Article

Restoration of Land Acquired for Resettlement and the Fast-Track Land Reform Programme in Zimbabwe

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Abstract: This paper examines the effect of the land reform program on the production of main agricultural crops, which are maize and soyabean, in a bid to deduce the implications of the possible restoration of land acquired for resettlement in Zimbabwe. The interest of this paper is in response to the new legislation by the Government of Zimbabwe under which former farm holders may apply for restoration of title to the piece of agricultural land that was compulsorily acquired from them for resettlement during the 2000 Fast-Track Land Reform Programme (FTLRP). Contrary to cross-sectional studies done before, this study applied the Ordinary Least Squares estimation technique on time series data covering the period 1980–2019. The results show that the period after the land reform has lower maize and soyabean output per hectare compared to the period before land reform. The findings imply that the FTLRP disrupted production, which has never been restored to prior output levels; this points to the new government’s interest in the restoration of land to former farm holders to sustain agricultural production, particularly maize and soyabean.

Keywords: fast-track land reform programme; sustainable; agriculture; maize output; soyabean output

1. Introduction and Background

The agricultural sector has remained one of the key pillars of the Zimbabwean economy, providing employment and income to 60–70% of the population and contributing approximately 17% to Zimbabwe’s Gross Domestic Product (GDP) [1]. With Zimbabwe having an agro-based economy, land remains a key asset, and the management of agricultural land plays a crucial role in ensuring that farming is sustainable. The government had the Fast-Track Land Reform Programme (FTLRP) in 2000 to address the colonial land imbalances, among other objectives. The farms were divided into large-scale (Model A2) and small-scale (Model A1) farms to ensure efficient utilisation of land. Land reform can therefore be argued to have brought sustainable agriculture if it was accompanied by an increase in agricultural output, or at least if the disruptions were correct in two to five seasons; however, there is general growing evidence that FTLRP brought a fall in the agricultural sector. Studies such as Ref. [2], which examined the effect of land reform, were descriptive and relied heavily on a short time period after the FTLRP; this would make the results be driven by what happened during that particular short period, such as good rainfall or just sampling farmers in agricultural regions which have good soil and favorable rainfall. The generalisability of the findings to Zimbabwe’s agricultural sector becomes constrained, which this paper addresses by using time series data covering the period 1980–2019. Policies and programmes of redress, like any other interventions, need evaluation post-implementation to ensure the intended goals are achieved. Despite the anecdotal evidence of poor outcomes of the FTLRP, limited scientific work exists to guide the next steps - much so in the wake of the restoration programme that has been initiated.
Post the FTLRP, many strategies have been put in place, including Agriculture Sector Productivity Enhancement Facility (ASPEF) in 2005 and Farm Mechanisation Scheme in 2008 to support farming; however, the pricing of products and input support was a challenge, and the Command Agriculture Programme was launched in 2016, providing needed inputs to farmers on credit. Due to the limited mechanisation and ownership of key assets such as cattle in farming, the Government of Zimbabwe implemented 'Pfumvudza' programme (This is a crop production intensification approach under which farmers ensure that they efficiently use the available resources on a small piece of land to optimise management and increase productivity) in 2020, training farmers in conservation agriculture to help bring food self-sufficiency and address the problems of low levels of productivity and production. Among the programmes which have been launched by the Government of Zimbabwe, there is debate concerning their sustainability as well as the success of the FTLRP of 2000 and few studies have been done, exploring whether the FTLRP improved agricultural production [2].

In the middle of the on-going debate, the Government of Zimbabwe gazetted a new legislation under which former farm holders may apply for restoration of title to the piece of agricultural land that was compulsorily acquired from them for resettlement and the new regulations apply to indigenous farmers whose farms were appropriated, as well as foreign farmers whose land was protected by the Bilateral Investment Protection and Promotion Agreements (BIPPAs) and Bilateral Investment Treaties (BITs). The Government of Zimbabwe is giving land in respect of the rule of law, property rights and the constitution since the law demands that compensation be paid to black farmers whose farms was protected by BIPPAs and BITs. One may ask, what would be the implication of the compensation for land taken over for resettlement on agricultural productivity in Zimbabwe? The implication on agricultural productivity of repossession of land taken over for resettlement can be derived by examining how the land reform programme affected agricultural production. The effect of land reform would enable one to argue if the new legislation may bring improvement in agricultural productivity and sustainable agriculture.

Based on the studies done, the implication is not clear such that a correct policy stance can be given with regards to the restoration of title to the piece of agricultural land. A study on land reform by Ref. [3] found that financial return to land reform is mediocre and Ref. [2] found that FTLRP beneficiaries are more productive than communal farmers in Zimbabwe; however, Ref. [2] argued that when comparing with statistics for the year 1999 just before the launch of the FTLRP, productivity of FTLRP beneficiaries fell short of the levels demonstrated by commercial farming sector in that year. Despite the achievement of some of the objectives, there is a general notion that land reform was a failure, as supported by welfare indicators showing high poverty levels amongst the land reform beneficiaries, with Ref. [2] showing a fall in agricultural production among the land reform beneficiaries following the launch of the FTLRP. Ref. [4] supports this general notion, arguing that studies show a decrease in aggregate national production because of FTLRP, with Ref. [5] showing that maize, groundnut, cotton, wheat, soya bean, sunflower, coffee, and sheep production plummeted between 50% and 90% during the 2000 to 2003 period. Although the FTLRP might have led to a decrease in agricultural production, studies are too descriptive and look at the trend of agricultural output, without considering exogenous factors such as climate change and natural disasters that might have created that trend; this study uses a different approach to examine the effect of land reform on agricultural output and deduce the implications of the new legislation of providing compensation for land taken over for resettlement; thus, the study uses the regression analysis, particularly focusing on key crops which are maize and soya bean.

When Zimbabwe attained independence in 1980, the agricultural sector was composed of large-scale commercial farmers which occupied vast amounts of fertile land and small-scale communal farmers. During the colonial era, land was disproportionately distributed, with approximately 4660 large-scale predominantly white commercial farmers owning about 14.8 million hectares of land (approximately 3176 hectares per farmer) and about
6 million black smallholder farmers owning about 16.4 million hectares of land (approximately 2.73 hectares per farmer), mainly in low agricultural potential areas [6]. To address this colonial land imbalance, the Government of Zimbabwe made a commitment to resettle 162,000 farmers by 1990 under the “willing buyer, willing seller” agreement.

However, by 1990, the government failed to reach the target and the agricultural sector was booming, providing employment to 25% of the national labour force, which was about 11% to 18% of the population in the 1990s [7]. In 1992, the government passed the Land Acquisition Act, a new and revised land reform policy aimed to speed up the land reform process. The Land Designation and Compulsory Acquisition allowed the government to acquire, for compensation, land that was deemed unproductive, but this law was applied only to rural areas. Over the period to 1997, the government managed to acquire 3.5 million hectares of land and resettled 71,000 families, with 4000 white farmers owning over 50% of the land, an average of 2000 hectares per farmer [7]; this phase of the land reform also failed as about 1 million black families lived in overcrowded communal lands as the land reform programme was not funded.

The government began the FTLRP in 2000, and in 2002, it passed the Land Acquisition Amendment Act to put a formal structure on the on going FTLRP. The FTLRP was designed into two models, where model 1 was to resettle people from overcrowded communal farm areas into acquired farmlands and model 2 was designed to establish small- to medium-sized commercial farms operated by black indigenous farmers. Between 2000 and 2002, Commercial Farmers Union membership dropped significantly and between 2000 and 2003, agricultural production fell by 25% [7]; this may be because the resettled farmers lacked the necessary skills, knowledge, and capital to invest in capital-intensive commercial farming. Whether this drop was attributed to 2002 drought, or the negative outcome of fast-track land resettlement and invasion of 2000 to 2003 is subject to empirical investigation.

Although several programmes have been implemented such as the Farm Mechanisation programme to boost agriculture productivity, a significant amount of output has not been realised as evidenced by high poverty levels, and high importation of grain food crops. The Farm Mechanisation programme run by the Reserve Bank of Zimbabwe influenced prices, so the reward for farmers was very low, discouraging production. Between the 2000/2001 and 1999/2000 agricultural season, the area under grain crop cultivation fell by 15 percent and Food and Agriculture Organisation reported a national cereal harvest of 1.57 million tonnes in 2000/2001 agricultural season, compared to 2.15 million tonnes in 1999/2000 agricultural season. Following the implementation of the FTLRP, macroeconomic indicators show that agricultural output and contribution of the agricultural sector to economic growth fell, with rising poverty levels especially in rural areas, making the viability and sustainability of the land reform programme questionable [6]. Zimbabwe’s major cash and food security crop production levels have been on a downward trend since the year 2000, when the FTLRP was implemented, except tobacco from 2008. The production of major cash and food security crops is shown in Figure 1.

From 1991 to 2000, the production levels of tobacco, cotton and soya bean shows an upward trend, though for some years such as 1992 and 1995, production levels fell because of drought. From the year 2000 when the FTLRP was implemented, production levels for tobacco, cotton and soya bean show a downward trend till the year 2019 except for tobacco, which shows an upward trend from the year 2008 to 2019. The fluctuation in agricultural output overtime among other factors was a result of natural disasters which include drought ranging from extreme drought to mild drought for the years 1991, 1992, 1995, 1998, 2002, 2003, 2005, 2007, 2009, 2010, floods for the year 2001 and epidemic for the year 1996 and 2008 [8,9].
Maize production has also been on a downward trend since the implementation of the FTLRP. Figure 2 shows the production levels for maize in Zimbabwe. The fluctuation in maize output may not all be attributed to land reform program but to other natural disasters such as drought, floods as well as epidemic.

Until 2020, no compensation had been given to commercial farmers whose land was taken for redistribution, leaving thousands of employed black farm workers jobless [5]. Although several factors negatively affected the agricultural sector, the FTLRP, climate change and natural disasters are the main variables which may have dramatically affected agricultural output since the year 2000. There is a general notion that the fall in the agricultural sector was attributed to the land reform program and in August 2020, the Government of Zimbabwe issued a new legislation under which former farm holders may apply for restoration of land that was compulsorily acquired from them for resettlement. As
the government seeks to maximise agricultural productivity and production, it is unclear and unknown how the agricultural production might be affected by this new legislation. Agriculture contributes 15–18% of gross domestic product, 23% to total formal employment and provides livelihoods to approximately 70% of the rural population \[10\]; it is against this backdrop that this study seeks to examine the effect of fast-track land reform program on agricultural production in Zimbabwe, focusing on few selected key crops; this paper hypothesise that land reform had a negative effect on agricultural output and that the new legislation would result in sustainable agriculture, increasing agricultural output through increased skills transfer from former farm owners to resettled farmers.

2. Literature Review

2.1. Farm Size and Productivity Relationship

The inverse relationship between farm-size and productivity goes back to Ref. \[11\] who highlighted that as the farm size increases, productivity falls. The inverse farm-size-productivity relationship states that for a given technology, small farms are more efficient than large farms, because in small farms, there is strict supervision and efficient utilisation of resources \[2\]. Ref \[11\] showed that small farms produced more output per unit of land than large farms in Russia. When small farms are intrinsically more productive than large farms, this would suggest land redistribution to improve agricultural productivity \[12\]; however, the relationship between output per hectare as a function of total farm size and other variables is sensitive to omitted variable bias and when measurement errors are controlled, there is little or no evidence of a native relationship between farm size and productivity.

The land reform programme changed the agricultural sector where large farms were divided into small farms. Thus, the inverse farm-size-productivity relationship suggest that land reform would result in increased productivity. As a bases for downsizing of farms, studies show that there is inverse relationship between farm-size and productivity \[11,13–18\]; however, Ref. \[19\] found the relationship between productivity and farm-size to be neither monotonic nor univocal, where less productive farm exhibits an inverted U-shape relationship between farm-size and productivity while more productive farmers showed a U-shaped relationship. Ref. \[20\] showed that the inverse relationship disappears when homogenous land area under cultivation is considered, rather than actual land area. Ref. \[21\] showed a negative relationship between farm-size and productivity within countries and positive relationship across countries. Thus, the relationship between farm size and productivity is debatable for it is subject to measurement errors and down-sizing of farms and/land reform might not be a sufficient justification for improved productivity.

Ref. \[11\] brought an inverse farm-size and productivity relationship puzzle. The dividing of farms to increase productivity would not be sustainable if the puzzle was just a spurious statistical result caused by market failures in labour and credit markets \[12\]. Although land reform has been done in various countries (Land reform has been done in different countries including Japan, Republic of Korea, China, Taiwan province, India, Nepal, Vietnam, Zimbabwe, South Africa among other countries), its success in achieving high productivity and food security has not been adequately researched. Few studies have been done on examining the impact of land reform program on agricultural output and different results have been found, with scholars having different opinions regarding the success and sustainability of the land reform program, particularly in Zimbabwe.

2.2. Evidence from Various Countries on the Impact of Land Reform

Several studies have been done in different countries on how land reform affected the agricultural sector and livelihoods, showing different findings. In Zimbabwe, a study by Ref. \[4\] on land reform showed improved livelihoods for Athlone households in Murehwa district after the FTLRP. The study found beneficiary households of land reform being able to meet their own food, grain needs; however, the study showed that the households’ livelihoods were vulnerable as they managed to survive at subsistence level. Ref. \[3\] found
that financial return to land reform is mediocre despite evidence that beneficiaries of the land reform program increased their agricultural productivity substantially over time in Zimbabwe; this could be because the target land reform beneficiaries performed their farming activities in areas favourable for farming or during a period having a bumper harvest and thus an increase in productivity for land reform beneficiaries may not translate to increased agricultural production for the economy.

Ref. [22] examined the FTLRP and agricultural productivity in Zimbabwe using the beneficiaries of the program and a control group of communal farmers to analyse the program’s impact on agricultural productivity. The study found that FTLRP beneficiaries are more productive than communal farmers, with the source of this productivity differential being differences in input usage. What explains differences in input usage explains the differences in productivity between land reform beneficiaries and communal farmers, suggesting that holding other factors constant, there would be no productivity differences between land reform beneficiaries and communal farmers; thus, within the Zimbabwean context, some studies show increased productivity and livelihoods due to the land reform programme, while others show no significant differences between land reform beneficiaries and communal farmers, ceteris paribus. In addition, a similar study in Mexico by Ref. [23] found that the growth rate of output was considerably higher for the land reform sector than for the private sector and this was attributed to the transfer of land from the private sector to the land reform sector; however, the study also found that crop yield was lower in the land reform sector than in the private sector.

In Tajikistan, a study was done by Ref. [24] on the economic effects of land reform and found that land reform programs increased agricultural production through increased productivity. A similar study in Pakistan by Ref. [15] on the impact of land reform on farm production and income distribution showed that employment increased as a result of land reform program and the magnitude of inequality of income distribution decreased after the land reform program. There are different success stories regarding the impact of land reform on agricultural output and most studies used a sample of beneficiaries of land reform and non-beneficiaries of land reform to examine its success; however, there are issues to do with sample selection bias, for there is need to control for other factors such as rainfall patterns in the different areas and farming environment.

Ref. [25] examined the impact of land reform policies on agricultural growth and performance in Commonwealth of Independent States (CIS). The study found that initially, there was rapid and continuous agricultural growth but five years before the transition into a new regime, there was stagnation. Steep decline was observed for seven years after land reform and thereafter, recovery of agricultural growth was observed. The conclusion was that policy decisions play a crucial role in determining agricultural performance. Ref. [26] assessed the land reform in four African countries which are Ghana, South Africa, Uganda, and Egypt. Land reform in Ghana, Uganda and South Africa was found to be biased against women since there is unequal land rights between men and women. In general, land reform in the four African countries was found to benefit the rich and those in authority, while the poor remain oppressed.

In Ireland, Huttman [27] investigated the impact of land reform on agricultural production. Regulated tenancy land regime led to economic inefficiency because individuals who owned small pieces of land could not enjoy economies of scale in their production. Ref. [28] examined the property rights associated with China’s land tenure systems and their impact on agricultural production. The study found that land insecurities lead to reduction in agricultural productivity; this may be explained by the fact that if individuals are aware that in the near future, they might lose the land to someone else, they reduce the amount of inputs such as fertilizers used on that particular piece of land, thus reducing its productivity.

Ref. [29] investigated the effects of agricultural land reform on income redistribution and rice production in Korea. The findings were that abolition of tenancy due to land reform positively influenced rice production. The size of the land also had a positive and
significant effect on rice production. Further, land reform resulted in income redistribution especially from landlords to tenants. In a similar study, Ref. [30] analyzed the impact of land reform on chemical fertilizer use and land productivity of rural farms in Vietnam. Land reform, wealth and non-farm income were found to have positive effects on both chemical fertilizer use and land productivity. Contrary to Ref. [29], this study found that farmland area had a negative effect on land productivity.

A study examining the implications of land reform on household decisions regarding forest conservation, agricultural intensification and land use in Amazon was carried out by Ref. [31]. Land reform, socioeconomic and institutional factors were found to affect households’ attitude towards land use and the need to adopt a more intensive production system. The results show that defined land tenure alone did not guarantee intensive forms of agriculture. Ref. [32] investigated the effects of land reform on land use and land cover in South-Eastern Albania. After reforms, agricultural land was abandoned which led to increase in forest cover; however, the land tenure system which advocated for redistribution of agricultural land to the rural population had significantly lower abandonment rate as compared to the regime that returned agricultural land to their initial owners; this is because most of the historic owners of the land had relocated to the urban areas and they had no incentives to go back to their lands and carry out agricultural activities, implying a fall in agricultural output following land reform program; however, although land was significantly occupied by the rural population, it was not revealed empirically how the occupation affected agricultural output.

A study investigating whether land reform has adverse impact on the livelihoods of poor land users was carried out in Ghana by Ref. [33]. In particular, the study examined the effects on land reform on pastoralists, women farmers, and migrant farmers. Land reform was found to have the potential of reducing poverty if it is implemented as part of integrated development initiative. Ref. [34] concluded that land reform in Botswana led to increase in agricultural productivity; however, the study found that there was decline in social equity achieved among the poor people. The hunters and gatherers, smallholder farmers, women, youth, and households who did not own cattle did not benefit from the land reform. Further, a study investigating how land reforms could contribute to revival of smallholder agriculture in Southern Africa was carried out by Ref. [35]. The study found that land reform is insignificant in ensuring assets redistribution to the poor as well as improving the livelihoods of the people in the rural areas.

In the Zimbabwean context, land reform was in the form of land redistribution where large farms in the hands of few minority white farmers were divided into small farms to ensure that abandoned or under-utilised land was being exploited to its full potential and opportunities are provided to the unemployed and landless. Redistribution of land was to disburse surplus land amongst small and marginal farmers, alleviate rural poverty and increase agricultural productivity. Small farm sizes being perceived to be more productive than large farms in literature as pioneered by Ref. [11], Zimbabwe’s main export crops dropped significantly as shown in Figures 1 and 2. Therefore, a question regarding the sustainability and success of land reform in boosting farming can be posed, which is the aim of this paper.

3. Methodology and Data

3.1. Model Specification

Assuming a Cobb-Douglas production function, this study proposes a national aggregate production function specified as follows:

\[
Q_t = A_t \prod_{i=1}^{n} X_{it}^{\alpha_i} \varepsilon_t
\]  

(1)

Whereas \( Q_t \) is the aggregate national output, \( X_t \) is a vector of input variables, such as capital, rainfall, temperature, labour, and land allocated to production, and \( A_t \) is total
factor productivity and \( \varepsilon_t \) is the error term. Output produced not only depends on the input variables but also rely on the price the farmer receives after selling the agricultural produce as highlighted by the theory of supply, price of other competing crops, drought and change in the land distribution as captured by land reform in this study. Equation (1) can be linearized by applying natural logarithms on both sides of the equation as done by Ref. [29] to interpret the coefficients as elasticities and the production function was specified as follows.

\[
\log(Q_t) = \alpha + \beta_0 \log(Acreage_t) + \beta_1 \log(Rainfall_t) + \beta_2 \log(Tempi) \\
+ \beta_3 \log(Price_t) + \beta_4 \log(PriceComp_t) + \beta_5 \text{ActivePop} + \beta_6 \text{LandRf} + \beta_7 \text{Drought}_t + \varepsilon_t
\]  

(2)

Specifically, the aggregate production function can be specified for a particular crop and the production function for maize and soybean are shown by Equations (3) and (4), respectively.

\[
\log(Q^M_t) = \alpha + \beta_0 \log(Acreage_t) + \beta_1 \log(Rainfall_t) + \beta_2 \log(Tempi) \\
+ \beta_3 \log(Price^M_t) + \beta_4 \log(Price^C_t) + \beta_5 \text{ActivePop} + \beta_6 \text{LandRf} + \beta_7 \text{Drought}_t + \varepsilon_t
\]  

(3)

\[
\log(Q^S_t) = \alpha + \beta_0 \log(Acreage_t) + \beta_1 \log(Rainfall_t) + \beta_2 \log(Tempi) \\
+ \beta_3 \log(Price^S_t) + \beta_4 \log(Price^C_t) + \beta_5 \text{ActivePop} + \beta_6 \text{LandRf} + \beta_7 \text{Drought}_t + \varepsilon_t
\]  

(4)

where \( Q^M_t \) is the quantity of maize per hectare (yield), \( Q^S_t \) is the quantity of soyabean, \( \text{Acreage}_t \) is acreage, \( \text{Rainfall}_t \) is the average annual rainfall in millimetres, \( \text{PriceComp}_t \) is the price of competing crop, \( \text{Tempi} \) is the average yearly temperature, \( \text{Price}^M_t \) is the price of maize per tonne in ZWL, \( \text{Price}^S_t \) is price of soyabean per tonne in ZWL, \( \text{Price}^C_t \) is price of cotton per tonne in USD, \( \text{ActivePop} \) is the economically active population in agriculture as a percentage of economically active population, \( \text{LandRf} \) is a dummy variable to capture a structural change, land reform where all years after 2000 take a value of 1 and the other years get a value of zero, \( \text{Drought}_t \) is a dummy variable to capture drought where any year that experienced drought takes a value of 1, and zero otherwise, \( \alpha \) is an intercept, \( \beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5 \) are slope coefficients and \( \varepsilon_t \) is the error term. The proportion of economically active population in agriculture was used as a proxy for employment in agriculture. The dummy variable \( \text{LandRf} \) would capture the difference in average output after the land reform to before the land reform and that difference would be the effects of land reform. The coefficient of \( \text{LandRf} \) would tell how much above or below the average output after the land reform is compared to output before the land reform, ceteris paribus.

Models 3 and 4 are based on the theory of supply and theory of production, where the theory of supply shows how the quantity supplied by the farmers responds to changes in the price of the own agricultural output. An increase in own price of the agricultural output incentivises farmers to produce and supply more output, resulting in a positive relationship between own price and quantity produced and supplied; however, not only own price of output affect quantity produced and supplied by farmers, but the price of other competing crops such as cotton affect the quantity of soyabean, and maize produced and supplied. An increasing in the price per tonne of a competing crop such as soyabean incentivise farmers to shift production towards the crop which has experienced an increase in price. Thus, a negative relationship between the price of a competing crop (cotton) and the quantity of agricultural output produced and supplied (soyabean and maize) is expected to be negative.

To estimate Equations (3) and (4), Ordinary Least Squares estimation technique was used in the study. Ordinary Least Squares turn out to be efficient when compared to certain categories of estimators. The Gauss–Markov theorem states that under the assumptions of the Classical Linear Regression Model (CLRM), OLS is optimal, and the estimator is the best linear unbiased estimator [36]. Before reporting the results on how land reform program
affected agricultural production for specific agricultural produce (maize and soyabean),
several pre-estimation and post-estimation tests were done. A stationarity test was done
using the Augmented Dickey–Fuller unit root test and is widely used in literature, and
it accommodates some form of serial correlations. A Breusch–Godfrey test was used to
test for serial correlation while the White test was used to test for heteroscedasticity.
The normality of residuals was tested using the sktest, which test normality based on skewness
and another based on kurtosis and then combines the two tests to get an overall test statistic.
These results are shown in Appendix A in Tables A1–A3.

3.2. Data Sources

The data used in this study are annual data covering the period 1980–2019 and were
obtained from the Ministry of Land, Agriculture, Water, and Rural Resettlement Agricul-
tural Statistical Bulletin, African Development Bank Group, Zimbabwe National Statistics
Agency, and Grain Marketing Board annual reports. It is assumed that the quantity pro-
duced is what is supplied to the Grain Marketing Board (GMB) by farmers for what is
observable is the quantity supplied by farmers to the GMB. Data on cotton prices were
obtained from Macrotrends Data. The choice of maize and soyabean was based on data
availability and both crops being among the major crops in Zimbabwe.

4. Econometric Results

The Augmented Dickey–Fuller unit root test was used to test for stationarity of the
data and the results show that all the variables were found to be stationary in levels except
for the proportion of economically active population in agriculture, producer price of maize
and producer price of soyabean. Thus, the proportion of economically active population in
agriculture, the producer price of maize and the producer price of soyabean were found to
be integrated of order one while all the other variables included in the model were found
to be integrated of order zero. As only three variables were found to be non-stationary
in levels, the Ordinary Least Squares estimation technique was used, and the results are
shown in Table 1.

Table 1. Estimated Maize and Soyabean Models.

| Variable          | Coefficient | t-Statistic | Prob  | Coefficient | t-Statistic | Prob  |
|-------------------|-------------|-------------|-------|-------------|-------------|-------|
| C                 | 31.82442 ** | 2.42        | 0.014 | 3.375055    | 0.51        | 0.613 |
| LOG(ACREAGE)      | −0.0423777 | −0.13       | 0.895 | 0.7970256 *** | 7.82        | 0.000 |
| LOG(RAINFALL)     | 0.7428045 * | 1.89        | 0.068 | 0.439602 **  | 2.17        | 0.038 |
| LOG(TEMP)         | −8.710285 ** | −2.56      | 0.016 | −0.4897244   | −0.27       | 0.788 |
| D(LOGMAIZEPR)     | −0.0474193 | −1.48      | 0.149 | 0.0006023    | 0.04        | 0.97  |
| D(LOGCOTTONPR)    | −0.2880366 | −1.04      | 0.308 | −0.2619241 * | −1.75       | 0.091 |
| ACTIVE_POP        | −0.0309725 | −0.78      | 0.440 | −0.0119727   | −0.56       | 0.578 |
| LAND_REFORM       | −0.3515911 ** | −2.43    | 0.021 | −0.2549943 *** | −3.46       | 0.002 |
| DROUGHT           | 0.0129911  | 0.09       | 0.931 | 0.0031803    | 0.04        | 0.968 |

R-squared 0.6281 Adjusted R-squared 0.8002
R-squared 0.5289 Adjusted R-squared 0.7469
F-statistic 6.33 F-statistic 15.02
Prob(F-statistic) 0.0001

(*) (**), (*** ) means significance at 10%, 5% and 1% level.

The other pre-estimation and post-estimation tests that were done include the multi-
collinearity test, serial correlation test, normality of residuals test, model misspecification
test and heteroscedasticity test. There was multicollinearity between the price of maize and
price of soyabean and as a result, these variables could not appear in the same regression
because multicollinearity makes it difficult to separate the effect of one variable from the
effect of another variable and the estimates would not be precise. The multicollinearity
between the two variables is justified because their prices are set at the government level and thus, tend to move in the same pattern. See the Appendix A for the test results. The White test, which is a special case of Breusch-Pagan test is normally used instead of the Breusch-Pagan test because the Breusch-Pagan test does not work well for non-linear forms of heteroscedasticity and has problems when errors are not normally distributed. The results in the Appendix A show that there is no problem of serial correlation, model misspecification, heteroscedasticity, and normality. Since the assumptions of the classical linear regression model were satisfied, the Ordinary Least Squares estimation technique was used as it is the benchmark when compared to other estimation techniques and it is the maximum-likelihood solution.

4.1. Estimated Maize Function

The estimated model is statistically significant at 1% level, implying that the model estimated is valid. The coefficient of determination shows that 63% of the variation in maize output per hectare produced and supplied is explained in the model. The estimated maize production and supply function shows that rainfall, temperature, and the land reform program significantly influence maize output per hectare. The coefficient of rainfall was found to be positive and statistically significant at 10% level, implying that a 1% increase in average annual rainfall result in approximately 0.74% increase in output per hectare produced and supplied in Zimbabwe, ceteris paribus. The coefficient of temperature was found to be negative and statistically significant at 5% level, meaning that a 1% increase in average annual temperature result in approximately 8.71% decrease in maize output per hectare produced and supplied in Zimbabwe, ceteris paribus; these results show that with climate change and increase in temperatures, maize production is at risk.

Contrary to the expectations, the coefficient of price for maize was found to be statistically significant insignificant, implying that maize price has no effect on the production and supply of maize. Although this is contrary to the theory of supply, this might reflect the nature of the maize market in Zimbabwe, where the producer price of maize is lower than the prevailing market price of maize such that an increase in producer price does not significantly induce farmers to supply maize to the GMB. Thus, farmers are not responsive to price changes as they rely on the parallel market prices—so the gazetted price does not have effect on production of maize. The results also show that the coefficient of land reform was found to be negative and statistically significant at 5% level, implying that the period after land reform has a lower maize output per hectare produced and supplied compared to the period before land reform. Specifically, the maize output per hectare produced and supplied after land reform is approximately \( (e^{-0.3516} - 1) \times 100\% = -29.64\% \) 29.6% lower than the maize output per hectare before the land reform. Thus, the result shows that the land reform program resulted in decline in maize output per hectare produced and supplied in Zimbabwe.

4.2. Estimated Soyabean Function

The estimated model is statistically significant at 1% level, implying that the model estimated is valid. The coefficient of determination shows that 80% of the variation in the soyabean output produced and supplied is explained in the model. The estimated soyabean function show that acreage, rainfall, producer price of cotton and land reform have impact on the amount of soyabean produced and supplied. Soyabean acreage was found to have a positive and statistically significant coefficient at 1% level, implying that a 1% increase in acreage for soyabean result in an increase in soyabean production by approximately 0.80%, ceteris paribus. Rainfall was found to have a positive and statistically significant coefficient at 5% level, implying that a 1% increase in average annual rainfall result in an increase in soyabean produced and supplied by approximately 0.45%, holding other factors constant. The coefficient of producer price of cotton was found to be negative and statistically significant at 10% level, implying that a 1% increase in producer price of cotton result in approximately 0.26% decline in soyabean produced and supplied; this shows that
cotton is a competing crop for soyabean-to-soyabean farmers such that when the producer price of cotton increases, the production and supply of soyabean falls; however, the result from the estimated maize function shows that to maize farmers, cotton is not a competing crop since an increase in the producer price of cotton does not significantly influence the quantity of maize produced and supplied; this might be explained by the fact that soyabean and cotton grow well under similar weather conditions, hence are competing crops.

The coefficient of producer price of soyabean was found to be positive and statistically insignificant, suggesting that soyabean output does not respond to gazetted price of soyabean; this might be because farmers are not responsive to price changes as they rely on the parallel market prices—so the gazetted price of soyabean does not have an effect on production of soyabean production/supply. The results also show that the coefficient of land reform was found to be negative and statistically significant at 1% level, implying that period after the land reform program experienced lower output of soyabean produced and supplied compared to period before the land reform program. Thus, soyabean output produced and supplied after the land reform was found to be \((e^{-0.2550} - 1) \times 100\% = -22.51\)% lower than the soyabean output produced and supplied prior the land reform program. The results are consistent with the findings of Li et al. (1998) who found that land insecurities led to reduction in agricultural productivity and Muller and Sikor (2006) who found that after land reform, agricultural land was abandoned which led to an increase in forest cover and fall in agricultural output.

4.3. Discussion of Econometric Results

The result from the study shows that rainfall, producer price of maize and the land reform significantly influence the production and supply of both soyabean and maize. In addition, the results reveal that the post-land reform period experienced lower maize and soyabean production compared to the period before the land reform program, holding other factors constant. Thus, land reform program brought a change in the agricultural production and supply to the GMB as the large-scale commercial farmers were replaced by indigenous farmers. Although land was successfully distributed to indigenous farmers, this was done at the expense of maize and soyabean production and the results of this study may be generalised to other crops. The results on the impact of land reform on agricultural output are consistent to the findings of other studies done in different countries, showing that land reform resulted in fall in agricultural output. For instance, despite some studies by Refs. [25,29,30] finding positive impact on land reform on agricultural output, studies by Refs. [28,32] showed the negative impact of land reform on agricultural output, with [27] showing that land reform led to economic inefficiency because individuals who owned small pieces of land could not enjoy economies of scale in their production. Similar findings were found in Zimbabwe by Ref. [2] who argued that when comparing with statistics just before the launch of the FTLRP, productivity of FTLRP beneficiaries fell short of the levels demonstrated by commercial farming sector in that year.

The paper expects that there might be measurement errors in aggregate output, because only output supplied by farmers to the GMB would be captured and aggregated to give national output. Although there might be limitations of this paper such as these measurement errors on the dependent variables (aggregate output), the measurement errors on the dependent variable still give unbiased coefficients. Future research might consider collecting data directly from farmers, or using a different methodological approach, if possible.

5. Conclusions

Since the year 2000 when the Fast-Track Land Reform Programme was implemented in Zimbabwe, a dramatic fall in agricultural production resulted, as the large-scale white farmers were replaced by smallholder indigenous farmers. There are many factors such as climate change that might have attributed to the decline in agricultural production, and the Fast-Track Land Reform Programme is believed to have brought this dramatic fall
in agricultural production; this therefore questions the sustainability of the land reform, and its success in promoting agricultural output. As a matter of policy concern, this paper examined the effect of the land reform programme on the agricultural production in Zimbabwe, particularly focusing on main crops, which are maize and soyabean.

The motivation for this paper comes at a time when Government of Zimbabwe gazetted a new legislation in 2020, under which former farm holders may apply for restoration of title to the piece of agricultural land that was compulsorily acquired from them for resettlement, and the new regulations apply to indigenous farmers whose farms were appropriated as well as foreign farmers whose land was protected by the Bilateral Investment Protection and Promotion Agreements (BIPPA) and Bilateral Investment Treaties (BITs). The paper therefore drew the implication of the restoration of land acquired for resettlement in Zimbabwe from the effect of FTLRF on agricultural Production. The study found that the period after land reform had lower maize output and soyabean output per hectare compared to the period before land reform. The results therefore suggest that the restoration of land to former farm holders is a viable policy option to boost agricultural production, particularly maize and soyabean. The study also found that rainfall and temperature influence maize output per hectare while acreage, rainfall, and producer price of cotton influence the amount of soyabean produced in Zimbabwe. The results showing higher temperature having a negative impact on maize production and rainfall having a positive impact on maize and soyabean production imply that agricultural production is at risk from climate change. Therefore, interventions need to be done, such as setting up of irrigation systems and growing of drought-resistant crops in drier regions. In addition, the restoration of land former farm holders is a viable and sustainable policy option to boost agricultural production and productivity; however, improvement in agricultural production following the restoration of land is conditional on favourable climatic conditions, good policies that support farmers among other factors.

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Appendix A

Table A1. Augmented Dickey-Fuller Unit root test Results.

| Variable           | ADF t-Statistic | Critical Value at 1% Level | Critical Value at 5% Level | Critical Value at 10% Level | Decision         |
|--------------------|-----------------|----------------------------|-----------------------------|----------------------------|------------------|
| Log(MaizeYield)    | −3.515          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(SoyaOutput)    | −2.638          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(Rainfall)      | −5.217          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(Temp)          | −3.758          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(AcreageMaize)  | −2.652          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(AcreageSoya)   | −3.283          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(CottonPrice)   | −3.100          | −3.662                     | −2.964                      | −2.614                     | Stationary I(0)  |
| Log(MaizePrice)    | −1.957          | −3.662                     | −2.964                      | −2.614                     | Non-stationary   |
Table A1. Cont.

| Test                  | Test Statistic | Calculated Value | p-Value | Conclusion                  |
|-----------------------|----------------|------------------|---------|----------------------------|
| Log(SoyaPrice)        | −2.007         | −3.662           | −2.964  | −2.614 Non-stationary       |
| Active                | −0.882         | −3.662           | −2.964  | −2.614 Non-stationary       |

Augmented Dickey-Fuller Unit root test Results after first difference

| Test                  | Test Statistic | Calculated Value | p-Value | Conclusion                  |
|-----------------------|----------------|------------------|---------|----------------------------|
| D(Log(MaizePrice))    | −5.690         | −3.668           | −2.966  | −2.616 Stationary I(1)     |
| D(Log(SoyaPrice))     | −4.475         | −3.668           | −2.966  | −2.616 Stationary I(1)     |
| D(Active)             | −4.219         | −3.668           | −2.966  | −2.616 Stationary I(1)     |

Table A2. Summary of the Model Diagnostic Test Results for Maize Model.

| Test                  | Test Statistic | Calculated Value | p-Value | Conclusion                  |
|-----------------------|----------------|------------------|---------|----------------------------|
| Autocorrelation       | Chi-squared test | 0.197            | 0.6574  | There is no autocorrelation |
| Normality Test        | Sktest (Adj Chi2) | 1.15             | 0.5625  | Residuals are normally distributed |
| Heteroscedasticity    | Chi-squared test | 39               | 0.4246  | No heteroscedasticity      |
| Ramsey RESET test     | F-statistic    | 0.58             | 0.6328  | Model correctly specified  |

Table A3. Summary of the Model Diagnostic Test Results for Soyabean Model.

| Test                  | Test Statistic | Calculated Value | p-Value | Conclusion                  |
|-----------------------|----------------|------------------|---------|----------------------------|
| Autocorrelation       | Chi-squared test | 0.370            | 0.5432  | There is no autocorrelation |
| Normality Test        | Sktest (Adj Chi2) | 8.66             | 0.0132  | Residuals are not normally distributed |
| Heteroscedasticity    | Chi-squared test | 39               | 0.4246  | No heteroscedasticity      |
| Ramsey RESET test     | F-statistic    | 2.06             | 0.1286  | Model correctly specified  |

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