Total vegetable area harvested (hectares)
- Total vegetable yield (kg/ha)

We obtained an identical dataset for fruits. For the FAOSTAT database, we used the item “-- Fruit + (Total)” for import value and quantity, and “Fruits - Excluding Wine + (Total)” for domestic supply and food supply. From MoALD, Nepal, the same variables as vegetables were also obtained for fruit.

Commodity-level trade data (tomatoes) were taken from Nepal's fiscal years 2012/13 through 2025/26 from Nepal's Department of Customs' annual reports.

Unit Harmonization and Key Indicator Calculation

All variables were converted to consistent units (tonnes for quantities, t/ha for yield). We then calculated the following variables for each year (2004–2023):

1. Self sufficiency ratio (SSR) = (Production / Domestic supply) × 100.....(1)
2. Import Quantity = Domestic supply – Production.....(2)
3. Import reliance = (Imports / Domestic supply) × 100.....(3)

4. Consumption gap/ Supply gap = Domestic supply (imports) – Production (tonnes)..... (4)

5. Average import price (USD/tonne)= Import value (USD) / Import quantity (tonnes).....(5)

In FAOSTAT data, Domestic Supply is the total quantity of a food available in a country. It's calculated as: Production + Imports - Exports - Changes in Stocks.....(6)

Compound Annual Growth Rates (CAGR, %) for Fruits and Vegetables

The average annual growth rates of area, yield, and production for fruits and vegetables were calculated using the following formula:

$$\text{CAGR (\%)} = \left[\left(\frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{1/n} - 1 \right] \times 100 \dots\dots\dots(7)$$

Where:

- Beginning year = 2004/05
- Ending year = 2023/24
- n = 19 years

Forecasting Production and Domestic Supply of Fruits and Vegetables

Production and domestic supply of fruits and vegetables were projected using an autoregressive integrated moving average model with drift, ARIMA (0,1,0). Annual historical data were converted into time-series data. A differencing component (d=1) was applied to convert the series into a stationary form. The drift component was included to capture the average annual growth trend observed in the historical time series. Separate ARIMA (0,1,0) models with drift were estimated for fruit production, fruit domestic supply, vegetable production, and vegetable domestic supply. The models were fitted individually using historical observations and calculated seven-year forecasts from 2024 through 2030.

The ARIMA model specification can be expressed as:

$$\Delta Y_t = \mu + \epsilon_t \dots\dots\dots(8)$$

Where,

ΔY_t represents the annual variation in production or domestic supply, μ represents the calculated drift (average annual increase), and ϵ_t represents the random error.

Forecasted values were used to calculate the supply gap and the self-sufficiency ratio (SSR). A higher SSR indicates greater reliance on domestic production, whereas a lower SSR indicates a greater need for external supply or imports. The same forecasting framework was applied to both fruit and vegetable categories to evaluate future domestic availability, production trends, and potential import dependency during 2024 to 2030.

Forecast Based on Predicted Population and Per Capita Consumption: A Robustness Check for ARIMA Forecasts

Annual population data (thousands) for 2004 to 2023 and projected population for 2024 to 2030 were obtained from FAOSTAT. To predict per capita vegetable and fruit supply (kg/person/year) from 2024 to 2030, we fitted linear trends to the historical data (2004 to 2023) using the model:

$$Y = a + bX \dots\dots\dots(9)$$

Where,

Y is the per capita fruit and vegetable supply, X is the year, and b is the average annual increase in per capita fruit and vegetable supply; a = intercept (constant term). By using the projected population per capita vegetable and fruit supply, we calculated the total domestic supply for 2024 to 2030 as:

$$\text{Total domestic supply (tonnes)} = \text{Per capita supply} \times \text{Population in thousands} \dots\dots\dots(10)$$

This calculation served as a robustness check against the direct ARIMA forecasts of domestic supply (presented in Section 4.6).

RESULTS AND DISCUSSION

Compound Annual Growth Rates (CAGR, %) for Vegetables and Fruits

The compound annual growth rate (CAGR) was calculated to assess the average annual growth of Nepal's fruit and vegetable sectors from 2004/05 to 2023/24. Fruit production increased at a CAGR of 5.42%, accompanied by annual growth rates of 4.01% in cultivated area and 0.42% in yield. Vegetable production increased at a CAGR of 4.06%, with cultivated area and yield growing at 2.91%

Table 3: Compound Annual Growth Rates (CAGR, %) for Vegetables and Fruits

Sector	Variable	2004/05	2023/24	CAGR (%)
Vegetable	Area (ha.)	180,823	311,885	2.91
Vegetable	Yield (Mt./ha.)	11.421	14.24	1.21
Vegetable	Production (Mt.)	2,065,193	4,440,116	4.06
Fruit	Area (ha.)	89,312	181,340	4.01
Fruit	Yield (Mt./ha.)	9.99	10.83	0.42
Fruit	Production (Mt.)	552,879	1,508,701	5.42

Source: Authors' computation based on MoALD, Nepal data (2004/05–2023/24)

and 1.21%, respectively. Overall, both sectors recorded positive growth over the study period, with fruit production expanding at a faster rate than vegetable production.

However, the vegetable sector recorded a higher rate of yield improvement, suggesting that productivity gains contributed more to its production growth (Table 3).

Why is the Production Growth of Vegetables and Fruits Slow?

First, most farmers rely on unimproved local fruit varieties, as seedling production and distribution systems remain very weak (Joshi, 2000). High yielding, disease resistant varieties for apples, citrus, and bananas are either unavailable or very expensive (Dhakal *et al.*, 2024).

Second, irrigation coverage remains inadequate: only 44.63% of Nepal's cultivable land has access to irrigation, while the remaining depends largely on monsoon rainfall (Paudel, 2025). Drip irrigation, which can raise yields by 30–50%, covers less than 5% of the fruit area (Subedi, 2011).

Third, orchard management practices are poor: low planting densities, poor pest control, lack of timely training and pruning, no post bloom thinning, etc., suppress yields (Ladon *et al.*, 2024).

Fourth, extension services are understaffed; the ratio of agricultural extension officers to farmers is less than 1:2,000 in major fruit growing districts (Dhital, 2017).

Fifth, there is a lack of commercial cultivation in climate-suitable areas (e.g., high altitude zones for apples). High

post-harvest losses remain a major constraint to Nepal's horticultural sector. Studies estimate that post-harvest losses of fruits and vegetables range from 20% to 50%, depending on the commodity and the quality of post-harvest handling such as storage, transportation, and marketing (Adhikari & G.C., 2021), highlighting the need for improved post-harvest management practices. Addressing these constraints together is essential to accelerate yield growth. Furthermore, soil fertility is also a major concern, as continuous cultivation without proper nutrient management has depleted it in many vegetable and fruit-growing areas. Improving soil health through balanced fertilization, compost use, and better farming practices could increase yields sustainably (Shrestha *et al.*, 2025).

Indexed Growth Trend of Nepal's Vegetable and Fruit Sector

In this study, the growth of area, production, and productivity in Nepal's fruit and vegetable sectors was analyzed using an index approach, which allows

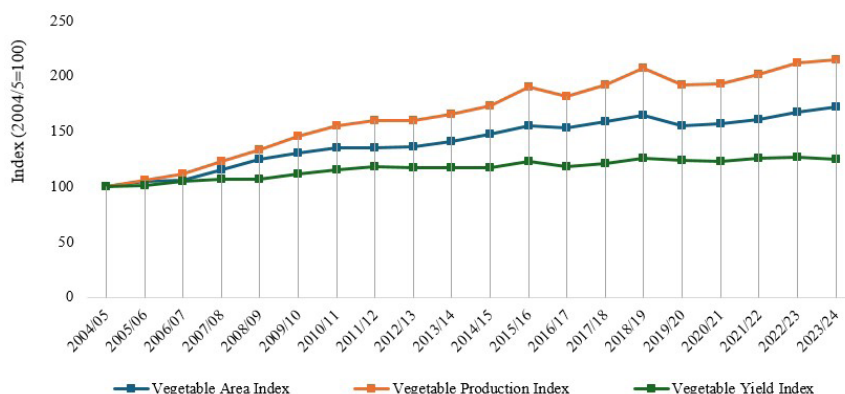


Figure 1: Indexed Trends in Vegetable Cultivated Area, Production, And Yield From 2004/05 to 2023/24 (2004/05 = 100).
Source: Authors' compilation based on data from the Ministry of Agricultural Development and the Ministry of Agriculture and Livestock Development, FY 2004/05-2025/26

comparison of relative changes over time. Using 2004/05 as the base year with an index value of 100, the index for each year was calculated using the formula:

$$\text{Index Value} = \left(\frac{\text{Value in current year}}{\text{Value in base year}} \right) \times 100 \dots\dots\dots (11)$$

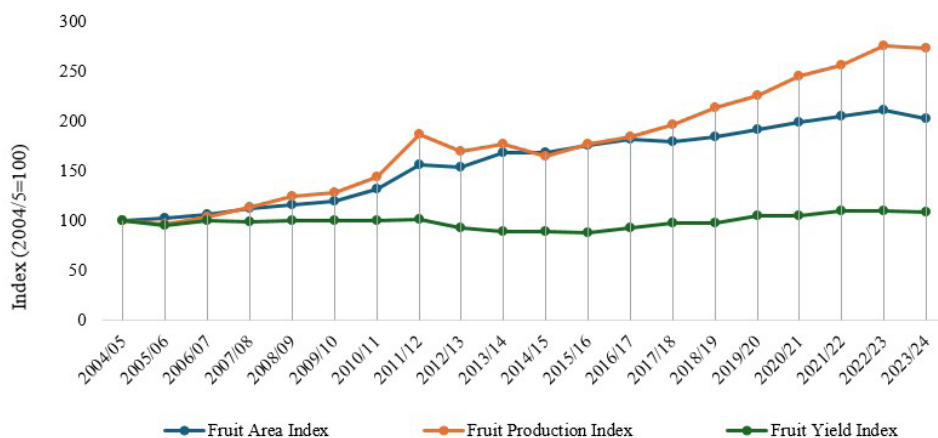


Figure 2: Indexed Trends in Fruit Cultivated Area, Production, and Yield From 2004/05 to 2023/24 (2004/05 = 100)
Source: Authors' compilation based on data from the Ministry of Agricultural Development and the Ministry of Agriculture and Livestock Development, FY 2004/05-2025/26

Indexed Growth Trends in Vegetable Cultivated Area, Production, and Yield

As shown in Figure 1, the vegetable sector grew faster, with substantial increases in total cultivated area, production, and yield. The faster rise in vegetable production relative to area expansion suggests yield improvements.

Indexed Growth Trends in Fruit Cultivated Area, Production, and Yield

The indexed trends show a continuous increase in Nepal's total fruit area and production from 2004/05 to 2023/24, reflecting gradual growth in market-oriented production (Figure 2). However, the fruit yield index doesn't show a substantial increase and shows some variation over the period.

Forecasting through 2030

Forecasting for Vegetables

We used an ARIMA model to forecast vegetable production and domestic supply from 2024 to 2030 using historical data from 2004 to 2023. The Augmented Dickey-Fuller (ADF) test shows that both historical data series were initially non-stationary and became stationary after first differencing. The best-fitting ARIMA models were selected by using the auto.arima function in the R package

'forecast', which evaluates different ARIMA models and selects the most appropriate model based on the Akaike Information Criterion. The best-fitting model for vegetable production and domestic supply was ARIMA(0,1,0) with drift. This specification represents a random walk with drift, in which the differenced series has a constant mean change over time. The drift coefficients of approximately 125,000 and 50,300 tons per year for vegetable and fruit production indicate a steady annual increase in vegetable and fruit production.

Residual diagnostics using the Ljung-Box test confirmed that the ARIMA model properly captured the underlying patterns in the data. For vegetable production, the test yielded a p-value of 0.48, and for domestic vegetable supply, it yielded a p-value of 0.97. Both values are well above the 0.05 threshold, indicating that the residuals are white noise (random, unpredictable fluctuations with no pattern). These results suggest that the residuals contain no significant autocorrelation, indicating an adequate model fit for forecasting. Using the estimated ARIMA model, we projected seven steps forward from 2024 to 2030. The results are presented in Table 4. Vegetable production is forecasted to increase from 4,565,112 tonnes in 2024 to 5,315,088 tonnes by 2030, a 16.43% increase. Domestic

Table 4: Forecasting Scenarios of Vegetables in Nepal, 2024–2030

Year	Production (tonnes)	Domestic Supply (tonnes)	Consumption Gap (tonnes)	Self-Sufficiency Ratio (%)	Import Bill (Million USD)
2024	4,565,112	4,953,842	388,730	92.2	133.2
2025	4,690,108	5,097,684	407,576	92.0	139.6
2026	4,815,104	5,241,526	426,422	91.9	146
2027	4,940,100	5,385,368	445,268	91.7	152.6
2028	5,065,096	5,529,211	464,115	91.6	159.1
2029	5,190,092	5,673,053	482,961	91.5	165.6
2030	5,315,088	5,816,895	501,807	91.4	172.1

Note: Forecasts were generated using ARIMA (0,1,0) with drift. The import bill was estimated by multiplying the projected deficit (gap) by the average vegetable import price over the last 5 years (2019–2023) of USD 342.6 per tonne.

Source: Authors' computation based on MoALD, Nepal (2004/05-2023/24), and FAOSTAT data (2004-2023)

vegetable supply (consumption) is forecasted to increase from 4,953,842 tonnes to 5,816,895 tonnes, a 17.42% increase. As a result, the supply gap (domestic supply minus production) is projected to increase from around 388,730 tonnes in 2024 to 501,807 tonnes by 2030. The self-sufficiency ratio is projected to decrease from 92.2% in 2024 to 91.4% by 2030, showing that imports will continue to help meet domestic vegetable demand.

Forecasting for Fruits

The fruit time series shows greater year-to-year variability

than the vegetable series but still displays a clear upward trend. Applying the same auto.arima function to fruit production and domestic supply historical data, ARIMA (0,1,0) with drift was selected, indicating a random walk with a constant increasing trend. Residual diagnostics using the Ljung-Box test confirmed adequate model fit for both models. Using the estimated ARIMA model, fruit production is projected to increase from 1,559,007 tonnes in 2024 to 1,860,846 tonnes by 2030, a 19.36% increase (Table 5). Domestic supply is projected to grow from 1,762,789 tonnes in 2024 to 1,977,526 tonnes by

Table 5: Forecasting Scenarios of Fruit in Nepal, 2024–2030

Year	Production (tonnes)	Domestic Supply (tonnes)	supply gap (tonnes)	Self-Sufficiency Ratio (%)	Import Bill (Million USD)
2024	1,559,007	1,762,789	203,782	88.4	110
2025	1,609,314	1,798,579	189,265	89.5	102.2
2026	1,659,620	1,834,368	174,748	90.5	94.4

2027	1,709,927	1,870,158	160,231	91.4	86.5
2028	1,760,233	1,905,947	145,714	92.4	78.7
2029	1,810,540	1,941,737	131,197	93.2	70.8
2030	1,860,846	1,977,526	116,680	94.1	63

Note: Forecasts were generated using an ARIMA (0,1,0) model with drift $Gap = Domestic\ Supply - Production$ (a positive value indicates a deficit) models. $Gap = Domestic\ Supply - Production$ (a positive value indicates a deficit). The import bill was estimated by multiplying the projected deficit (gap) and the average fruit import price over the last 5 years (2019–2023) of USD 540 per tonne. Source: Authors' computation based on MoALD, Nepal (2004/05-2023/24), and FAOSTAT data (2004-2023)

2030, a 12.18% increase. The supply gap is projected to narrow from around 218,000 tonnes in 2024 to 116,680 tonnes by 2030, and the self-sufficiency ratio is projected to improve from 88.4% in 2024 to 94.1% by 2030, a 7.49% increase. This shows that Nepal could achieve near-full fruit self-sufficiency by 2030 if current trends continue.

Required Yield Acceleration

The forecast results indicate that future self-sufficiency of fruits and vegetables in Nepal will depend on yield improvements. The required yield analysis estimated the yield levels needed to maintain current self-sufficiency ratios (SSR) by 2030. The analysis assumes that the harvested area remains at the 2023 level, isolating the contribution of yield improvements from land expansion effects.

Vegetable Sector

The vegetable sector has a relatively stable self-sufficiency outlook, but maintaining the current level of self-reliance will require accelerated yield growth. Historical analysis shows that vegetable yields increased at an average annual rate of about 1.21% from 2004 to 2023. To maintain the current self-sufficiency ratio of around 91.4 % by 2030, projected domestic supply requirements indicate that yields must increase from 14.24 tonnes/ha in 2023 to 17.2 tonnes/ha. This corresponds to a required annual

yield growth rate of about 2.7%, more than double the historical rate of 1.21%. These results indicate that future growth in vegetable supply cannot rely only on expanding cultivated area and will increasingly depend on yield improvements. Therefore, policies should prioritize yield-enhancing interventions, including improved seed varieties, extension services, irrigation efficiency, adoption of advanced production technologies etc.

Fruit Sector

The fruit sector shows a more favorable self-sufficiency trend under the forecast scenario. Historical fruit yield growth averaged approximately 0.42% per year from 2004 to 2023, with current yield at 10.83 tonnes/ha. The analysis indicates that maintaining the current level of self-sufficiency would not require further yield acceleration. Under the projected production and consumption scenario, maintaining the current fruit self-sufficiency ratio of 88.4 requires a yield of approximately 9.3 tonnes/ha. The estimated yield growth requirement is -2.1% per year, indicating that the current rate of production growth is sufficient to maintain the current level of self-sufficiency (94.1%) and that there is no need to further increase yield. Achieving full fruit self-sufficiency (100%) by 2030 requires a yield of approximately 10.9 tonnes/ha. Continued improvements in orchard management, irrigation efficiency, high-quality planting materials, and post-harvest systems remain important to sustain

Table 6: Population and Per Capita Consumption Projections of Vegetable and Fruit (2024–2030)

Year	Population (thousands)	Per Capita Vegetable Supply (kg/year)	Per Capita Fruit Supply (kg/year)	Total Vegetable Consumption (tonnes)	Total Fruit Consumption (tonnes)
2024	29,651	159.6	62.2	4,731,215	1,845,594
2025	29,618	163.6	63.2	4,845,836	1,870,957
2026	29,629	167.7	64.1	4,967,618	1,899,098
2027	29,727	171.7	65.0	5,104,343	1,932,884
2028	29,948	175.8	65.9	5,263,408	1,974,937
2029	30,232	179.8	66.9	5,435,782	2,021,684
2030	30,510	183.8	67.8	5,609,245	2,068,511

Source: Authors' computation based on FAOSTAT data (2004-2023)

productivity growth and reduce import dependence.

Population and Per Capita Consumption Projections

Per capita fruit and vegetable supply trends from 2004

to 2023 were extended to 2030 using linear regression. The estimated slopes from 2004 to 2023 were +4.05 kg/person/year for vegetables ($R^2 = 0.98$) and +0.93 kg/person/year for fruits ($R^2 = 0.85$). For vegetables, $R^2 =$

0.98 indicates that the model explains 98% of the pattern in the data; similarly, for fruit, $R^2 = 0.85$ indicates that the model explains 85% of the pattern in the data. The results of the population and per capita consumption projections are presented in Table 6.

Nepal's population is projected to grow from 29,651 thousand in 2024 to 30,510 thousand by 2030, a 2.9% increase over six years (FAO, 2026). Vegetable per capita

supply is projected to increase from 159.6 kg/year in 2024 to 183.8 kg/year by 2030, representing an increase of 15.16%. Total vegetable consumption is projected to reach 5,609,245 tonnes by 2030, driven by population growth and rising per capita consumption. Similarly, fruit per capita supply is projected to increase from 62.2 kg/year in 2024 to approximately 67.8 kg/year by 2030, an increase of approximately 9.0%. Total fruit consumption is projected

Table 7: Comparison of Vegetable Supply Projections Using the ARIMA and Per Capita Methods

Year	Forecast of Vegetable Supply (tonnes) using ARIMA	Forecast of Vegetable Supply (tonnes) using Per Capita Method	Difference (%)
2024	4,953,842	4,731,215	4.5%
2025	5,097,684	4,845,836	4.9%
2026	5,241,526	4,967,618	5.2%
2027	5,385,368	5,104,343	5.2%
2028	5,529,211	5,263,408	4.8%
2029	5,673,053	5,435,782	4.2%
2030	5,816,895	5,609,245	3.6%

Source: Authors' computation based on FAOSTAT and MoALD data (2004-2023)

to reach 2,068,511 tonnes by 2030.

As shown in Table 7, forecasts of vegetable supply using two projection approaches (ARIMA and Per Capita) produced closely aligned results, with small differences

ranging from 3.6% to 5.2% over the forecast period. These small differences reflect methodological variation between the two approaches. Both methods indicate a similar increasing trend in vegetable demand, providing a

Table 8: Comparison of Fruit Supply Projections Using the ARIMA and Per Capita Methods

Year	Forecast of fruit Supply (tonnes) using ARIMA	Forecast of fruit Supply (tonnes) using Per Capita Method	Difference (%)
2024	1,762,789	1,845,594	4.7
2025	1,798,579	1,870,957	4.0
2026	1,834,368	1,899,098	3.5
2027	1,870,158	1,932,884	3.4
2028	1,905,947	1,974,937	3.6
2029	1,941,737	2,021,684	4.1
2030	1,977,526	2,068,511	4.6

Source: Author's computation based on FAOSTAT and MoALD data (2004-2023)

sensitivity check for the projected demand trend.

As shown in Table 8, forecasts of fruit supply using two projection approaches (ARIMA and Per Capita) produced closely related results, with small differences ranging from 3.4% to 4.7% over the forecast period. These small differences reflect methodological variation

between the two approaches. Both methods indicate a similar increasing trend in fruit demand, providing a sensitivity check for the projected demand trend forecasted providing a sensitivity check for the projected demand trend.

Table 9: Comparison of Average Import Prices of Vegetables and Fruits with Global Benchmark Prices

Commodity	Average price (USD t ⁻¹)	Global benchmark (USD t ⁻¹)
Vegetables	343	500–800
Fruits	540	600–1200

Source: Authors' computation based on FAOSTAT data (2019–2023)

Import Prices: Evidence of Trade Distortion

Table 9 shows Nepal's average import prices for vegetables and fruits from 2019–2023. The average price

of vegetable imports is USD 343 per tonne (total value imported/total quantity imported), which is 30–50% below global benchmark prices (USD 500–800 per tonne)

(World Bank, 2023). Fruit import prices (USD 540 per tonne) are also far below global benchmarks (USD 600-1,200 per tonne) (World Bank, 2023). This large gap cannot be explained by quality differences or normal market variations. The most likely reasons are:

1. **Agricultural support and trade policies:** Differences in agricultural support measures and trade policies between India and Nepal may contribute to

differences in the prices and competitiveness of imported and domestically produced vegetables. However, the available data do not allow the specific effect of Indian subsidies on Nepalese import prices to be quantified (e.g., MEIS, duty drawback, etc.) that lower the price of its vegetable exports (Sharma *et al.*, 2017). These low import prices can undermine the competitiveness of domestic farmers by putting downward pressure on local

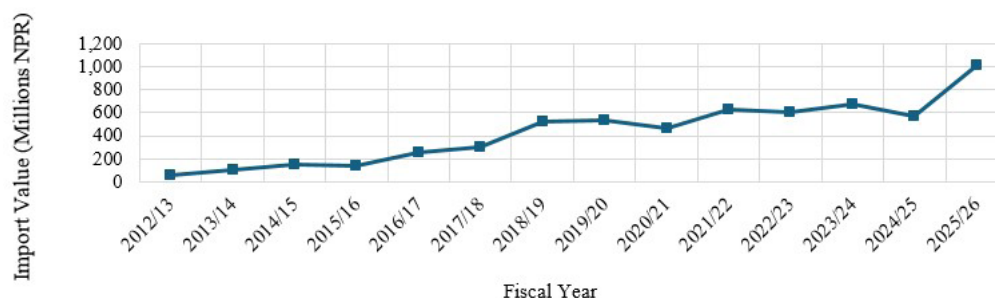


Figure 3: Trend in Tomato Import Value by Nepal (FY 2012/13 to 2025/26) (1USD = 151.09 Nepalese Rupee, September 05, 2026)

Source: Department of Customs, Nepal, annual reports (FY 2012/13–2025/26)

market prices and reducing incentives for commercial cultivation in Nepal.

2. **Informal cross border trade:** The open border allows large volumes of vegetables to enter Nepal without a formal customs declaration, evading tariffs and quality checks (Pohit & Taneja, 2004).

3. **Potentially relevant trade-pricing factors:** Some imported vegetables may be sold far below the cost of production to capture the market (Pohit & Taneja, 2004). These low prices further suppress local prices.

Tomato Subsector: A Case Study in Import and Export Situation

Tomato Import Value

The tomato subsector provides a clear illustration of the import situation across Nepal's broader vegetable sector, as it is one of the main vegetables imported and consumed.

Figure 3 shows that the value of fresh tomato imports rose from NPR 63.3 million in FY 2012/13 to NPR 1.01 billion in FY 2025/26, a 16-fold increase. The same

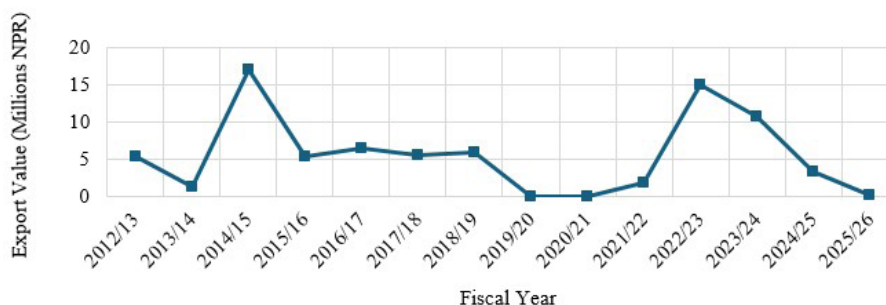


Figure 4: Trend of Tomato Export Value (NPR) from Nepal (FY 2012/13 to 2025/26) (1USD = 151.09 Nepalese Rupee, September 05, 2026)

Source: Department of Customs, Nepal, annual reports (FY 2012/13–2025/26).

trend is also present in Nepal's overall vegetable and fruit imports. This trend is neither fiscally sustainable nor consistent with Nepal's stated agricultural development goals under the Agriculture Development Strategy (ADS) 2015–2035. This growing dependence on fruit and vegetable imports indicates a widening trade imbalance in Nepal's agricultural sector (Nepal News, 2026). In response, Nepal's Sixteenth Periodic Plan aims to improve agricultural self-sufficiency by raising productivity (vegetable yield from 14.33 to 16.61 t/ha and fruit yield from 10.94 to 12.08 t/ha), while also reducing

imports and promoting exports between FY 2022/23 and 2028/29 (National Planning Commission, 2024).

Tomato Export Value

Figure 4 shows the trend in fresh tomato export value from FY 2012/13 to 2025/26. Export values remain relatively very low and highly variable compared to imports.

CONCLUSION

This study assessed Nepal's fruit and vegetable self-sufficiency prospects by forecasting through 2030 using

historical data from 2004 to 2023. Due to increasing trend of per capita consumption and population growth, demand is expected to increase, with vegetable and fruit consumption expected to reach approximately 5.61 and 2.07 million tonnes, respectively, by 2030. Vegetable production is projected to increase to about 5.32 million tonnes, maintaining a self-sufficiency ratio above 90%. Fruit production is projected to reach approximately 1.86 million tonnes by 2030, while the fruit self-sufficiency ratio is projected to increase from 88.4% in 2024 to 94.1% by 2030. These trends indicate potential for reduced import dependence if productivity continues to improve. However, the findings should be interpreted cautiously. Official trade data may not represent informal cross-border imports, while forecasts assume historical trends will continue and do not fully capture the impact of policy changes, technological shifts, changing consumer preferences, or climate-related risks. National-level analysis also masks regional, seasonal, and commodity-specific differences. Policy should prioritize improved seeds and planting materials, efficient irrigation, modern production technologies, extension services, and orchard management. Investment in cold storage, collection centers, grading, packaging, and transport is needed to reduce post-harvest losses. Stronger farmer cooperatives, contract farming, digital market information, processing, and value-chain linkages can improve commercialization. Climate-resilient varieties, water-efficient technologies, weather services, and crop insurance should also be promoted. Finally, production clusters, rural infrastructure, private investment, youth participation, and agribusiness development should be strengthened to support sustainable horticultural growth and reduce import dependence.

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Appendix

List of Abbreviations

ADF	Augmented Dickey–Fuller (Test)
ADS	Agricultural Development Strategy
AGDP	Agricultural Gross Domestic Product
AIC	Akaike Information Criterion
ARIMA	AutoRegressive Integrated Moving Average
CAGR	Compound Annual Growth Rate
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FY	Fiscal Year
GDP	Gross Domestic Product
MEIS	Merchandise Exports from India Scheme
MoALD	Ministry of Agriculture and Livestock Development
NARC	Nepal Agricultural Research Council
NPR	Nepalese Rupee
SAARC	South Asian Association for Regional Cooperation
SSR	Self-Sufficiency Ratio
USD	United States Dollar (1USD = 151.09 Nepalese Rupee, September 05, 2026)
WFP	World Food Program