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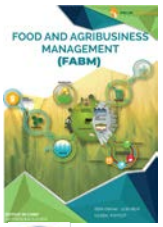

RESEARCH ARTICLE

PRODUCTION AND TRADE SCENARIO OF CITRUS FRUITS IN NEPAL

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ABSTRACT

Agriculture contributes about one-third to the Gross Domestic Product and is the major source of employment in Nepal. Citrus fruits being cultivated in about 60 districts of the country contributes 22.37 % to total fruit production and share 3 % of total fruit export by volume. Considering the contribution of citrus fruits to food and nutritional security, and improved living standard of farmers, Government has implemented various programs to improve this sector. However, no studies were carried out to evaluate the effectiveness of these programs. This study was conducted to analyze the trend of production and trade of citrus fruits in Nepal useful to evaluate the effectiveness of the implemented programs. Mann-Kendall test and Sen's slope method were used for study these trends. The result showed the increasing trend of area, productive area, and production of citrus fruits under study i.e. Mandarins, Sweet orange and lime and their decreasing productivity during the study period from 1999/2000 to 2017/18. Furthermore, their import, both value and quantity showed significant and increased trend whereas the export was negligible and insignificant during the period from 2009 to 2018. This concludes that the increased production of citrus fruits is insufficient to meet the demand of the country and Nepal is losing a huge amount for import of these fruits.

KEYWORDS

Mann-Kendal test, Sen's slope, Trend, Import, Export

1. INTRODUCTION

Citrus is a genus of flowering trees and shrubs belonging to subfamily Aurantioideae of Rutaceae family. Citrus plants are native to subtropical and tropical regions of Asia, Australia, Melanesia and Polynesia and believed to be originated from southeast Asia. It grows well in temperature range of 15-30 ºC with well distributed annual rainfall of 1250 to 1850 mm (FAO & MoAC, 2011). Well drained loams and sandy loams soil with p^H 6.0 to 6.5 is considered ideal for Citrus orchard establishment (DAF, 2013).

Agriculture sector which involves 60.4 % of the total population and contributes 27.1 % in GDP is the main foundation for economic prosperity of Nepal (15th 5-Year Plan, 2019). Fruits and spice crops contribute about 7.04 % to agricultural GDP and orange alone contribute 0.97 % to AGDP (Bhandari & Aryal, 2017). In Nepal, Citrus was being cultivated in mid hills regions from ancient times but now commercial citrus farming is being carried out in Terai region too. At present, citrus is being cultivated in about 60 districts of Nepal (Acharya, 2016). It is grown in an area of 46,328 ha with only 26,759 ha productive area which accounts total production of 2,39,773 Mt and the productivity is 8.96 Mt/ha (MoALD, 2017). Citrus Fruit contributes 22.37 % of total fruit production in Nepal. Horticultural crops including citrus fruits can contribute in food security, improve nutritional status and provide employment, increase income and increase overall GDP of the country (Bhandari & Aryal, 2017).

The export share of citrus fruits in Nepal is about 3 % by volume and its share on export by values are insignificant (Pandey, et al., 2017). A market survey conducted in Kalimati market revealed that the domestic lime contributes only 5.5 % of total demand and rest was imported from India. It suggested that there is huge market opportunity for increased production through commercialization and it would help import substitution (Dhakal & Tripathi, 2005). Bhandari and Aryal (2017) also stressed that the potentiality of fruit production in Nepal should be explored for import substitution and export promotion and also to raise living standard of farmers. Citrus fruit commercialization has led to economic upliftment of farmers and has increased export to decrease trade deficit. Citrus farming can be developed as a way to improve economy and nutrition of farmers and to reduce poverty (NCDP, 2017).

Considering the opportunity and benefit of commercialization of citrus farming in Nepal, the Government of Nepal established NCDP in 1972 to promote citrus commercialization. Commercial Agriculture Development program was launched from 1994/95 with particular focus on commercialization of citrus in mid-hills of Nepal. Also, Government of Nepal has taken policy initiatives to promote commercialization of citriculture through implementation of National Agriculture Policy 2004 and Agri-Business Promotion Policy 2007 (FAO & MoAC, 2011). Citrus has been recognized as main high value crop for mid-hills and is highly profitable crop than other crops in mid-hills of Nepal (FAO & MoAC, 2011). Fruit area expansion program is being implemented from F.Y. 2015/16 which has set the long-term goal to increase the area of citrus production from 39,035 ha (F.Y. 2014/15) to 94,554 ha, increase production from 2,22,894 Mt. (F.Y. 2014/15) to 5,93,877 Mt. and increase productivity from 8.82 Mt/ha (F.Y. 2015/16) to 10.22 by the end of F.Y. 2036/37. (Nepal Horticulture Promotion Centre, 2017).

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Fruit decade program is being implemented in Nepal from 2016/17 to 2026/27 to substitute fruit import and promote export of suitable fruit. The agroecological diversity of Nepal provides comparative advantages for producing citrus for import substitution and export promotion. Good temperature, sunlight, well distributed rainfall and fertile soil has favored the production of citrus with good quality and taste compared to neighbor country (Nepal Horticulture Promotion Centre, 2017; Acharya, 2016).

Though Nepal has better climatic and soil conditions to grow citrus compared to other south Asian countries, the productivity of citrus fruit in Nepal is subsequently decreasing (Kaini, 2019). APP recognized Citrus and Apple as high value commodity and many programs were implemented to develop and improve these sectors, however these programs have not been effective as expected (Nepal Horticulture Promotion Centre, 2017).

However, remoteness, poor access to transportation, storage facilities and processing are bottleneck for the development of citrus sub-sector. Furthermore, lack of experience of commercial citrus farming, limited knowledge of importance and marketability of citrus and low awareness about prospects of citrus commercialization has limited the scope for expansion of area under citrus cultivation. Commercial orchard establishment requires high initial investment and a basic technical knowledge. The resource poor farmers have weak risk bearing capacity and cannot invest huge amount for orchard establishment. So, farmers are mostly subjected to grow conventional food crops and follow their traditional farming techniques. Kaini (2019) also revealed that though Nepal has better climatic and soil conditions to grow citrus compared to other south Asian countries, the productivity of citrus fruit in Nepal is subsequently decreasing. Nepal Horticulture Promotion Centre (2017) concludes that though many programs were implemented to develop and improve citriculture, these programs have not been effective as expected. The growth pattern of citrus fruits over time needs to be assessed in order to determine if the plans and programs implemented for the development of this sector are effective. However, the studies on analysis of recent trends of production and trade of citrus fruits in Nepal is insufficient, which has led to ineffective planning and program development as well as their implementation. Thus, this study was conducted in order to determine the trend of various citrus fruits production and productivity as well as to assess the export and import trend of various citrus fruits in Nepal.

2. METHODOLOGY

2.1 Data and Data Types

Time series secondary data for area, production and productivity of citrus fruits in Nepal was collected from "Statistical Information on Nepalese Agriculture: Time series Information" published by Ministry of Agriculture and Livestock Development (MoALD) for 25 years period from 1993/94 to 2017/18. The data for selected major citrus fruits were collected from "Statistical Information on Nepalese Agriculture" published yearly by MoALD for 19 years period from 1999/2000 to 2017/18.

The export and import data of selected citrus fruits for 11 years period from 2009 to 2018 were collected from Trade and Export Promotion center, Ministry of Industry, Commerce and Supply, Nepal. The data consisted both the value and the quantity of export and import.

2.2 Data Analysis Technique

Trend means the general direction in which something is changing. Most naturally occurring timeseries in economics exhibits various kind of trends, cycles, and seasonal patterns. Many statistical approaches are available for detecting and estimating trends that may be present in time series data. In this study, Mann-Kendall test was used to detect the presence of monotonic trend in the time series data and Sen's slope method was used to quantify the trend as adopted by Poudel and Shaw (2016), Dhakal et al. (2016) and Tripathi, et al. (2014). Mann-Kendall test is a distribution free test to detect trend and is robust against outliers and also has higher power than other tests (Hess, Iyer, & Malm, 2001).

Mann- Kendall test is a non-parametric test initially developed by Mann (1945) and Kendall (1975), that is used to detect monotonic trend in time-series data. It analyses the sign of the difference between later measurement with earlier measurement in time series data. Each later measured value is compared to all values measured earlier which results total $\frac{n(n-1)}{2}$ possible pairs of data, n being the total observations. The null hypothesis (H_0) for this test is, "there is no monotonic trend in timeseries" and the alternative hypothesis (H_A) for this test is, "there is monotonic trend in timeseries" (Meals, Spooner, Dressing, & Harcum, 2011).

The Mann-Kendall Statistics was calculated as:

$$S = \sum_{i=1}^{n} \sum_{j=1+1}^{n} sign(x_i - x_j) \quad (1)$$

Where,

n = total observations, and x_i *and* x_j are sequential data values.

The function $sign(x_i - x_j)$ assumed the following values:

$$sign(x_i - x_j) = \begin{bmatrix} 1, if\ (x_i - x_j) > 0 \\ 0, if\ (x_i - x_j) = 0 \\ -1, if\ (x_i - x_j) < 0 \end{bmatrix} \quad (2)$$

For independent, normally distributed random variables with no tied data values, we have E(S) = 0 and the variance was calculated as:

$$Var(s) = \frac{n(n-1)(2n+5)}{18} \quad (3)$$

When some of the data values are tied, the variance was calculated as:

$$Var(s) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{t} t\,(t-1)(2t+5)\right] \quad (4)$$

Where, n is the length of time series and t is the extent of any given tie. The Z-statistics for the test, when n is larger than 10 was computed as:

$$Z = \begin{cases} \frac{s-1}{\sqrt{Var(s)}}, & if\ s > 0 \\ 0, & if\ s = 0 \\ \frac{s+1}{\sqrt{Var(s)}}, & if\ s < 0 \end{cases} \quad (5)$$

This computed Z-value was then compared to Z-value from standard Z-probability table at 5 % level of significance to accept or reject the hypothesis and conclude if monotonic trend occurred (Dinpashoh, Jhajharia, Fakheri-Fard, Singh, & Kahya, 2011). The trend was considered increasing if Z was positive and the decreasing trend was concluded if Z was found negative (Alhaji, Yusuf, Edet, Oche, & Agbo, 2018; Gajbhiye, Meshram, Mirabbasi, & Sharma, 2016).

In this study, the conclusion about if monotonic trend existed in the given timeseries data was made using the p-value obtained in Mann-Kendall test. If the p-value was less than the level of significance (α = 5 %) i.e. 0.05, null hypothesis was rejected, and it was concluded that there was monotonic trend in the timeseries data. Failure to reject the null hypothesis (p > 0.05) would conclude that there is no monotonic trend in the timeseries data.

The conclusion about how strongly the two variables were monotonically related was made based on Kendall's correlation coefficient, generally Known as Kendall's tau (τ). Correlation coefficient is the measure of quantifying and testing the strength of monotonic relationship between two variables. Kendall's tau (τ) is an effective and general non-parametric method of measuring correlation between two variables. It is rank based procedure and thus is resistant to extreme values or outliers and to deviations from linear relations. The Kendall's correlation coefficient takes values between -1 to +1. The sign of the coefficient indicates the sign of the slope of relation i.e. increasing or decreasing trend and the absolute value indicates the strength of the relationship (Hirsch & Helsel, 1993). The Kendall's correlation coefficient is given as:

$$\tau = \frac{2s}{n(n-1)} \quad (6)$$

Where,
s = Mann-Kendall Statistics calculated in equation (1) and,
n = length of time series.

If linear trend is present in timeseries data, the slope (rate of change per unit time) or magnitude of trend may be estimated by using the method of least square or simple linear regression. But the least square estimate of regression coefficient (i.e. slope) is vulnerable to gross errors and the confidence interval obtained are sensitive to non-normality of the parent distribution (Sen, 1968). Sen (1968) argued that median is least affected

by gross errors or outliers compared to weighted average and hence estimation of regression coefficient (i.e. slope) based on median will be more robust than slope obtained from method of least square.

So, in this study, the magnitude of the trend was computed by simple non-parametric method developed by Sen (1968) which is commonly called Sen's slope. The linear model assumed was:

$$Y = \alpha + \beta t \quad (7)$$

Where,
β = slope,
α = intercept,
Y = dependent variable and,
t = time i.e. independent variable.

Sen's estimate of slope is associated with Mann-Kendall test and was derived firstly by computing slopes of all data pairs as:

$$\beta_{ij} = \frac{y_j - y_i}{j - i} \quad (8)$$

$$1 \leq i \leq j \leq n$$

Where,

β_{ij} = all the slopes of lines connecting each pair of points (t_i, y_i) and (t_j, y_j) and $t_i \neq t_j$.

If there are n values in the series, we obtained exactly $N = \frac{n(n-1)}{2}$ slope estimates (β_{ij}). The N values of slopes are arranged in ascending order of magnitude and the median was calculated which is the Sen's estimator of the slope.

$$\beta = \begin{cases} \frac{1}{2}\left(\beta_{N/2} + \beta_{N/2+1}\right), & if\ N\ is\ even \\ \beta_{\frac{N+1}{2}}, & if\ N\ is\ odd \end{cases} \quad (9)$$

The intercept was computed according to Sen's method for each time step t as:

$$\alpha_t = Y_t - \beta t \quad (10)$$

And the corresponding value of intercept (α) is the median of all values of α_t (Sirois, 1998; as cited in, Alhaji, et al., 2018; Pohlert, 2020). The positive value of Sen's slope (β) indicates upward trend and the negative value represents downward trend. The regression line was plotted based on the Sen's slope and intercept to visualize the trend.

This method was used to analyze time series data for area, production, and productivity as well as export and import scenario of citrus fruits in Nepal and to detect the presence of linear trend. Microsoft Excel program and XLSTAT tool for Ms. Excel program developed by Addinsoft (2020) were used for data analysis and visualization of data.

3. Results and Discussion

3.1 Trend of Production

3.1.1 Citrus Fruits

The observation of original series showed the increased production during the period 1993/94 to 2010/11. The production then falls rapidly after 2010/11 and again started increasing towards the end of 2015/16. This has caused the decrease in productivity of citrus fruits from 2009/10 to 2015/16 and increase after 2015/16. In contrast, the area and productive area under citrus fruits was more or less increasing during this period (Figure **1**). The percentage increase in area, productive area, and production of citrus fruits in 2017/18 compared to 1993/94 was 227.9 %, 228.7 % and 220.6 % respectively whereas the productivity was found to have decreased by 2.9 % during this period. The highest production during the period was 2,63,710 Mt. in the year 2010/11 and the highest productivity during this period was 11.37 Mt./ha. in the year 2007/08. The average annual productivity of citrus fruits for 25 years period from 1993/94 to 2017/18 was 10.11 Mt./ha. The productivity was below this annual average in year from 1993/94 to 1997/98 and from 2011/12 to 2017/18.

It is evident from Table 1 that all parameters had increasing trend during the period of 1993/94 to 2017/18 as indicated by positive value of Tau (τ), but only the trend of area, productive area and production were statistically significant at 95 % confidence level as indicated by p-values. Sen's slope method quantified that the area of citrus fruits increased at the rate of 1332.63 ha. per year, productive area increased at the rate of 818.53 ha. per year and the production increased at the rate of 7412.05 Mt. per year during this period. Kendall's tau value showed that there was very strong correlation between Area and time, productive area and time and it showed strong correlation between production and time.

Table 1: Results of Mann-Kendall and Sen's Slope for Citrus Fruit Production in Nepal.

Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha(α)
Area (ha.)	<0.0001	0.987	1332.63	Increasing	Significant	0.05
Productive Area (ha.)	<0.0001	0.967	818.53	Increasing	Significant	0.05
Production (Mt.)	<0.0001	0.78	7412.05	Increasing	Significant	0.05
Productivity (Mt/ha)	0.6073	0.077	0.051	Increasing	Insignificant	0.05

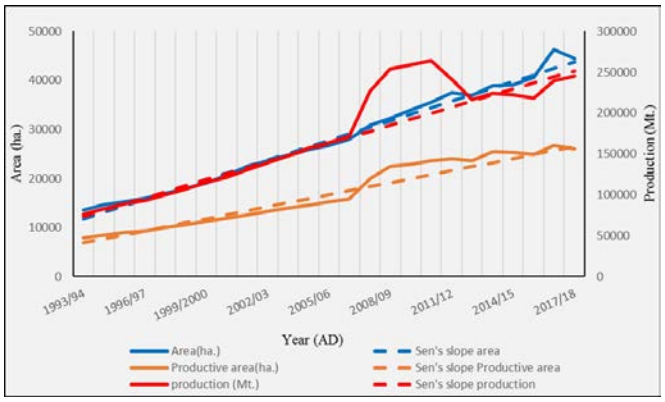

Figure 1: Production Trend of Citrus Fruits in Nepal

3.1.2 Mandarin Orange

While observing the original series, the production of mandarin orange was found increasing from 1999/2000 to 2010/11, but it started decreasing after 2010/11 up to 2015/16 and it again started increasing after 2015/16. This has led to the decrease in productivity during the period 2010/11 to 2015/16. Whereas, the area and productive area under mandarin orange was increasing more or less consistently during this period (Figure **2**). The percentage increase in area, productive area, and production of mandarin orange in 2017/18 compared to 1999/2000 was 144.5 %, 145.2 % and 127.9 % respectively but the productivity was found to have decreased by 7 % during this period. The highest production during this period was 1,79,494 Mt. in the year 2010/11and the highest productivity was 12.03 Mt./ha. in the same year. The average annual productivity of mandarin orange for 19 years period from 1999/2000 to 2017/18 was 10.71 Mt./ha. The productivity was below the annual average in the period 2012/13 to 2017/18.

The Mann-Kendall test showed that the area, productive area, and production had changed significantly during the study period ($p<0.05$). The positive value of Kendall's tau (τ) further illustrates that these parameters were increasing during this period. Sen's slope method quantified that the area increased at the rate of 1,010.15 ha. per year, productive area increased at the rate 639.35 ha. per year and the production increased at the rate of 5,518.83 Mt. per year during the period 1999/2000 to 2017/18 (Table 2). It is also evident from the table that the productivity of mandarin orange had decreased during this period, as indicated by negative tau (τ), at the rate 0.068 Mt./ha., as indicated by

Sen's slope but it was insignificant at 95 % confidence level, as indicated by the p-value. The absolute value of Kendall's tau (τ) showed that there was very strong correlation between area and time and productive area and time whereas the correlation between production and time was moderate.

Table 2: Results of Mann-Kendall and Sen's Slope for Mandarin Production in Nepal.

Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha(α)
Area (ha.)	<0.0001	0.935	1010.15	Increasing	Significant	0.05
Productive Area (ha.)	<0.0001	0.915	639.35	Increasing	Significant	0.05
Production (Mt.)	0.0006	0.575	5518.83	Increasing	Significant	0.05
Productivity (Mt/ha)	0.506	-0.117	-0.068	Decreasing	Insignificant	0.05

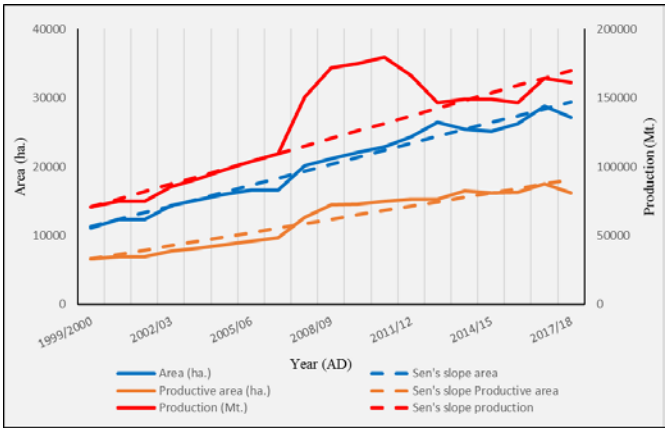

Figure 2: Production Trend of Mandarin Orange in Nepal

3.1.3 Sweet Orange

The production of sweet orange was consistently increasing from 1999/2000 to 2010/11 but it rapidly decreased after 2010/11 and again started growing since 2015/16, as observed from the original series. It was also seen that the productive area under sweet orange followed same pattern as its production did i.e. it had increased up to 2010/11, after which it fell rapidly and again revived after 2015/16. Whereas the total area under sweet orange showed fluctuations, it was found increasing slowly during the period from 1999/2000 to 2005/06 after which it declined in year 2007/08 and it again started increasing from 2007/08 to 2011/12. The total area under sweet orange again started to drop from 2011/12 until 2014/15, after which it rose till 2016/17 and finally declined recently in year 2017/18 (Figure 3). The percentage increase in area, productive area, and production of sweet orange in 2017/18 compared to 1999/2000 was 52.7 %, 67.2 % and 57.8% respectively whereas productivity has decreased by 5.6 % during this period. The highest production during this study period was 50,679 Mt. in the year 2010/11 and the highest productivity was 12.74 Mt./ha. in the year 2007/08. The average annual productivity of sweet orange for 19 years period from 1999/2000 to 2017/18 was 11.27 Mt./ha. The productivity was below the annual average after 2011/12.

As evident from the value of Tau (τ) and p-value from Mann-Kendall test; the area, productive area and production of sweet orange showed significant and increasing trend whereas the productivity of sweet orange showed decreasing but insignificant trend at 95 % confidence level. Sen's slope quantified that the area increased at the rate of 67.5 ha. per year; the productive area increased at the rate of 85.21 ha. per year and the production increased at the rate of 643.27 Mt. per year within the study period from 1999/2000 to 2017/18. However, the productivity of sweet orange had decreased at the rate of 0.063 Mt./ha. per year (Table 3). The correlation of area, production and productivity with time was relatively weak whereas there was moderate correlation between productive area and time, as showed by the absolute value of Kendall's tau (τ).

Table 3: Results of Mann-Kendall and Sen's Slope for Sweet orange Production in Nepal.

Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha(α)
Area (ha.)	0.024	0.382	67.5	Increasing	Significant	0.05
Productive Area (ha.)	0.0003	0.61	85.21	Increasing	Significant	0.05
Production (Mt.)	0.019	0.399	643.27	Increasing	Significant	0.05
Productivity (Mt/ha)	0.505	-0.117	-0.063	Decreasing	Insignificant	0.05

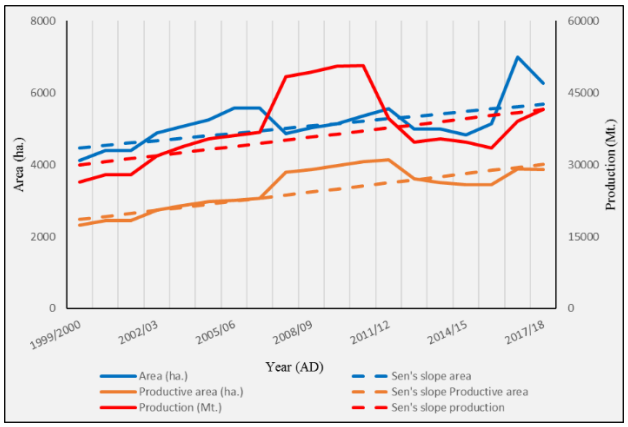

Figure 3: Production Trend of Sweet Orange in Nepal

3.1.4 Lime

The observation of original series revealed that the area under lime was consistently increasing from 1999/2000 to 2017/18. The productive area under lime was also increasing during this period, except in year 2007/08 and 2015/16 when it had decreased slightly. Similarly, production of lime was increasing during the period, except in year 2007/08 and 2012/13, when the production had decreased (Figure 4). The original series also showed that the area, productive area, and production of lime had increased by 193 %, 147 % and 120 % respectively in year 2017/18 compared to 1999/2000. However, the productivity had decreased by 10.8 % in year 2017/18 compared to 1999/2000. The highest production during this period was 31,003 Mt. in the year 2017/18 and the highest productivity was 8.5 Mt./ha. in the year 2009/10. The average annual productivity of lime during this 19-year period was 7.67 Mt./ha. The productivity was below this annual average in year between 1999/2000 to 2001/2002 and 2012/13 to 2017/18.

The result of Mann-Kendall test and Sen's slope for variation of area, productive area, production and productivity is shown in Table 4, which revealed that the trend of area, productive area and production was increasing as indicated by positive tau (τ) and statistically significant at 95 % confidence level as indicated by p-values. However, the productivity was decreasing as indicated by negative tau (τ), but statistically insignificant at 95 % confidence level as indicated by p-value. The table also showed that the area was increasing at the rate of 283.69 ha. per year, productive area was increasing at the rate of 129 ha. per year and the production was increasing at the rate of 841 Mt. per year, whereas the productivity was decreasing at the rate of 0.049 Mt./ha. per year during the 19 years period from 1999/2000 to 2017/18. There was very strong correlation of area, productive area and production with time as indicated by the value of Kendall's Tau(τ).

Table 4: Results of Mann-Kendall and Sen's Slope for Lime Production in Nepal.						
Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha(α)
Area (ha.)	<0.0001	0.912	283.69	Increasing	Significant	0.05
Productive Area (ha.)	<0.0001	0.915	129	Increasing	Significant	0.05
Production (Mt.)	<0.0001	0.88	841	Increasing	Significant	0.05
Productivity (Mt/ha)	0.248	-0.199	-0.049	Decreasing	Insignificant	0.05

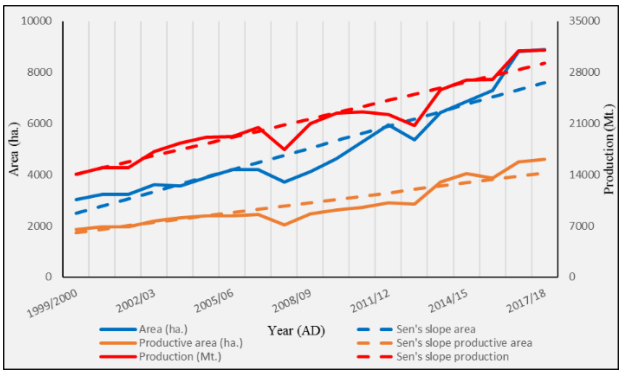

Figure 4: Production Trend of Lime in Nepal

3.2 Trade Trend

3.2.1 Citrus Fruits

Mann-Kendall test and Sen's slope in
Shows that all the parameters i.e. import value, import quantity, export value and export quantity of citrus fruits had an increasing trend in Nepal for the 10 years period from 2009 to 2018. However, only the increasing trend of import value and import quantity were statistically significant at 95 % confidence level. Sen's slope method further quantified that the import value of citrus fruits increased at the rate of $ 1,654,306 per year and the quantity of import increased at the rate of 3,655,613.5 Kgs per year.

It also showed that the export value and export quantity were increasing at the rate of $ 1,520.14 per year and 15,480.71 Kgs per year though insignificant at 95 % confidence level. The tau (τ) value further illustrated that there was perfect correlation between import value (USD) and time and the correlation of import quantity (Kgs.) with time was also very strong.

The observation of original series revealed that the value of import was rising consistently during the 10-years study period from 2009 to 2018 whereas the quantity of import showed consistent rise from 2009 to 2017 and the import quantity rose sharply in year 2018 (Figure **5**). However, the export of citrus fruits, both quantity exported and value of export, were fluctuating during the study period (Figure **6**).

It further revealed that the quantity imported (Kgs.) had increased by 5086 %, value of import (USD) had increased by 2978 %, quantity exported (Kgs.) increased by 89% and the value of export (USD) had decreased by 3 % in 2018 compared to 2009.

Table 5: Results of Mann-Kendall and Sen's Slope for Import/Export of Citrus Fruits in Nepal.						
Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha (α)
Import Value (USD)	<0.0001	1	1654306	Increasing	Significant	0.05
Import Quantity (Kgs.)	0.00035	0.911	3655613.5	Increasing	Significant	0.05
Export Value (USD)	0.72	0.111	1520.14	Increasing	Insignificant	0.05
Export Quantity (Kgs.)	0.59	0.156	15480.71	Increasing	Insignificant	0.05

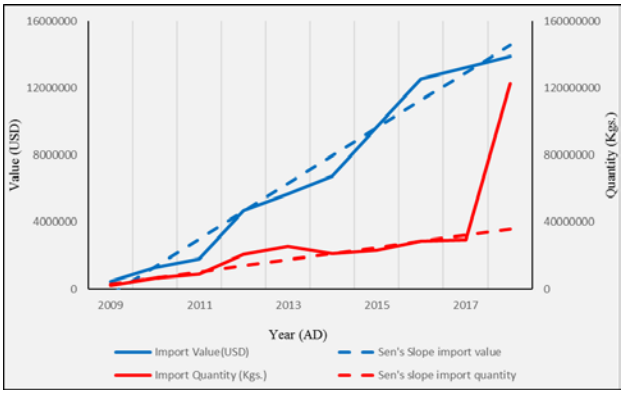

Figure 5: Import Trend of Citrus Fruits in Nepal.

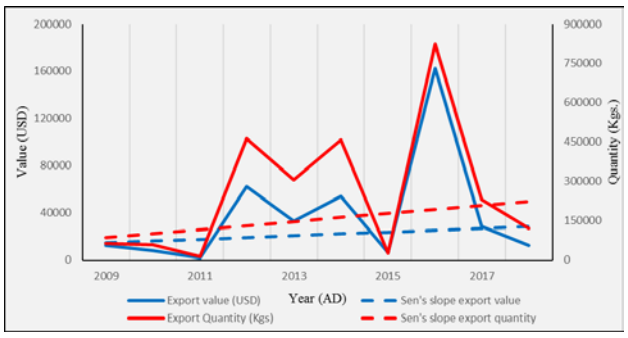

Figure 6: Export trend of Citrus Fruits in Nepal

3.2.2 Oranges

The result of Mann-Kendall test and Sen's slope for variation of import value, import quantity, export value and export quantity is shown in which shows that the trend of both import value and import quantity was increasing as indicated by the positive tau (τ) and was also statistically significant at 95 % confidence level. However, both the export value and export quantity had decreasing trend as indicated by negative tau (τ) but only the trend of export quantity was statistically significant at 95 % confidence interval. Sen's slope method quantified that the import value (USD) was increasing at the rate $ 946,719 per year and the import quantity was increasing at the rate 2339511.75 Kgs. per year. Whereas the export value and export quantity were decreasing at the rate of $ 462 per year and 5,726.5 Kgs. per year respectively. The tau (τ) value illustrated that there was very strong correlation of import value and import quantity with time and the correlation of export quantity with time was moderate.

The original series showed that the import quantity (Kgs.) of oranges had rose steadily during the 10 years period from 2009 to 2018 while the import value (USD) showed consistent rise from 2009 to 2017 and it showed sharp decline in 2018 (Figure **7**). However, the export of oranges, both quantity exported and value of export, showed fluctuation with decreasing trend (Figure **8**). It further showed that the quantity imported (Kgs.) had increased by 1975 % and the value of import (USD) had increased by 3232 % whereas quantity exported (Kgs.) had decreased by 98 % and the value of export (USD) had decreased by 95 % in 2018 compared to 2009.

Table 6: Results of Mann-Kendall and Sen's Slope for Import/Export of Oranges in Nepal.						
Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha (α)
Import Value (USD)	0.0003	0.911	946719	Increasing	Significant	0.05
Import Quantity (Kgs.)	0.00017	0.956	2339511.75	Increasing	Significant	0.05
Export Value (USD)	0.28	-0.289	-462	Decreasing	Insignificant	0.05
Export Quantity (Kgs.)	0.015	-0.629	-5726.5	Decreasing	Significant	0.05

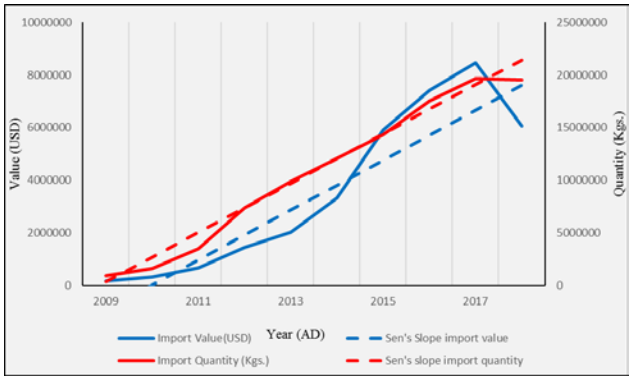

Figure 7: Import Trend of Oranges in Nepal.

3.2.3 Lime

The Mann-Kendall test showed that the import value and import quantity of lime had changed significantly over time. The import value had increased by $ 392,525.2 every year and the quantity of lime imported increased by 751,202 Kgs. every year. However, the value of export was decreasing, as indicated by negative tau (τ) but statistically insignificant at 95 % confidence level, as indicated by p-value. Furthermore, the quantity of lime exported did not show any trend at 95 % confidence level, as indicated by Sen's slope of zero. The tau (τ) value revealed that there was very strong correlation between import value (USD) and time, and also between import quantity (Kgs.) and time (Table 7).

The observation of original series revealed that the import value (USD) and import quantity (Kgs.) had increased by 6198 % and 2193 % in 2018 compared to 2009. It also showed that the value and quantity of import of lime increased steadily from 2009 to 2015, after which the decreased up to 2017 and again increased sharply in 2018 (Figure 9). However, the export of lime, both quantity and value showed marked fluctuation during the period from 2009 to 2018 (Figure 10).

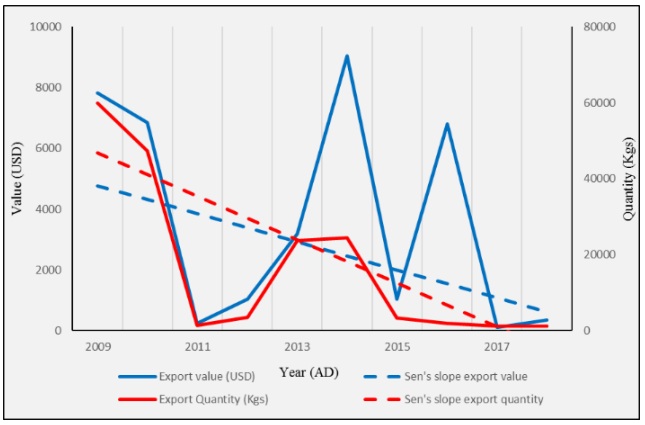

Figure 8: Export trend of Oranges in Nepal

Table 7: Results of Mann-Kendall and Sen's Slope for Import/Export of Lime in Nepal.						
Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha (α)
Import Value (USD)	0.00035	0.911	392525.2	Increasing	Significant	0.05
Import Quantity (Kgs.)	0.00068	0.867	751202	Increasing	Significant	0.05
Export Value (USD)	0.78	-0.09	-87	Decreasing	Insignificant	0.05
Export Quantity (Kgs.)	1	0	0	No	-	0.05

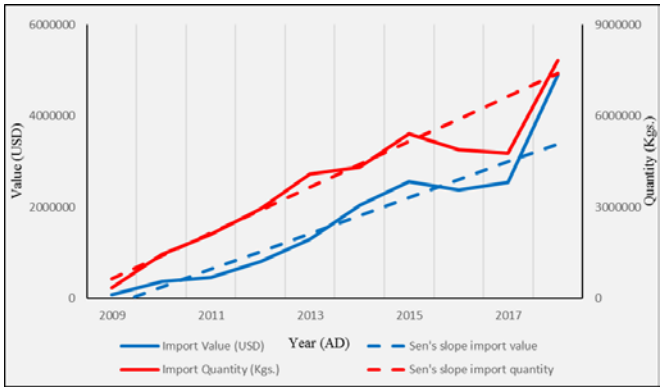

Figure 9: Import Trend of Lime in Nepal.

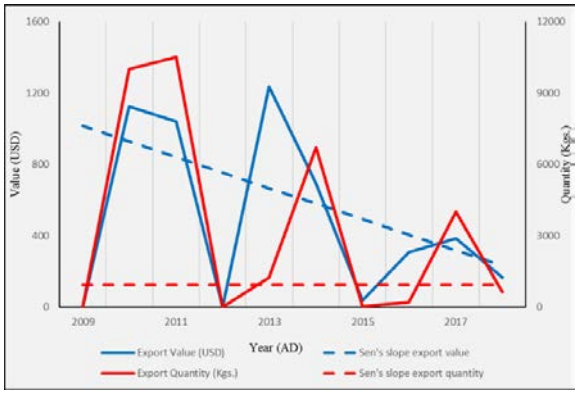

Figure 10: Export Trend of Lime in Nepal

Table 8: Results of Mann-Kendall and Sen's Slope for Import/Export of Mandarin in Nepal.						
Parameter	p-Value	Tau(τ)	Sen's Slope	Trend	Significance	Alpha (α)
Import Value (USD)	0.24	0.315	189	Increasing	Insignificant	0.05
Import Quantity (Kgs.)	0.28	0.289	236	Increasing	Insignificant	0.05
Export Value (USD)	-	-	-	-	-	-
Export Quantity (Kgs.)	-	-	-	-	-	-

- = *Data not available.*

3.2.4 Mandarins

As evident from the values of Mann-Kendall's tau (τ) and p-values, the time series data for import value (USD) and import quantity (Kgs.) of mandarin, both showed positive but insignificant trend at 95 % confidence level. Sen's slope quantified that the value of import had increased at the rate of $ 189 per year and the quantity of import had increased at the rate of 236 Kgs. per year (Table 8).

4. CONCLUSION

The area, productive area and production of total citrus fruits showed significantly increasing trend while its productivity showed increasing but insignificant trend over the past 25 years from 1993/94 to 2017/18.The area, productive area and production of citrus fruits had jumped by 227.9 %, 228.7 % and 220.6 % whereas the productivity had dropped by 2.9 % during this period. The average annual productivity of citrus fruits during the study period was 10.11 Mt./ha.

Similarly, the area, productive area and production of major citrus fruits under study i.e. Mandarin orange, Sweet orange and Lime, all showed significant and increasing trend whereas their productivity showed decreasing but insignificant trend over the past 19 years period from 1999/2000 to 2017/18. The area, productive area, and production had increased by 144.5 %, 145.2 % and 127.9 % respectively for Mandarin orange; 52.7 %, 67.2 % and 57.8 % respectively for Sweet orange; and 193 %, 147 % and 120 % respectively for Lime during this period. However, the productivity of Mandarin orange, Sweet orange and Lime had decreased by 7 %, 5.6 % and 10.8 % respectively. The average annual productivity was 10.71 Mt./ha. for Mandarin orange, 11.27 Mt./ha. for Sweet orange and 7.67 Mt./ha. for lime during the study period from 1999/2000 to 2017/18. This showed that the average annual productivity of sweet orange was highest compared to other citrus fruits which is coherent to the findings of Pandey, et al. (2017).

Furthermore, the import value (USD) and import quantity (Kgs) of total citrus fruits, both showed increasing and significant trend whereas export showed increasing and insignificant trend during the study period from 2009 to 2018. The quantity of import had jumped by 5,086 % and value of import had jumped by 2,978 % while the quantity exported had increased by 89 % but the value of export had decreased by 3 % during the study period.

Similarly, the import value and quantity of citrus fruits under study i.e. Oranges and Lime showed significantly increasing trend during the 10 years period from 2009 to 2018. However, the export value of both Orange and Lime and export quantity of orange showed decreasing and insignificant trend whereas the export quantity of lime showed no trend at all. Also, the information on the export of mandarin was unavailable which indicates that mandarin is not exported at all from Nepal.

The findings from this study showed that though the production of citrus fruits is increasing, this increased production is not sufficient to meet the demand of the country, which has led to the increase in the import. Furthermore, the export of major citrus fruits from Nepal is negligible. This indicates that Nepal is losing a huge amount of money for import of these fruits.

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