



## Causal Relationship Between Maize Production and Its Price in Zambia

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### Abstract:

In Zambia, changes in food prices specifically maize prices have received much of the attention of late because of its effect on national food security, farming systems, and political-economic conditions of the country. Measures have been taken in order to prevent future food crises and to achieve zero hunger by 2030 as per Sustainable Development Goal number 2 targets 2.4 and 2.c. The national strategies to stabilise the price and influence productivity depend on availability of data from different researchers. Most studies on maize production in Zambia have focused on climatic and demographic factors with insufficient efforts taken in addressing

price changes on maize production. The article examined the consequences of changing price from 1990 to 2021 of maize on maize production in Zambia. It used a cross sectional research design to analyse secondary data from Zambia Statistics Agency and Food Agriculture Organization. The use of Granger causality test (time series) during analysis revealed unidirectional causation between price and production. This implies that price of maize is the Granger cause of maize production ( $p$ -value = 0.0010). The increase of price of maize influences maize productivity among peasants. The policy implication stemming from this study is that since price influences maize production, controlling maize production without stabilizing price levels cannot be enough to boost the agricultural economy and alleviate poverty. The government needs to control maize prices to meet the domestic self-sufficient and affordable prices.

**Keywords:** *Maize production, price of maize, granger causality test, statistical agency, food and agricultural organisation, Zambia.*

### Introduction

Food security is cardinal for the development of any country, its currently a global subject following recurring global food prices (Swinnen & Squicciarini, 2012). Most of the households in developing countries are the net buyers, therefore, any changes or fluctuations in food

prices immediately put household food security at risk. The fluctuations in prices do not only affect the direct beneficiaries of agriculture but also those involved in agribusinesses (Mustapha & Culas, 2013). In order to prevent future food crises and achieve zero hunger by 2030, according to SDG goal number 2 targets 2.4 and 2.c (sustainable food production and resilient



agricultural practices and ensure stable food commodity markets and timely access to information), it is important to aim to limit extreme food price volatility. Mustapha and Culas (2013) found that Africa has the largest population of the world's hunger who are adversely affected by the frequent fluctuations maize prices.

Globally, price fluctuations have received much of the attention of late (Routledge et al., 2008 and Rafael & Medvedev, 2011) because price fluctuation has affected a number of countries around the globe. After the grain reform in china, the prices of agricultural product went up and many food policies implementation did not favour production among famers. World food price volatility has increased since food crisis of 2007–2008 but food price volatility in Africa has not increased since the crisis (Minot, 2014). By the year 2008, most of the farmers witnessed sharp decrease in global agricultural and food prices. In order to protect the interests of farmers, the government of China adopted a minimum price support policy to improve the purchase price of grain.

The price of maize can significantly influence its production and, consequently, have far-reaching effects on the national and regional economy, food security, and rural livelihoods. In many developing countries, especially Africa has also experienced continued fluctuations in agricultural prices. Maize farming supports the livelihoods of smallholder farmers; hence, changes in maize prices can influence income levels and living standards of rural communities, who are the majority smallholder farmers, thereby shaping their economic resilience and poverty levels. Sub-Saharan African (SSA) households often face much larger nationally and regionally induced food price fluctuations. These price fluctuations are due to the unpredictable market forces between supply and demand and they are the major barriers to growth in subsistence farming in Africa (Fafchamps, 1992). These fluctuations have led to the extensive engagement of marketing boards or strategic grain reserves in developing countries (Pierre et al., 2018). According to a study that was done by Chapoto and Jayne

(2009) observed that Southern and Eastern African countries like Kenya and Tanzania that have adopted less interventionist and more predictable staple grain market policies have achieved higher agricultural growth and lower food price volatility.

Since Zambia got its independence in 1964, the Government of Zambia (GOZ) controlled all pricing and marketing of maize including setting a uniform price. In 1991, the GOZ opened up domestic markets to private traders, by 1993 they had removed all price controls in the maize pricing. Zambia's Food Reserve Agency (FRA) was established in 1996 with the mandate to guarantee food security in the country through the procurement, storage and distribution of grain, mainly maize. FRA has the mandate to stabilize prices with the help of export bans and to ensure domestic food security across the country and prevent food prices from rising too much. Low years of production prices go up and this provides an incentive for farmers to increase production in the next season (Wroblewski et al., 2009). However, farmers face a risk in the sense that increase in production this year will result into a reduction in prices.

Many Zambians rely on maize scientifically known as "zea" mays as their main source of food, popularly known as "mealie meal", the crop is grown in the country for both consumption and export. It is the main crop grown by smallholder as half of all rural households cultivate at least some maize. Maize meal prices remain highly volatile and rural poverty remains high from 76.6 percent in 2015 to 78.8 percent in 2022 (Zambia Statistics Agency -ZamStats, LCMS 2023).

This article aimed to shed new light onto the assessment of the relationship between price fluctuations and maize production in Zambia. The significance of maize extends far beyond human consumption, as it plays a crucial role in the livestock and poultry industries, as well as in the production of biofuels and various other products. Price fluctuation can be attributed by so many factors which when put together can lead to dangerous consequences for the most vulnerable farmers who are mostly located in

rural areas. Food prices have different consequences for well to do families and poor families (Trzesniewski et al., 2006). Price fluctuations in maize will tend to discourage investment in staple food because they have other important sources of food they can depend on while for the poor households they will continue to devote scarce resources to staple production which will result into low productivity and high volatility (Poulton et al., 2006).

Despite measures taken by FRA to end all forms of price fluctuations, maize production and its prices have continued to fluctuate since 1990s. The data from Food Agriculture Organization (FAO) website indicate that the minimum price of a 20 litres tin was about 0.05 US dollars in 1994 and was maximum in 2020 at 3.4 US dollars. Most studies on maize production in Zambia have focused on climatic and demographic factors such as sex of household head, marital status, educational level, size of a household among other variables with insufficient efforts taken in addressing price fluctuations on maize production, an act that might compromise reducing price fluctuations and help reduce hunger by 2030. Filling in this gap requires a study on the effects of maize price on maize production. Limited studies have looked at the Granger causality between maize price and its production, this article adds value to this subject matter.

This article assessed the effects of price fluctuation on maize production in Zambia in order to ascertain the causal relationship between maize production and its price. The article on maize production and its price is of great practical importance to the maintenance of food security of the country. The causal dynamics between maize production and its price is an empirical question worthy of further investigation to help determine what causes what. This research adds to the thin empirical evidences on the effects of price fluctuations on maize production on smallholder farmers in Zambia. Only a handful of studies have addressed the effects of price fluctuations on maize production. This article is equally important because food prices affect future

production, hence it is important to understand the nature of maize prices in Zambia as well as determine its effect on production in order to inform both the producer and consumer for them to be able to make well informed decisions. Understanding this dynamic is essential for policymakers, farmers, agribusinesses, and consumers as they navigate the challenges posed by fluctuating maize prices and strive to promote sustainable agriculture and food systems.

### Theoretical Perspective

The cobweb theory is a dynamic analysis theory that uses the principle of elasticity to explain the different fluctuations in food commodities with long production periods. This theory was found by Nicholas Kaldor who analyzed the model in 1934. This theory was guided by previous researchers in German, Henry Schultz and Umberto Ricci. The theory indicates that price changes can lead to fluctuations in production which can cause a cycle of raising and falling prices.

The assumptions of the theory are that farmers have to decide how much to produce in advance before they know what the market price will be in that particular year based on the price of the produce from the previous year. This means low price in the previous season, some farmers may not produce in the next season for fear of the same low price. The other assumption is that a smaller percentage increase in demand will result into a smaller percentage increase in price, this means that demand is inelastic.

Figure 1 shows the transmission of maize price in maize production. The interaction effect of each link is shown. The figure shows us that the price of maize plays a cardinal role in regulating production and consumption. From Figure 1 a very good harvest means that production will be greater than expected and this will cause a fall in price. However, this fall in price may cause some farmers to go out of business or produce something different next year. The consequence is that if the current year has low price, next year farmers reduce the amount of maize to be produced because farmers may opt to go for other food crops which are more economical. On the other hand, if production reduces, then

the price is expected to rise. If the farmers see high prices, then you expect an increase in production the next year.

In summary, the model assumes farmers base next years production purely on the previous price and assume that next year's price will be the same as last year. This can be seen as good year

or bad year. What is needed is to stabilise the agricultural market price. This theory is beneficial to this article because it pays attention on the fact that the present events depend upon the past happenings, it furnishes us with technique to demonstrate the process of change over time.

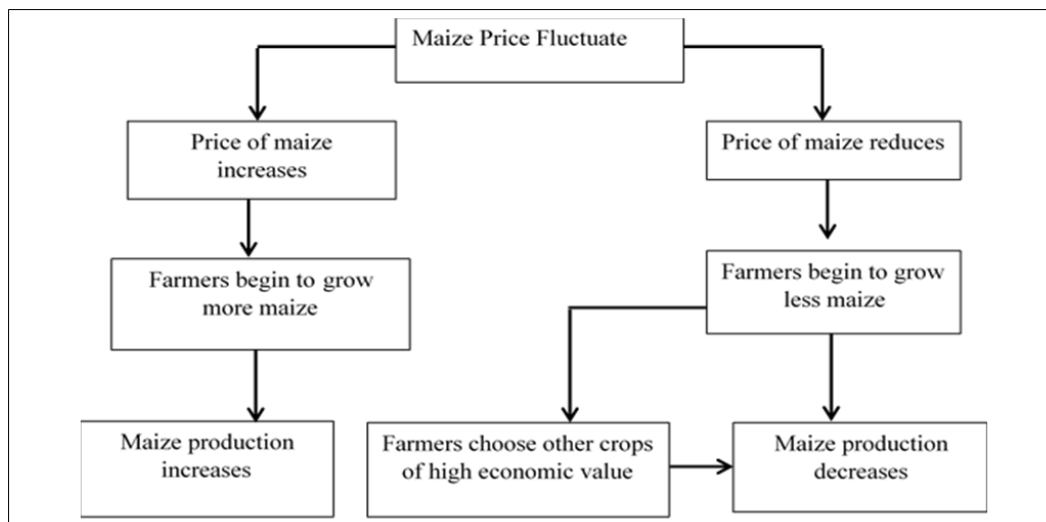


Figure 1. The Transmission mechanism of Maize Price and Maize Production

## Methods and Materials

### Description of the Study Area and Coverage

The article has been composed based on the study which was conducted in Zambia in 2023. Zambia is located in the southern part of Africa. The whole country was preferred because the price of maize is of national concern and interest which is mainly determined by the FRA of Zambia. This has a number of effects on both the economy and individuals of the country because majority of the Zambian people largely depend on agricultural production and the fluctuations in prices bring a lot of instability and does not guarantee predictable income.

This is a cross sectional research design that focussed on the assessment of the relationship between price fluctuations and maize production in Zambia. Secondary data was used in the analysis consisting of annual observations from 1990 to 2021. Maize production, yield and area harvested data was obtained from the FAO

website open data set and price data was obtained from Zambia Statistics Agency (ZamStats). The article focussed on a 32-year span because of the non-availability of the trend data on price for the other years. The article was guided by the cobweb theory analysis.

### Data Analysis

The Stata software version 16 was used to analyse annual data (1990 to 2021) on maize production. Two variables were used in the analysis. These are dependent variable which involved data on maize production and the independent variables which involved the price of maize, yield and the area harvested. The general relationship between the dependent variable (Maize production) and its associated explanatory variables can be expressed in the form of a simple supply function specified in equation 1:

$$M_{prod} = f(M_{price}, M_{yield}, Area) \quad (1)$$

Where:

$M_{prod}$  = Maize production in tonnes

$M_{yield}$  = Maize yield in 100g/ha

$M_{price}$  = Price of 20 litres tin of maize in  
Zambian Kwacha

$Area$  = Area harvested for maize in hectares

## Granger Causality Test

The article employed the Granger causality to establish the causal relationship between maize production and its price. Granger causality is when a (time series) variable A causes B, if the probability of B conditional on its own past history and the past history of A (beside the set of the available information) does not equal the probability of B conditional on its own past history alone (Granger, 1980: p. 334). The Granger causality test is commonly used in time series to describe which sequence of fluctuations can cause another sequence of fluctuations. In this case, the Granger causality relationship between the two variables, maize production and its price is defined as how price can help explain the future variation of the maize production; then we say, price of maize is the granger cause of maize production or vice versa. Granger-causality testing was more preferred due to its growing popularity of both the field of science where theoretical background is insufficient and the quantitative methods as such. It has been considered to be the most influential approach to causality in economics (Hoover, 2006).

According to Granger (1980), causality is based on three assumptions

(1) The past and the present may cause the future, but the future cannot cause the past.

(2)  $\Omega_n$  (all the knowledge available in the Universe on t) contains no redundant information, so that if some variable  $Z_n$  is

functionally related to one or more other variables, in a deterministic fashion, then  $Z_n$  should be excluded from  $\Omega_n$ .

(3) All causal relationships remain constant in direction throughout time Variable Y prima facie causes variable X, if:

$$(X_{n+1} \in A | X, Y) \neq (X_{n+1} \in A | X) \text{ for some } A \text{ where,} \quad (2)$$

X; Y = history of time series: X; Y

$X_{n+1}$  = the value of X on t+1

## Results and Discussion

### Demographic Characteristics

The results from Table 1 show descriptive statistics of the variables used in this article with annual series data covering a period of 32 years (1990 to 2021), to analyse the assessment of the relationship between price fluctuations and maize production in Zambia and also to forecast the maize price for the next 10 years. Table 1 presents the summary statistics of the variables used in the article with a total of 32 observations.

The average price of maize grain was found to be about 0.9 USD with the maximum price of 3.18 USD and a minimum of 0.05 USD for a 20 litre tin of maize. Maize production was found to have an average of 1,765,328 tonnes with minimum maize production of 483,492 and maximum of 3,620,244 per tonne. The yield of maize was found to an average of 20,567 for every 100g/ha, while the minimum yield was found to be 7,311 and maximum 30,310 per 100g/ha. The descriptive statistics further indicated that area harvested had a mean of 808492 hectares with a minimum of 362,787 and maximum of 1,433,944 hectares.

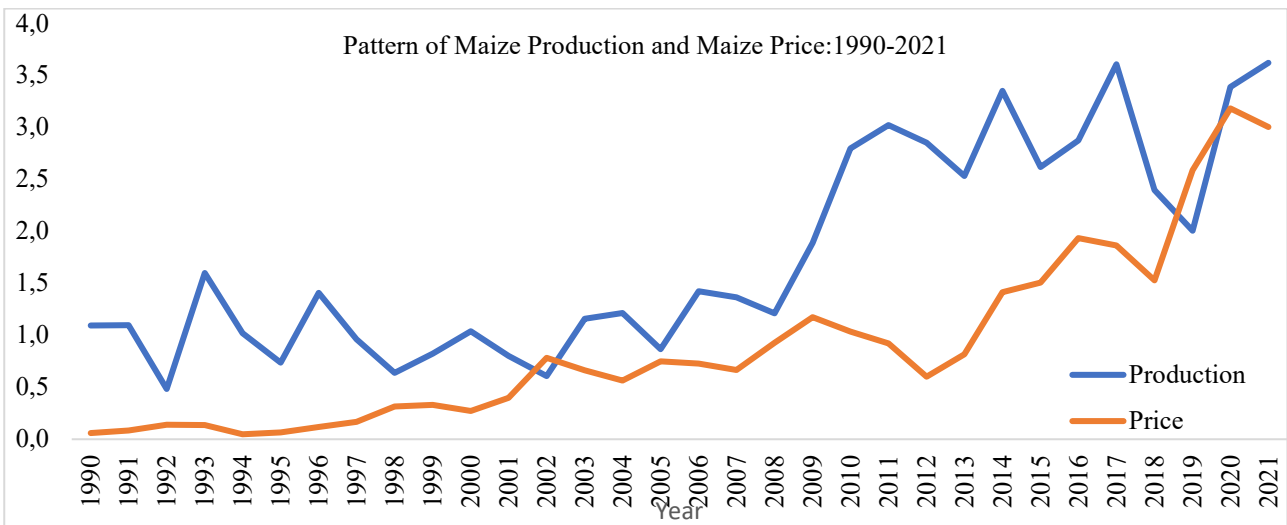
**Table 1. Descriptive Statistics of Maize Production, Yield and Area harvested**

Description	Mean	Median	Std.Dev	Skewness	Kurtosis	Min	Max
Area (Ha)	808,492.5	673,282.5	292,422.9	0.69	2.34	362,787	1,433,944
Yield (100g/Ha)	20,567.03	21,458	5,535.43	-0.35	2.28	7,311	30,310
Maize Prod (Tons)	1,765,328	1,387,822	996,518.5	0.55	1.87	483,492	3,620,244
Maize Price (USD)	0.90	0.70	0.85	1.26	3.89	0.05	3.18

**Source:** Author’s own computation using STATA, August, 2023

The results in Figure 2 show the pattern of maize price in USD and the pattern of maize production in 1 million tonnes. It can be seen from Figure 2 that price and production of maize took on different series of lows and highs at an unprecedented rate. These changes in price also contribute to the production instability as shown in Figure 2. The lowest price then was recorded in 1994 and the all-time highest price of maize was in 2020 at 0.05 USD and 3.18 USD, respectively for a 20 litres tin of maize. As illustrated in Figure 2, production has also experienced significant variability, varying from 483,492 tonnes in 1992 to 3,620,244 tonnes in

2021. This disparity raises concern on production shocks and consequently on food security of the country. Possible reasons for fluctuation could include higher costs of production than usual in some years, the impact of rural urban migration and climate impacts as well. Figure 2 also indicates that in years where maize production had fallen, maize prices went up. In some times when the price increases the production also increases. The findings concurs to Cobweb theory by Nicholas Kaldor (1934) who pointed out that low price in the previous season, some farmers may not produce in the next season for fear of the same low price.



**Figure 2. Trend Analysis of Maize Production and its Price**  
**Source:** Author’s own computation using STATA, August, 2023

**Stationarity Tests**

The Augmented Dickey Fuller (ADF) test was used in order to test for stationarity for all the variables that were used in the article. Table 2

presents the ADF test statistic obtained and the critical values as a result of the unit root test (URT). The results indicate that all the variables were found to be stationary at first differencing.

**Table 2. Summary of Unit Root Tests (ADF) for the Variables**

Variable	In levels	Critical Value	In first Difference	Critical Value
	ADF	5%	ADF	5%
Area Harvested (Ha)	-1.401	-2.983	-6.973*	-2.986
Maize Yield (100g/Ha)	-2.829	-2.983	-10.467*	-2.986
Maize Production (Tons)	-1.197	-2.983	-6.981*	-2.986
Maize Price (USD)	0.556	-2.983	-5.050*	-2.986

**Source:** Author’s own computation using STATA, August, 2023

The unit root test results given in Table 2 indicates that, the unit root null hypotheses are not rejected for the four variables, area harvested, maize yield, production and price in their levels when including constant in the model. The results revealed that all the four variables are non-stationary in levels, then become stationary at first differencing by referring to 5% level of significance.

### The Causal Relationship Between Maize production and its Price

The article ascertained the causal relationship between maize production and its price in Zambia. Granger causality test was used to analyze this relationship. The Granger causality test investigates whether the occurrence of one

variable causes the occurrence of another variable. The Granger Causality test results shown in Table 3 shows the direction of causation between price of maize and its production but there is no reverse causation from maize production to maize price. This implies that price of maize is the granger cause of maize production, meaning that the increase in price of maize leads to increase in maize production. These results concurs with those of Xie and Wang, (2017) who indicated that the change in agricultural product price is the Granger cause of grain yield change. Therefore, changes in maize price have a significant impact on changes in maize production but the impact of changes in maize production on prices is not obvious.

**Table 3. Pairwise Granger Causality Tests: Sample 1990-2021**

Equation	chi2	Prob > chi2
Maize Production does not Granger Cause Price of Maize	3.799	0.15
Price of Maize does not Granger Cause Maize Production	14.833	0.0010

**Source:** Author’s own computation using STATA, August, 2023

### Conclusion, Implications and Recommendation

This article has studied the dynamics of maize production and price of maize in Zambia. The changes in the price of maize increase the production of maize in Zambia. The causation which runs from price of maize to maize production in Granger causality test reveals a directional causality between maize price and

maize production. The policy implication stemming from the results is that since price influenced maize production, it means controlling maize production without stabilizing price levels cannot be enough to boost the agricultural economy and alleviate poverty. By controlling price and production, it will help the country to address and be in line with the SDG agenda number 2 target 2.4 which focus in ensuring sustainable food production and

resilient agricultural practices and also stabilizing food commodity markets and timely access to agricultural information as per target 2.c. The government needs to control prices and production systems across the country resources so as to create profits among peasants and farmers.

## References

Chapoto, A. & Jayne, T.S. (2009). *Effects of Maize Marketing and Trade Policy on Price Unpredictability in Zambia*. Food Security Collaborative Working Papers 54499, Michigan State University, Department of Agricultural, Food, and Resource Economics.

Fafchamps, M. (1992). Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American Journal of Agricultural Economics*, 74(1), 90–99. <https://doi.org/10.2307/1242993>

Granger, C.W.J. & Joyeux, R. (1980). An Introduction to Long-Memory Time Series Models and Fractional Differencing. *Journal of Time Series Analysis*, 1, 15-29. <http://dx.doi.org/10.1111/j.1467-9892.1980.tb00297.x>

Hoover, T.L. (2006). *The relationship between nurses' anxiety and attitude related to pediatric hospice*. Graduate Theses and Dissertations.

Minot N. (2014). Food price volatility in sub-Saharan Africa: Has it really increased? *Food Policy*, 45, 45-56. <https://doi.org/10.1016/j.foodpol.2013.12.008>

Mustapha, U. & Culas, R. (2013). *Causes, Magnitude and Consequences of Price Volatility in Agricultural Commodity Market: An African Perspective*. Osino, Melbourne.

De Hoyos, R. & Medvedev, D. (2011). Poverty

Effects of Higher Food Prices: A Global Perspective. *Review of Development Economics*, 15, 387-402. <https://doi.org/10.1111/j.1467-9361.2011.00615.x>.

Routledge, C., Arndt, J., Sedikides, C., & Wildschut, T. (2008). A blast from the past: The terror management function of nostalgia. *Journal of Experimental Social Psychology*, 44, 132-140. <https://doi.org/10.1016/j.jesp.2006.11.001>

Swinnen, J., & Squicciarini, P. (2012). Global food supply. Mixed messages on prices and food security. *Science (New York, N.Y.)*, 335(6067), 405–406. <https://doi.org/10.1126/science.1210806>

Trzesniewski, K. H., Donnellan, M. B., Moffitt, T. E., Robins, R. W., Poulton, R., & Caspi, A. (2006). Low self-esteem during adolescence predicts poor health, criminal behavior, and limited economic prospects during adulthood. *Developmental psychology*, 42(2), 381–390. <https://doi.org/10.1037/0012-1649.42.2.381>

Wroblewski, J., Cook, J., & Cagley, J. H. (2009). *Zambian Maize Price and Production Analysis*. Retrieved from <https://epar.evans.uw.edu/research/zambian-maize-price-and-production-analysis>

Xie, H., & Wang, B. (2017). An Empirical Analysis of the Impact of Agricultural Product Price Fluctuations on China's Grain Yield. *Sustainability (Switzerland)*, 9(6), 1–14. <https://doi.org/10.3390/su9060906>

Zambia Statistics Agency (ZamStats). (2023). *The 2022 Poverty Assessment in Zambia*. Retrieved from <https://www.zamstats.gov.zm/wp-content/uploads/2023/09/Highlights-of-the-2022-Poverty-Assessment-in-Zambia-2023.pdf>