ANALYSING PRICE BEHAVIOUR AND FORECASTING OF ORANGE PRICES IN SOUTH AFRICA FROM 2001 TO 2021

BY

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ABSTRACT

The citrus sector in South Africa exports more than 60% of the citrus produced in the Southern Hemisphere, making it the leading citrus exporter in the region. After Spain, South Africa is the country that exports the most citrus. However, the increased trend in orange pricing over the past 20 years is a sign of a strong sector with room to expand as demand outstrips supply. The forecasting of agricultural commodity futures prices has a significant impact on the stability of the market economy and is essential to economic progress.

The study aimed to analyse price behaviour and forecasting of orange prices from 2001 to 2021. The objectives were to determine trends in the price behaviour of oranges in South Africa from 2001 to 2021 and forecast orange prices from 2022 to 2026. The study used secondary time series data from 2001 until 2021 of price measured in rands and yield in tonnes. The first objective was addressed by Ordinary Least Squares (OLS) and descriptive statistics and results revealed that there are upward and downward trends in price of oranges.

Objective two was to forecast future orange prices. Supplemental the study went on to determine the values of p, d, and q in addition using Dickey-Fuller Test to assess stationarity at first. The average price was found to be 275.81 in million rands, while the average yield was found to be 14839830 in tonnes. Moreover, ARIMA 512 was estimated to be fit for forecasting because it had the highest adjusted R squared value of 0.272978 than other identified models. Therefore, the study recommends that farmers work with agricultural advisors to make fruitful decisions and farmers also need to understand and learn models of forecasting to be aware of future prices of goods and services. The state should also make sure there is flow of information in the agricultural sector.

Keywords: Orange, price trends, Yield, ARIMA, Forecasting

DECLARATION

I, Mashita Mosima Marvel declare that this research project titled “ANALYSING PRICE BEHAVIOUR AND FORECASTING OF ORANGE PRICES IN SOUTH AFRICA FROM 2001 TO 2021” submitted to the University of Limpopo in partial fulfilments for the requirement of the degree of Master of Science in Agricultural Economics, is my work. It has never been submitted before by anyone else at the University of Limpopo or any other higher institution. Citations and references have been done to acknowledge the authors from which the information was collected.

Student: Ms Mashita MM Date: 14 November 2023

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My sincere gratitude goes to everyone who made contributions towards my project, and I say, may the good Lord bless you all with everything that your heart desires.

DEDICATION

To my late beloved, mother (Makwena Bedphina Mashita)

To my father (Maphuthi Alfred Mashita)

To my beloved twin sister (Rasenaka Majory Mashita)

And everyone close to me

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ADF Augmented Dickey-Fuller

ACF) Autocorrelation Function

AIC Akaike information criterion

AR Auto Regressive model

ARIMA Autoregressive Integrated Moving Average

Eviews Econometric views

DAFF Department of Agriculture, Forestry and Fisheries

DF Dickey Fuller

FAO Food and Agriculture organisation

FPE Final prediction error

HQ Hannan-Quinn information criterion

MA Moving Average

OLS Ordinary Least Square

P Price

PACF Partial Autocorrelation Functions

SC Schwarz information criterion

SA South Africa

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Orange is one of the popular citrus fruits with high economic value (Sharifi *et al*., 2007). Fruit cultivation encompasses a broad range of fruits in South Africa, from table grapes and dragon fruit to oranges and apples. South Africa is one of the world's leading fruit-producing nations and a place of amazing fruit. One of the most popular tropical fruits in the world is the orange. Oranges come in a variety of varieties, from sweet to bitter, and they all grow on trees in the citrus family of crops. According to Mustafa (2020), orange is a spherical, orange-coloured fruit that is sour. Moreover, orange is a food high in vitamin C since it is one of the main sources of this vitamin and consuming one orange every day can help the body make up for its lack of vitamin C.

Orange production is one of the biggest job creators in the farming sector. The most common citrus variety in South Africa is by far orange. Roughly 60% of all citrus exports from South Africa are made up of it. The largest division of this, Valencia, produces and exports more navel oranges than any other variety of orange, by a factor of more than two (Glenneis, 2018).

Bulagi *et al.* (2016) stated that the agricultural sector in South Africa is dualistic: a sizable number of small farms coexist with a developed commercial farming sector. About one-third of the country's agricultural output is exported, which indicates that the sector is becoming more export-oriented. Even though reforms of agricultural policies have also been started, significant macroeconomic and social reforms carried out from the middle of the 20th century until the present have moulded changes in South African agricultural policy during the past ten years. Furthermore, In 2022–2023, orange exports from South Africa are anticipated to increase by 3% and reach a record high of 1.4 MMT. Over half of South Africa's total citrus exports are oranges. Although the nation sends oranges to more than 100 nations, the European Union continues to be its top destination for exports, receiving over 40% of all orange exports. After expanding by approximately 40% in 2021–2022, China is currently the second-largest orange market in South Africa (South African Citrus,2022).

McCausland (2022) stated that the soaring price of citrus may soon put American`s love of oranges and orange juice to the test. Florida growers and the U.S. Department of Agriculture issued warnings about a very poor crop yield this year brought on by unfavourable weather and an orange disease. Farmers in Florida are facing a difficult position. Demand for orange juice increased over the last two years after plummeting for more than ten years. The expected orange supply for processing is, however, at or very near a record low.

Trostle *et al*. (2011) reported that the price rise of 2007–2008 is still fresh in the minds of food consumers, livestock farmers, agribusinesses, and the government, rising food prices have attracted a lot of media attention and caused many concerns. The Agricultural and Agriculture Organization of the United Nations (FAO) raised awareness of the rise in food commodity prices at the beginning of January 2011. According to the FAO, the food commodity price index for December 2010 increased more than it did for the previous record established in 2008 and history demonstrates that when price spike peaks, markets correct, and prices decline. However, consumers in low-income, food-importing nations are especially susceptible to rising food prices. Concerns are being raised for nations with limited foreign exchange reserves to import food due to the drop in global stocks and food commodities and the accompanying increase in costs.

Thukwana (2021) stated that, Dr. Johnny van der Merwe, managing director of the organization Agrimark Trends (AMT), which provides agricultural information. In his weekly video tracking the market prices for fresh fruit and vegetables, Van Der Merwe stated that "in the citrus market, the latest orange prices declined to R3.08 per kilogram when volumes sold to local markets climbed by 13% week on week."

1.2 Problem statement

The citrus industry in South Africa has shown a massive potential in agriculture for wealth creation. The study conducted by Chisoro-Dube and Roberts (2021) reported that the citrus industry continued to grow because of the citric acid found in oranges that provide human beings with vitamin C. In 2004/2005 was declining and good climatic conditions and orchard expansion contributed to a steady increase in orange production since 2009 and declined by 22 percent in 2016 when paralleled with 2015.

In 2017 orange production was 1.4 million tons and increased to 1.7 million tons in 2018 (Department of Agriculture, Forestry and Fisheries, 2019).

Furthermore, output declined by nearly 10.2 percent in 2009/2010, but was quickly followed by an increase to close to 1.81 million metric tons, the highest level in the time under consideration. Orange production fell by 24.4 percent between 2014 and 2017. According to Van der Walt (2020), South Africa encountered COVID-19 in 2020, which resulted in increased demand for oranges and a price increase. Because price is determined by supply and demand, the study's goal is to examine how prices have been behaving and to estimate the price of oranges in South Africa. The study conducted by Citrus Fruit Farming (2020) conquers with Van der Walt (2020), that oranges are expected to be the biggest winner in 2020, even though producers have found lemons and soft citrus to be profitable in recent years and will continue to do so. Oranges are viewed as a fantastic source of vitamin C, which is thought to strengthen the immune system, which is one of the key factors driving the growing demand, especially in the US.

1.3 Rationale of the study

The study of analysing price behaviour and forecasting of oranges prices in South Africa is rational because it has provinces which are larger producers of oranges. Provinces such as Limpopo, Mpumalanga and KwaZulu Natal their climate suitable for the cultivation of orange because are warmer and the farm sizes in these regions are larger (DAFF, 2019). More than 60 percent of orange trees are in Limpopo, 14 percent in Eastern Cape and 9 percent in the Western Cape (Glenneis, 2018). This makes it important to analyse price behaviour since the outcome will benefit producers and the economy. Price is one of the important elements in the market and supported by Kotler and Keller (2012), that price analysis helps farmers with decision-making to improve marketing designs and control. Forecasting of prices will help suppliers to make informed decisions about future prices of oranges. The study conducted by Veer *et al* (2020) mentioned that forecasting of price made farmers sell their produce immediately after harvesting and not store them and about half of the farmers who got this information benefited significantly unlike those who did not follow the information revealed by the study.

1.4 Scope of the study

1.4.1 Aim

The study aims to analyse price behaviour and further forecast orange`s future prices for the next five years (2022 to 2026) in South Africa.

1.4.2 Research objectives

To determine trends in price behaviour of oranges in South Africa from 2001 to 2021.

To forecast oranges prices from 2022 to 2026 in South Africa.

1.4.3 Hypotheses

There are no upward and downward trends in the price behaviour of oranges in South Africa.

Prices of oranges from 2022 to 2026 will not change in South Africa.

1.5 Structure of the study

The study going forth is structured into four chapters. Chapter 2 is based on the literature review, and consists of explanations of concepts, factors affecting orange price and reviews of studies conducted in South Africa and internationally. This chapter also reveals an overview of the citrus industry. Then, chapter 3 consists of the study area and analytical techniques. Chapter 4 focuses towards presenting and discussing the obtained results while chapter 5 focuses on recommendations drawn from the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides an overview of the literature on various ideas that are employed in this research. The assessment of prior research on pricing behaviour and price forecasting in South Africa and globally provides a thorough explanation of terminologies and approaches to time series.

2.2 Explanation of concepts

Forecasting is defined as using historical data as inputs, it is a process that produces accurate predictions of the future course of trends. Businesses use forecasting to decide how to spend their budgets and make plans for upcoming expenses. Typically, this is based on the anticipated demand for the offered goods and services. However, since the future is unpredictable and actual results can differ significantly, forecasts constantly need to be adjusted (Tuovila, 2022).

Alternative definitions of price behaviour include security analysis disciplines used to predict price direction by analyzing current price movement (Dhakre and Bhattacharya, 2014).

Skylar *et al* (2021), Price trends are described as an asset's price or the overall direction of a market. Technical analysis uses trendlines or price action to identify times when the market is creating higher swing highs and lower swing lows for an uptrend or lower swing highs and lower swing lows for a downtrend.

2.3 Overview of the citrus industry

Citrus is a crucial fruit category in South Africa's fruit sector. It is the primary fruit exported from South Africa, accounting for 45 percent of all fruit export revenues and 32 percent of the country's total fruit production. The first orange and lemon trees were planted in the Cape in 1654 by the Dutch East India Company, and the first fruit was harvested there in 1666, beginning South Africa's citrus sector. South Africa shipped its first citrus fruits to England, and Britain, in 1907, after two and a half centuries. The citrus industry is export-oriented and has more white commercial farmers and limited black participation (Chisoro-Dube, 2020).

The fact that small and medium-sized citrus growers have restricted access to local, regional, and global markets is one of the major difficulties they confront because of the citrus industry's export-oriented character. Furthermore, the local market`s low costs and restricted availability of technical and scientific information, for small and medium-sized producers, business management expertise and services make it challenging to the creation of profitable and effective businesses.

2.4 Factors affecting price trends.

The findings of the study conducted by Harahap *et al.*, (2019), indicate that income and preferences do not significantly affect customer demand for orange fruits in Pantai Buaya, whereas pricing has a limited influence on that desire. A percentage of 8,7 of the variation in demand for orange fruits comes from factors outside the scope of this study, including price, income, and flavour. Customers should be more interested in purchasing oranges with the proper pricing plan, so orange traders are suggested to assess the pricing. It is advised that future researchers include additional factors including promotion, distribution, and product/service quality, increase the number of samples used, and broaden their research areas so that findings may be generalized.

Prices are important factors in decisions relating to production and consumption, though they are by no means the only ones. Pricing levels and price variations have an impact on both producers and consumers. either volatility or variation. Policies about agriculture and food there have been several discussions about appropriate food product price levels and methods of bringing down price volatility to a level where it does not affect the signalling effects of various costs for business choices. Those legislative concerns centre on balancing the objectives of both producers and consumers in increasingly diverse civilizations both developed and emerging nations (Díaz-Bonilla and Ron, 2010)

According to Sharma and Kumar (2001), Costs are imposed on producers and consumers alike by price instability. Producers lose if a commodity's price drops below a given threshold since it might not be able to cover the true cost of producing the good. Low costs do, however, help customers because they allow them to purchase more of the same goods. On the other hand, if a commodity's price increases,

producers profit while consumers suffer since they have to modify their spending and budget in reaction to shifts in relative pricing. Changes in farm prices have macroeconomic implications in addition to these microeconomic ones. Although the government can attain self-sufficiency by offering farmers favourable pricing incentives, changes in agriculture prices have a knock-on effect on other areas of the economy. increasing the inflation rate overall. Serious issues can occasionally arise from a sharp spike in the price of agricultural goods, as was the case with wheat in 1996 and onions and other vegetables in 1998.

Furthermore, Large pricing fluctuations have detrimental effects. Firstly, they give room for speculators to profit from the situation, particularly when there are limits on the movement of goods and no place for outside commerce. Secondly, they result in the creation of bad policy decisions, which can be highly expensive. As a result, the government needs to find a way to combine protecting consumers through the Public Distribution System (PDS) and enabling producers to set fair prices to achieve self-sufficiency. The government must closely monitor the costs of a few basic goods, which account for a sizable amount of the ordinary consumer's budget, to meet these goals. As a result, it was thought that research into the price dynamics of a few key agricultural commodities was necessary. The goal of the current study is to analyse the price behaviour of groundnuts and two important grains, wheat and rice.

2.5 Review of studies on price trends and forecasting.

ARIMA model was recommended as one of the most common forecasting methods (Mulla *et al.*, 2020). Moreover, Sain *et al*., (2020) revealed that forecasting of price made farmers sell their produce immediately after harvesting and not store them and about half of the farmers who got this information benefited significantly unlike those who did not follow the information revealed by the study.

Sain *et al* (2020) went further stating that Forecasting Basmati rice for an average monthly price of the Taraori market for the Karnal district, the developed model for average prices for basmati rice in the Karnal district was found to be ARIMA (0, 1, 0) (1, 1, 2) respectively. The anticipated average price increases in the following years can be seen from the forecast variable utilizing the constructed model. When information for the lead periods is made accessible, the accuracy of the anticipated value can be verified. Researchers can forecast typical pricing in Karnal using the

methodology. However, it should occasionally be updated to include the most recent information.

Makridakis and Hibbon (1999) further reported price projections for the main Karnal district market and were found to be between 1567 and 1329 in the Karnal market for the arrival season in September to December 2017, 1652 to 1259 in the Gharunda market, 1637 to 1515 in the Assandh market, and 1701 to 1680 per quintal in the Taraori market. The subsequent months' projections, from January to August, ranged from about 2269 to 1615 in the Karnal market, from roughly 2215 to 1593 in the Gharunda market, from roughly 2314 to 1637 in the Assandh market, and from roughly 2304 to 1680 per quintal in the Taraori market. For this reason, farmers are advised to keep their produce and sell it during the months when the market is more favourable or offers a greater price.

Previous studies were conducted on descriptive statistics.

The main cultivated variety of orange is the Washington navel orange, and it is more popular because of its delicious taste, nutrition, and it`s seedless besides being rich in vitamin C.

Table 2. 1: Results of Descriptive statistics of orange and total citrus during (2007/2008-2019/2020) in Egypt.

Crop	Mean	Standard deviation	Minimum	Maximum	Growth rate (%)	% From orange growth	% From total citrus
Orange fruit area	272	34,1	213	313	2,9***	100	67,0
Production	2762	416	2055	3351	3,6***	100	69,6
Total citrus Fruit area	407	35,8	344	450	1,9***	_	100
Production	3966	492	3134	4647	2,9***	_	100

According to Table 1, orange fruit areas expanded from 213 to 313 thousand feddans with a substantial yearly growth rate of around 2.9 percent. These areas made up

approximately 67 percent of all citrus fruit areas. Orange fruit areas totalled approximately 272 thousand feddans. Furthermore, during the study period, orange production grew from 2.1 to 3.4 million tons, exhibiting a noteworthy yearly growth rate of around 3.6 percent. This amounts to approximately 69.6 percent of all citrus production in Egypt (Shawky *et al*., 2022).

Previous studies conducted internationally.

Price has the highest role in the decision-making process of buying one of the substitutes. Stagnation of supply and demand can be viewed during the period of harvesting and within the enlarging of supply and assortment of other fruits which have a direct influence on prices of apples and oranges during this period. Six years was analysed monthly (2003-2008). Apple prices presented larger intervals of variation in the analysed period. The average price, minimal and maximal price of oranges was higher than apple prices. Interpolated trend line as a second-degree polynomial for average yearly price shows similar accommodation (R^2=0.88 apples and R^2=0.85 oranges). Prices of both products are presenting explicit seasonal variations. Both products have the highest prices during the summer period when the supply and assortment of other fruits is higher, at the opposite during the winter period when there is no wideness of assortment of other fruits and their direct substitution is also conditioning their lower prices in this period (Food and Agriculture Organisation of the United States, 2012).

Price variation is an important component of profit that influences commodity investment behaviour, food security, and farm income and thus needs to be quantified, according to a study that was done to evaluate the seasonal nature of price movement of citrus fruits, namely lime and sweet orange, and to identify the temporal business opportunity in Nepal. Large-scale price swings harm farmers since they are unpredictable. In the hope of making a sizable profit, farmers are lured to a commodity when its price is abnormally high for an extended period. This leads to an oversupply and a subsequent price drop. The region covered by that commodity hence tends to increase (Nsumba, 2017) as cited by (Dahal, 2020).

Moniruzzaman et al. (2008) also showed that the price of raw jute varied seasonally, with a price above average during a lean production phase and a price below normal during a peak production period. Additionally, Sharma and Burark (2015)

demonstrated that the price of maize followed a seasonal trend, peaking during the production-off season and falling during harvest. Similar findings were published in 2016 by Meera and Sharma, who demonstrated that the price of wheat peaked during the off-season and fell during the harvest season.

The study of Maize flour price trends in rural districts and urban districts of Lesotho under COVID-19 also showed that prices of maize flour were stable after the harvest season in March 2019 (with notable relative fluctuations in the Mokhotlong district). However, the maize flour prices rose sharply in March – April 2020 from LSL5.86/ Kg and LSL5.75/Kg to LSL6.27/Kg and LSL6.13/Kg in Mokhotlong and Thaba-Tseka respectively. The rise in prices continued and the peak was recorded in July 2020 (LSL6.51/ Kg for both Mokhotlong and Thaba-Tseka).

The sharp rise in March – April 2020 and the continuous rise in maize flour may be attributed to the COVID-19 Pandemic because the declaration of a State of Emergency by the Government of South Africa in March 2020 imposed the closure of borders (Lesotho is a landlocked country surrounded by South Africa, from where 95% of her imports come and where 40% of her exports go to (Bureau of Statistics, 2018/2019)). The restriction in movement between Lesotho and South Africa may have affected the movement of maize between the countries to supplement Lesotho's requirement hence leading to a scarcity which contributed to the spike and continuous growth of the maize flour prices. With both Mokhotlong and Thaba-Tseka being further away from the urban districts and not easily accessible, the shortage of maize flour was much more felt hence the notable and significant price increases (Nhlengethwa *et al*,2020).

According to the findings, the price of onions in the Kurnool market increased during the study. For the study, 264.39 + 6.22*t was the calculated trend equation. In the Kurnool market, it was found that the annual increase in onion prices was less than 6.22 per quintal. Mulla *et al* (2019) revealed that the annual increase in prices of onion in the Bangalore market was ` 6.92 per quintal for the period from Jan-2003 to Dec-2017 and it was found to be statistically significant.

2.6 Summary

Previous research around the world has shown price trends and forecasting in several markets, particularly in onions, apples, and other commodities, but there is insufficient data on other commodities like oranges especially in South Africa. From the reviews it was revealed that this study was never conducted in South Africa hence, there is no literature review locally. This research was conducted to improve the citrus industry, particularly on oranges and fill up the gaps. Many studies show that weather conditions play a vital role in agricultural commodities.

CHAPTER 3: METHODOLOGY AND ANALYTICAL TECHNIQUES

3.1 Introduction

This chapter gives an overview of the research methods that were used to carry out the study, whereby attention is on the choice of the study area, data collection and analytical technique. Data was collected annually for yield and orange prices with 20 observations.

Additionally, it provides a summary of the study area, which includes all the provinces in the South African orange-producing regions. This chapter's methodology begins with a measurement of orange price trends and then introduces the concept of the forecasting model.

3.2 Study area

The study took place in South Africa (SA), located in the continent of Africa. South Africa is covering a total surface area of 1,219,090 km^2 with nine provinces. It enlarges along the Indian Ocean's South Atlantic on the north by the neighbouring countries Botswana, Zimbabwe, and Namibia, and on the east and northeast by Mozambique and Swaziland; it also encompasses the kingdom of Lesotho (FAO - AQUASTAT, 2005).

South African map

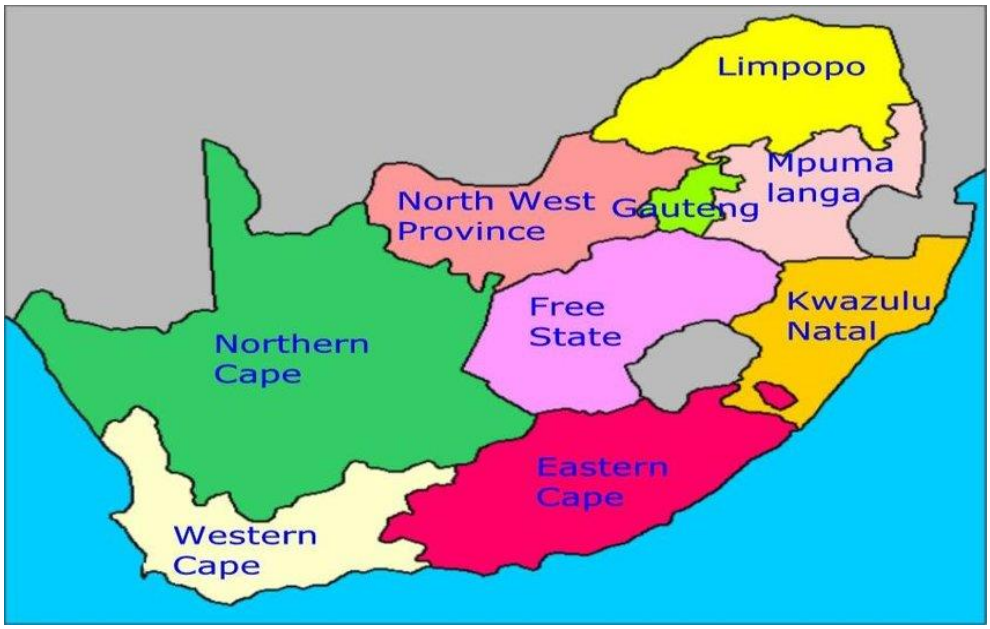


Figure 3. 1: South African map

Source: Christopher Nwafor (2017)

3.2.1 South Africa`s orange-growing regions.

South Africa has more than two provinces that produce oranges efficiently (Glenneis, 2018). It is anticipated by Citrus Industry (2022) that, the orange-planting area will continue to develop steadily, rising by 2 percent to 47,750 hectares in 2021–2022. Limpopo province with 48 percent leads the Eastern Cape (23 percent) and Western Cape (14 percent) provinces in terms of orange production.

3.3 Data collected and source of data.

Table 3. 1: Data collection and sources

Data collected (all in years)	**Source of the data**
Price	FAOSTAT
Yield	Statista

The study used time series data that was accessed from FAOSTAT, and Statista for 20 years. Data for all the variables price and yield are yearly from 2001 to 2021. Price

data was converted from USD to rands. The study further used the Eviews statistical tool.

3.4 Analytical technique

This section describes the analytical techniques used for this study. The first objective, which was to determine the trends in the price behaviour of oranges, adopted the descriptive statistics model and Ordinary least squares.

Unit root test

The Augmented Dickey-Fuller (1987) approach was used in the study to determine whether the variables were stationary. In cases where a variable was found to be non-stationary, differencing was employed iteratively until stationarity was obtained. These variables included yield and price of oranges. A variable was deemed integrated of order one, designated as I (1) if it only required one round of differencing. Below is a representation of the equations used in the Augmented Dickey-Fuller (1987) test.

$$\Delta P = \propto_0 + yP_{t-1} + \propto_2 t + \sum_{i=1}^{p} \delta_i \Delta P_{t-i} + u_t \quad (1)$$

$$\Delta Y = \propto_0 + yY_{t-1} + \propto_2 t + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + u_t \quad (2)$$

Wherein $\propto_0$ is a vector of determinist terms (constant, trend, etc.), $\propto_2$ is the coefficient on a time series trend, y is the coefficient of y_{t-1}, $+\Delta y_{t-1}$y are changes in the lagged values, y_{t-1} are lagged values of order one of y_t, P represents an order of lag order in autoregressive process, and $_{it}$ is the error term. y_t, is I (1) under the null hypothesis, implying that $\delta = 0$

3.5 Johansen's procedure for cointegration.

To ascertain whether there was cointegration between the variables, the study first loo

+ked at their order of integration. The Johansen test, a commonly used cointegration test, was used to achieve this. The Johansen test enables the detection of several cointegrating relationships as opposed to the Engle-Granger test, which concentrates on a single cointegrating relationship utilizing the Dickey-Fuller test for unit roots in the residuals (Davison, 2000).

3.6 ARIMA MODEL

The second objective which was to forecast orange prices in South Africa adopted the Auto Regression Integrated Moving Average (ARIMA) model. The study conducted by Mulla., *et al* (2020) recommended the ARIMA model as one of the most common forecasting methods.

$Y_t = a + bX_t + e_t$

Wherein,

Y_t = Trend value at a time t

X_t = period (Serial number assigned to the t_{enth} month)

e_t = Random disturbance term (assumption of zero mean and constant variance)

a = Intercept parameter

b = Slope parameter

Forecasting of orange future prices from 2022 to 2026 in South Africa adopted the ARIMA model which consists of four steps such as identification, estimating the parameters, diagnostic checking, and forecasting.

Identification……. (1)

This step is all about finding the appropriate values of p, d and q

Estimation…….. (2)

Having identified the appropriate p and q values, the next step is to estimate the parameters of the autoregressive and moving average terms included in the model.

Diagnostic checking……. (3)

Having chosen the ARIMA model and estimated the parameters, the next step is to check the goodness of fit.

Forecasting …… (4)

$Y_t = \theta_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{p-1} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \ldots - \theta e_{t-q}$

Box Jenkins is an essential forecasting method that can yield more accurate forecasts than other time series algorithms for certain kinds of data. Model identification was

once a difficult, time-consuming, and highly subjective process (Box and Jenkins, 1976).

3.7 Summary

In this chapter unit root was adopted to test stationarity of the variables. The correct procedure to adopt ARIMA was followed, and analytical techniques adopted by the study are recommended fit for the study.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

In Chapter 4, the results of the analysis of price behaviour and the focus on orange prices in South Africa are presented. The study used data that was extracted from FAOSTAT and Statista. Therefore, this chapter begins by examining the descriptive statistics of price and yield between 2001 and 2021, followed by a graph which shows price trends over the years. The study further adopted the Augmented Dickey-Fuller test to check stationarity or unit root. ARIMA model was also used to address the second objective of forecasting.

4.2 Descriptive statistics for price and yield for oranges between 2001 and 2021

Table 4.1 displays the mean and standard deviation for each variable for orange price and yield from 2001 to 2021.

Table 4. 1: **Measure to evaluate price trends.**

Variables	**Standard deviation**	**Mean**
Price	83.93298	275.81
Yield	201942.9	1483980

Using a single value that reflects the middle of the data, the mean may be used to explain the sample. The mean is a common measurement of the centre of the data distribution and is used in many statistical analyses. Therefore, in this case, 275.81 is the average price while 1483980 is the average yield produced.

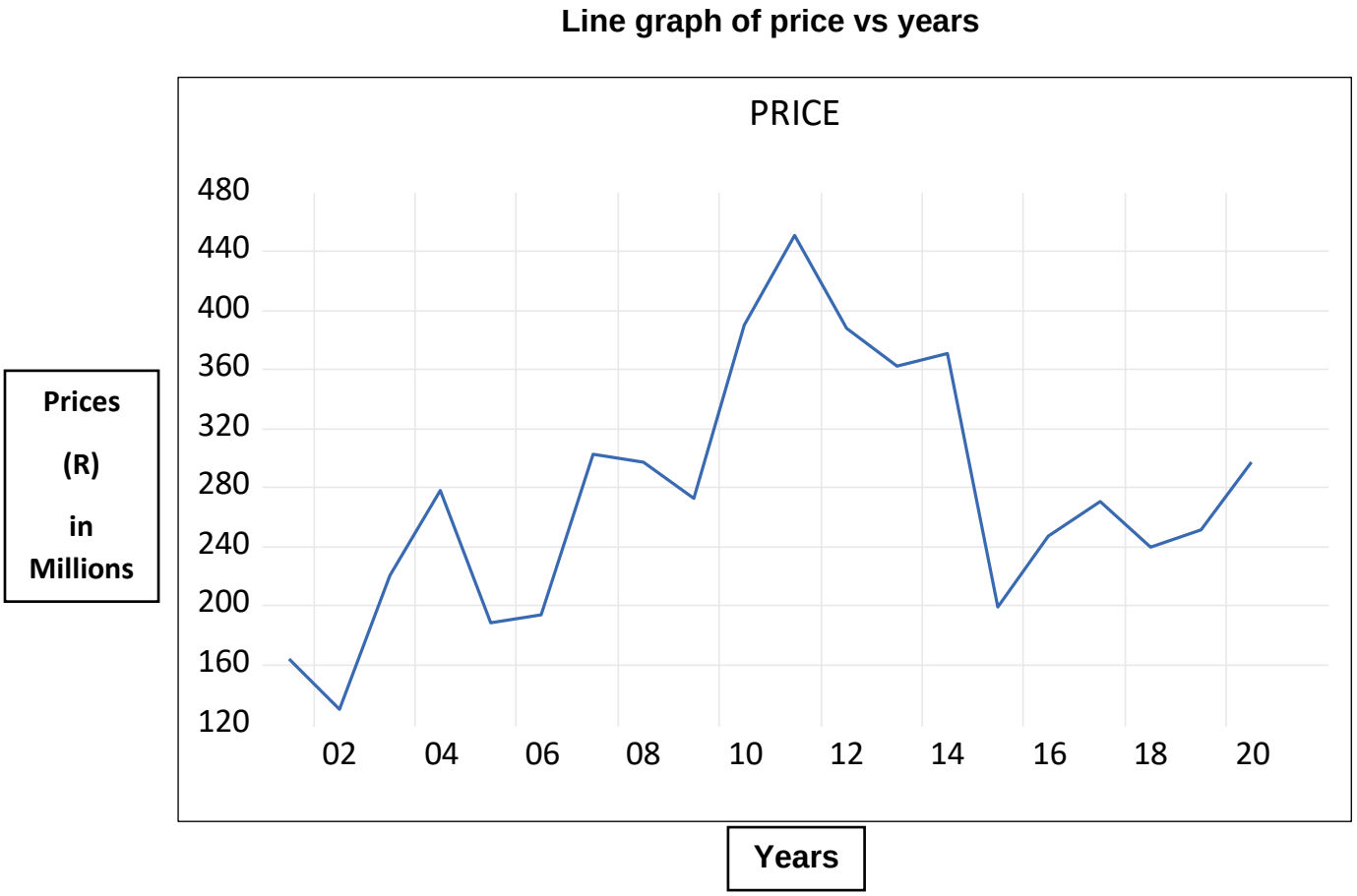


Figure 4. 1: Prices of oranges over 20 years period

Source: own design

Figure 4.1 shows price trends of oranges over 20 years, price in million rands has been fluctuating as the graph shows upward and downward trends. On the X-axis number 02 represent year 2002, 04 being 2004 up to number 20 representing 2020. In 2002 the price was at its lowest. Between 2010 and 2012 the price was at its peak and from there, price dropped drastically between 2014 and 2016. Therefore, from these results, the hypothesis was rejected because results showed that there were upward and downward trends.

4.3 Testing for stationarity

Stating the null hypothesis as

H_0: non-stationarity (the existence of unit root)

H_1: Stationarity (no unit root)

Table 4. 2: ADF Unit root results.

To determine whether the series is non-stationary and has a unit root, unit root tests were run. Every test includes the first differencing, the intercept at the level.

Series	Level	Test equation	ADF test statistic	Test critical value	Prob	Conclusion
Price	At level	Intercept	-2.179662	-3.029970	0.2191	Non-stationary
	1st differencing	Intercept	-4.567026	-3.040391	0.0024	Stationary
Yield (Y)	At level	Intercept	-2.126204	-3.029970	0.2373	Non-stationary
	1st differencing	intercept	-2.179662	-3.029970	0.2191	Non-stationary

Table 4.2 indicates unit root tests performed to test whether the series is non-stationary and possesses unit roots. The augmented Dickey-Fuller statistics value for the price was -2.179662, which was less than the test critical value of -3.029970. As a result, the price was found to be non-stationary at a 5 percent level and the first differencing price was found stationary because the ADF value of price -4.567026 was greater than the -3.040391 test critical value. Therefore, we do not reject the null hypothesis as the price became stationary at first differencing. Yield was found non-stationary at level and first differencing. The values of ADF are less than the critical values.

Table 4. 3: Ordinary least square

Variable	Coefficient	Std-error	t-statistic	Prob
D(Price(-1))	**-1.130297**	**0.247491**	**-4.567026**	**0.0003**
C	**9.955612**	**17.34997**	**0.573811**	**0.5741**

R-squared 0.565898

Adjusted R-squared 0.538767.

Durbin Watson stat 1.950510

Table 4.3 was obtained from Eviews through OLS regression and the t-stats value shows how the best price with the value -4.567026 can explain yield. The probability value of 0.0003 implies that the price is significant because is less than 0.05. the coefficient of -1.130297 for price means that for every one percent increase in yield, price decrease. Durbin Watson's stat with the value of 1.950510 shows that there is no autocorrelation between price and yield. The study was significant at a 5 percent level.

4.3.2 VAR Lag Order Selection Criteria

The VAR Lag Order selection procedure has been used in the study. The outcomes of several selection criteria are presented in the table below.

Table 4. 4: Lag order selection criteria

Price and yield are endogenous variables in this study.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	**-336.3241**	**NA**	**2.36e+14**	**38.77096**	**38.87038**	**38.78779**
1	**-352.4443**	**23.37660***	**8.39e+13***	**37.73098***	**38.02922***	**37.78145***

*Indicates lag order selected by the criteria.

LR: sequential modified LR test statistic (each test at 5 percent level)

FPE: final prediction error

AIC: Akaike information criteria

SC: Schwarz information criteria

HQ: Hannan-Quinn information criteria

Table 4.4, indicates information criteria wherein; AIC (Akaike information criterion), SC (Schwarz criterion) and HQ (Hannan-Quinn information criterion) confirm the lag 1 as the appropriate lag to be used. Then, the study proceeds to test for cointegration using lag 1.

4.3.3 Johansen test for cointegration

To determine whether there is a relationship between orange price and independent variables, the study used both the unconstrained cointegration rank test (Trace) and the unrestricted cointegration rank test (Maximum Eigenvalue). The outcomes are shown in the following table.

Stating null hypothesis as;

H_0: There is no cointegration.

H_1: There exists cointegration.

4.3.3.1 Unrestricted cointegration rank tests

Table 4. 5: Unrestricted cointegration rank test Trace and Maximum Eigenvalue

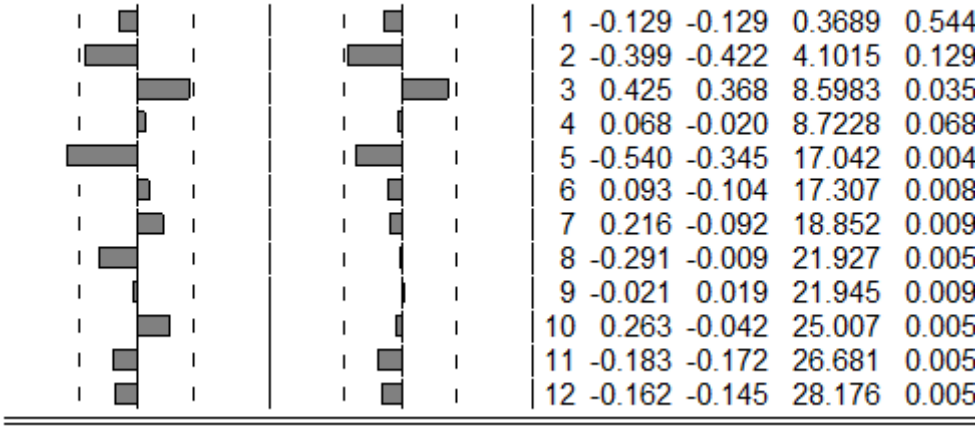
This table shows the trace and maximum eigenvalue.

Unrestricted cointegration rank test (Trace)				
Hypothesized No of CE(s)	**Eigenvalue**	**Trace statistic**	**0.05 Critical value**	**Prob ****
None	**0.0533301**	**19.89182**	**25.87211**	**0.2314**
At most 1	**0.290383**	**6.174541**	**12.51798**	**0.4384**
Unrestricted cointegration rank test Trace and Maximum Eigenvalue				
Hypothesized No of CE(s)	**Eigenvalue**	**Maximum Eigenvalue**	**0.05 Critical value**	**Prob ****
None	**0.533301**	**13.71728**	**19.38704**	**0.2736**
At most 1	**0.290383**	**6.174541**	**12.51798**	**0.4384**

Table 4.5 presents that there is no cointegration between price and yield of oranges as the trace statistics are less than the critical value at none. In the first column, the null hypothesis states that there is no cointegration between the series. The null hypothesis was accepted at 0 05 and a conclusion on cointegration can also be made

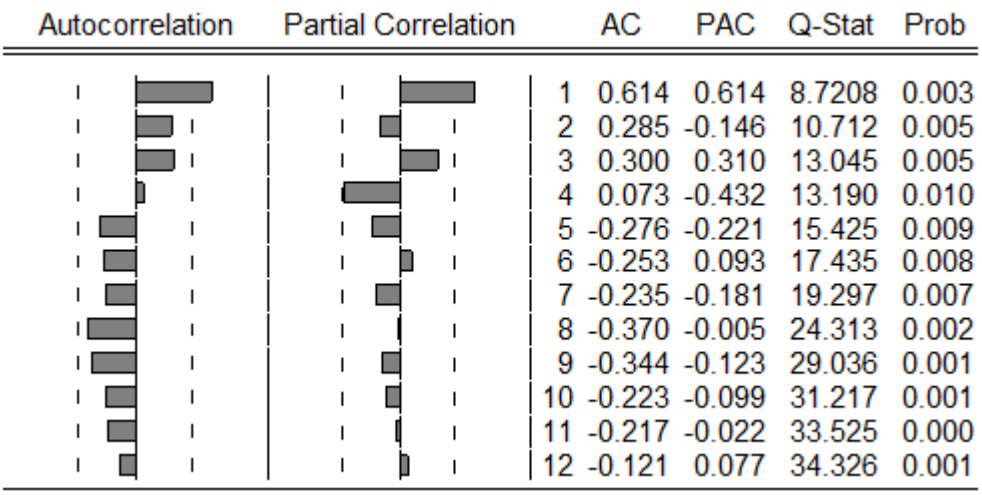
from the probability value. In Table 4.5, the probability value is 0.2736 which is greater than 0.05. As a result null hypothesis will be accepted. But, at most 1 critical value of 12.51798 is greater than the trace statistics value of 6.174541, therefore null hypothesis is accepted that there is no cointegration at 0 05. The study concludes that there is no cointegration in the long-run relationship between the price of oranges and yield.

Table 4. 6: Correlogram of the price at level



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.129	-0.129	0.3689	0.544
		2	-0.399	-0.422	4.1015	0.129
		3	0.425	0.368	8.5983	0.035
		4	0.068	-0.020	8.7228	0.068
		5	-0.540	-0.345	17.042	0.004
		6	0.093	-0.104	17.307	0.008
		7	0.216	-0.092	18.852	0.009
		8	-0.291	-0.009	21.927	0.005
		9	-0.021	0.019	21.945	0.009
		10	0.263	-0.042	25.007	0.005
		11	-0.183	-0.172	26.681	0.005
		12	-0.162	-0.145	28.176	0.005

Table 4. 7: **Correlogram of the price at first difference**



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.614	0.614	8.7208	0.003
		2	0.285	-0.146	10.712	0.005
		3	0.300	0.310	13.045	0.005
		4	0.073	-0.432	13.190	0.010
		5	-0.276	-0.221	15.425	0.009
		6	-0.253	0.093	17.435	0.008
		7	-0.235	-0.181	19.297	0.007
		8	-0.370	-0.005	24.313	0.002
		9	-0.344	-0.123	29.036	0.001
		10	-0.223	-0.099	31.217	0.001
		11	-0.217	-0.022	33.525	0.000
		12	-0.121	0.077	34.326	0.001

Box- Jenkins Autoregressive Integrated Moving Average (ARIMA) Model

The identification stage of the model is the initial phase that establishes if the process is stationary and whether it can be transformed to become stationary. This stage additionally verifies whether the procedure is moving average (MA), autoregressive

(AR), or both ARMA. The integration parameter (d), the MA parameter (q), and the AR parameter (p) are the three parameters used to summarize an ARIMA model. The parameters p and q represent the AR and MA order, while d indicates how much the series must differ for it to become stationary. The most effective method typically used to identify accurate parameter values is the combination of a series autocorrelation (ACF) and partial autocorrelation functions (PACF).

While PACF provides equivalent partial autocorrelations and accounts for autocorrelations at intervening lags, ACF provides the autocorrelations determined at lags 1, 2, and so on. The results also contained the parameter estimates, standard errors, residual variance estimate, estimate of standard error, natural log-likelihood, Akaike's information criterion (AIC), and Bayesian information criterion (BIC). The minimizing of AIC and SBC served as the basis for model selection. As they simultaneously consider the model's fit onto the observed series and its parsimony, these criteria are descriptors of the observed series.

Table 4.7 presents findings of stationarity at level; the data was found not stationary as probability values are all above zero. The first differencing was then applied (table 4.7). From Table 4.7 stationarity exists because, at d=11, the probability value is 0.000. Bars outside the threshold identify models which are fit for forecasting. Models identified are: ARIMA 111, ARIMA 114 and ARIMA 512

Table 4. 8: Least square of orange price for ARIMA 111

Variable	Coefficient	St. Error	t-statistic	Prob
C	**7.187413**	**18.75281**	**0.383271**	**0.7069**
AR (1)	**-0.630852**	**1.288453**	**-0.489620**	**0.6315**
MA (1)	**0.798689**	**1.249484**	**0.639215**	**0.5323**
SIGMASQ	**4487.988**	**1450.885**	**3.93275**	**0.0074**

Table 4. 9: Least square of orange price for ARIMA 114

Variable	Coefficient	St. Error	t-statistic	Prob
C	**7.228674**	**18.94860**	**0.381489**	**0.7082**
AR (1)	**-0.108047**	**0.392267**	**-0.275441**	**0.7867**

MA (4)	**0.111380**	**0.447917**	**0.248663**	**0.8070**
SIGMASQ	**4597.542**	**1500.399**	**3.064212**	**0.0079**

Table 4. 10: Least square of orange price for ARIMA 512

Variable	Coefficient	St. Error	t-statistic	Prob
C	**7.419311**	**7.487101**	**0.723820**	**0.4803**
AR (5)	**-0.483862**	**0.223358**	**-2.166304**	**0.0468**
MA (2)	**-0.249996**	**0.315507**	**-0.792363**	**0.4405**
SIGMASQ	**2857.319**	**1533.346**	**1.863454**	**0.0821**

The above three models were compared based on significant coefficient, sigma, adjusted R squared and AIC to come up with the best model for forecasting orange prices in South Africa.

Table 4. 11: Model summary

	ARIMA 111	ARIMA 114	ARIMA 512
Sig Coeff	**0**	**0**	**0**
Sigma	**4487.988**	**4597.542**	**2857.319**
Adj R^2	**-0.141932**	**-0.169807**	**0.272978**
AIC	**11.67448**	**11.69545**	**11.29353**

Results from the table above reveal that from all three tentative models, none had a significant coefficient. Also, the summary showed that ARIMA 512 had a smaller sigma of 2857.319 as paralleled to ARIMA 111 and ARIMA 114 with values of 4487.988 and 4597.542 respectively. Among the models that were selected, ARIMA 512 exhibited the highest Adj R squared value of 0.272978. Additionally, its AIC value was found to be smaller. From the findings, ARIMA 512 is the most effective model for predicting the price of oranges from 2022 to 2026. Therefore, the diagnostic check was performed to investigate autocorrelations. Sain *et al* (2020), also stated that in the forecasting of basmati rice for an average monthly price of the Taraori market for the Karnal district, the developed model for average prices for basmati rice in the Karnal district was found to be ARIMA (0, 1, 0) and (1, 1, 2).

Table 4. 12: Correlogram for diagnostic check

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.047	-0.047	0.0490	
		2	0.008	0.006	0.0505	
		3	0.246	0.248	1.5656	0.211
		4	-0.015	0.009	1.5719	0.456
		5	-0.051	-0.062	1.6467	0.649
		6	-0.039	-0.113	1.6932	0.792
		7	-0.025	-0.031	1.7145	0.887
		8	-0.135	-0.114	2.3772	0.882
		9	-0.060	-0.039	2.5216	0.925
		10	-0.038	-0.030	2.5840	0.958
		11	-0.223	-0.186	5.0668	0.828
		12	-0.100	-0.122	5.6331	0.845

The Correlogram above was done to do a diagnostic check which is step 3 of ARIMA. These results show that there is autocorrelation at lag 3, meaning that there is uncaptured data.

CHAPTER 5: SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the study, highlighting the conclusions drawn from the tests and the recommendations provided to the decision-makers to ensure that the nation's pricing behaviour and goods forecasts are taken into consideration.

5.2 Summary

The study's objective was to investigate the price trends of oranges in South Africa. Two research objectives were observed and analysed. The initial objective Determine the trends of orange prices in South Africa from 2001 to 2021, which was accomplished by applying descriptive statistics and OLS. The study used the unit root to evaluate the stationarity of orange price from 2001 to 2021 following Augmented Dickey-Fuller. The VAR lag order selection criteria implied that the optimal lag length between the variables is one. The study proceeds to test for cointegration and the results revealed that there was no cointegration.

The second objective of the study which was to forecast future orange prices from 2022 to 2026 in South Africa, adopted ARIMA. The model parameters p, d and q values were identified. Three tentative models were discovered ARIMA 111, ARIMA 114 and ARIMA 512. Thereafter estimations were done to identify the model that would be fit for forecasting. ARIMA 512 had the highest value of Adj R^2 of 0.272978 as compared to other identified models and the AIC value was also smaller as a result, the model was found fit for forecasting.

5.3 Conclusion

The hypotheses of the study were tested. The first one was there were no upward and downward trends in the price behaviour of oranges in South Africa. The study applied descriptive statistics and OLS. Ordinary least square regression and the t stats value showed how the best price at the value -4.567026 could explain yield. The probability value of 0.0003 implies that the price is significant because is less than 0.05. the coefficient of -1.130297 for price means that for every one percent increase in yield, price decreases. Durbin Watson's stat with the value of 1.950510 shows that there is no autocorrelation between price and yield. The study was significant at a 5 percent

level. A line graph was also drawn to evaluate price trends and it was found that price was at its peak between 2010 and 2012. Price dropped drastically between 2014 and 2016. Between 2004 and 2006 the price was at its lowest. Therefore, from those results, the hypothesis was rejected because results showed that there were upward and downward trends.

The second hypothesis was prices of oranges from 2022 to 2026 will not change in South Africa. Data was not stationary at the level and became stationary at first differencing. The null hypotheses for the unrestricted cointegration rank test (Maximum Eigenvalue) and the unconstrained cointegration rank test (Trace) state that there is no cointegration. Then the results revealed that there is no cointegration between the variables and this means that there could be misspecification. Analysis of forecasting revealed three tentative models, of which only one model was fit for forecasting future orange prices.

5.4 Recommendation

Agricultural advisors need to work together with farmers to help them make fruitful decisions. Sain *et al*., (2020) revealed that forecasting of price made farmers sell their produce immediately after harvesting and not store them and about half of the farmers who got this information benefited significantly unlike those who did not follow the information revealed by the study.

Moreover, farmers need to learn and understand the forecasting models. This model will make them aware of future prices. Farmers will know profitable years when the price will be at its peak and act accordingly. The government should organise workshops and invite people who are well equipped with knowledge rating to agricultural prices and production, these people will do skill transfer to farmers, therefore, profit will be maximised. Policymakers can also use findings from the study in making future principles in the citrus industry. Also, producers would benefit much from such studies if they were to be conducted for other commodities.

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7. DATA SET USED

Year	Price (R)	Yield (ton)
2001/2022	1169806	164.4
2002/2003	1293497	129.7
2003/2004	1237835	220.8
2004/2005	1325217	277.9
2005/2006	1126460	188.5
2006/2007	1244151	193.9
2007/2008	1347330	303.0
2008/2009	1523203	297.3
2009/2010	1367706	273.0
2010/2011	1415447	389.6
2011/2012	1496417	450.6
2012/2013	1646425	387.9
2013/2014	1808142	362.1
2014/2015	1797476	370.9
2015/2016	1761173	199.7
2016/2017	1366083	247.2
2017/2018	1454841	270.3
2018/2019	1774841	240.0
2019/2020	1687493	251.9
2020/2021	1555132	297.5