Agricultural Production, Employment and Gender Vulnerability: Covid-19 Implications

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Abstract

South Africa responded to the Covid-19 outbreak by implementing a national lockdown aimed at slowing down the spread of the virus. While numerous businesses closed down, leading to mass job losses, essential services, including agriculture, remained open. Agriculture, a predominantly rural/peri-urban economic activity, supports the livelihoods of vulnerable groups such as women and the youth. The sector's contribution to South Africa's output, however, is not only modest but also declining. This paper investigates the relationship between production and employment in agriculture disaggregated by gender within the short and long run. Estimations of a growth model of agricultural production using quarterly data from 2008:Q1 to 2019:Q1 show that in the short run, an increase in aggregate labour has a positive effect on agricultural production. Separating aggregate labour into male and female labour, we observe that in the short run, male labour has a positive effect while female labour has an insignificant effect on agricultural production. The estimation results further indicate that, in the long run, aggregate labour employed in the agricultural sector makes a negative contribution to agricultural production. This finding is mirrored by the contribution of male and female labour separately, to agricultural production, which is also negative and significant.

Keywords: Covid-19, agricultural production, employment, women, gender, vulnerability

Introduction

Agriculture is a predominantly rural or peri-urban economic activity that supports the livelihoods of many vulnerable communities. The contribution of the agricultural sector to South Africa's aggregate output, however, is not only modest but has also been declining. It was recorded at 3.08 percent in 1994, before decreasing to 2.73 percent in 1999, 2.39% in 2010 and 2.19 percent in 2019. During the same period (1994 to 2019), the South African economy grew by an estimated 2.7%. Effectively, while aggregate output has been growing, on the average, the significance of agriculture in the country's total production of goods and services has been on the decline.

Following the detection of the first case of the novel coronavirus infection in Wuhan, China, in December 2019, and the subsequent proliferation of the pandemic to various parts of the world during January and February 2020, a national state of disaster was declared in South Africa on 15 March 2020. The declaration also pronounced several measures that included the closure of schools and travel restrictions. To minimise the spread of the disease which occurs primarily through close contact between people, the country was placed under alert level 5 lockdown as from 26 March 2020. The country's alert levels were subsequently adjusted downwards to level 4 from 01 May 2020, level 3 effective 01 June 2020, level 2 beginning 18 August 2020 and Level 1 from 21 September 2020. The national lockdown invariably led to the closure of numerous business establishments, leading to mass job losses. Essential services, however, remained open. For example, agriculture and the food supply chain, was allowed to function throughout the different phases of the lockdown.

In a survey conducted by Statistics South Africa (2020) covering the period 14 to 30 April 2020, 89.6 percent of the respondents reported that turnover was below the normal range; 47.9 percent indicated temporary closure or pause in trading activities; 8.6 percent stated that they have permanently ceased trading; 36.4 percent reported the laying off of staff in the short to medium term; 45.6 percent expected to lay off some staff within two weeks of the survey; 29.7 percent indicated that they can only survive for less than a month without turnover; and 55.3 percent stated that they can survive up to three months without turnover.

One of the few sectors that has displayed resilience is agriculture. The Statistics South Africa (2020) survey observes that Agriculture was one of only three sectors that reported the largest proportion of its players (87.7 percent) having a turnover within the normal range. The survey results also indicate that only a small proportion of the respondents emanating from five different sectors, including agriculture, reported that their turnover was above the normal range. Sustaining operations in the agricultural sector was imperative as it provided the nation with a continuous supply of essential food items. Agricultural communities operated throughout all the phases of the lockdown in the country. Accordingly, food supplies continued to flow to shops, supermarkets and other community markets.

While the agricultural sector provided an essential service during the Covid-19 national lockdown in South Africa, it comprises a relatively small part of the economy. Its contribution to the country's aggregate output has also been dwindling over the years. A key component of the agricultural community includes vulnerable groups of people, such as women, youths and rural communities. With the declining relevance of agriculture in the country's output, it is expected that the livelihoods of the vulnerable communities are also endangered. Policymakers, however, are not adequately guided as the relationship between agricultural production and disaggregated employment in the agricultural sector is not known.

While it is apparent that the understanding of gender dynamics in agricultural production is essential for poverty reduction and food security, with or without a pandemic, research on agricultural production and employment, disaggregated by gender in the agricultural sector is rare, particularly in South Africa. This has created significant policy implications for the growth of the sector, especially with the downward trend of the country's aggregate output over the years. Unfortunately, past studies that have explored the role of gender in agricultural production have omitted analysis of gender and employment in the sector (see for example, Mkpado & Mkpado, 2020; Dzanku, 2019; Gumata & Ndou, 2019; Hansen, Jensen & Skovsgaard, 2015).

Previous studies on agricultural production and gender have addressed the contribution of women to food security, and off-farm income (Dzanku, 2019; Tibesigwa & Visser, 2016; Mohammed & Abdulquadri, 2012), agricultural value chains (Derera, 2020; Coles & Mitchell, 2011; Dolan & Sorby, 2003), smallholder agricultural production and exports (Lastarria-Cornhiel, 2006), agricultural entrepreneurship (Rijkers & Costa, 2012; McGehee, Kim & Jennings, 2007), and asset ownership (Akinola, 2018; Johnson, Kovarik, Meinzen-Dick, Njuki & Quisumbing, 2016). There are, however, few studies that have focussed on the nexus between agricultural production, employment and gender in the agricultural sector (Mkpado & Mkpado, 2020; Gumata & Ndou, 2019; Hansen, Jensen & Skovsgaard, 2015). The results of Mkpado and Mkpado's (2020) study show that the global labour force in agriculture decreased from 49.77 to 40.04 percent, but increased from 12.43 to 16.94 percent in Africa during 1980 to 2016. The study also found that global female employment in the sector ranged from 40.40 to 43.02 percent in developing economies, but decreased from 40.39 to 36.08 percent in developed economies between 1980 and 2016 (Mkpado & Mkpado, 2020). Hansen et al. (2015), using a sample of countries in the European region, and immigrants living in the US observed a significant negative relationship between years of agriculture and female labour force participation rates, as well as other measures of equality in contemporary gender roles. Within the South African context, Gumata and Ndou (2019) examined the distribution of social income grants, population dynamics and employment trends by gender in the agricultural sector. Results of the study show that males still dominate the agricultural labour market, and the upward movement in the sector's employment post-2014 did not result in any significant shift in the distribution of gender employment trends (Gumata & Ndou, 2019). The current study contributes to the literature by investigating the relationship between agricultural production and gender employment in the agricultural sector and providing implications for the Covid-19 pandemic.

This study investigates the relationship between agricultural production and employment in the agricultural sector disaggregated by gender. The study estimates an autoregressive distributed lag framework of an agricultural production growth model using data from Statistics South Africa's Quarterly National Accounts and Labour Force Survey. Additional data were obtained from the World Development Indicators, a World Bank database of economic and demographic indicators.

The rest of the paper is organised as follows. Section 2 presents a review of the literature. Section 3 is an outline of the methodology, data and data sources. The study results are discussed in Section 4. Section 5 presents a summary of the paper and conclusions.

An overview of agriculture production and employment

Globally, the role of agriculture in economic growth has attracted attention in development economics for several decades (McArthur & McCord, 2017). The agricultural sector serves as an essential engine for economic growth (Aker, 2011), and it is recognised as an indispensable tool for ensuring food security, particularly in developing countries (Awokuse & Xie, 2015; Juma, 2015). The development of the sector is one of the most powerful tools that can be used to alleviate extreme poverty, boost shared prosperity and feed over 9.7 billion people by 2050, globally (World Bank, 2020). McArthur and McCord (2017) point out that the benefits of agriculture are underscored in its contribution to long-term growth and poverty reduction.

The agricultural sector accounts for about a third of the global Gross Domestic Product (GDP) (World Bank, 2020**a**; World Economic Forum, 2020); and employs over a billion people, translating into one out of every three workers (FAO, 2020). According to the World Bank (2020), the sector employed 65 percent of the poor adult working population in 2016 (World Bank, 2020).

In Africa, agriculture is a fundamental economic activity, accounting for 30 to 40 percent of GDP (World Bank, 2020**c**). However, agricultural production in the continent has not kept pace with population growth (NEPAD, 2013). In recent years, economic growth has followed a regular pattern of structural change from agriculture to other sectors of the economy (McArthur & McCord, 2017). The sector employs between 65 and 75 percent of the working population on the continent (FAO, 2020; World Bank, 2020**c**) but contributes less than 5 percent towards rural income (World Bank, 2020b). The largest proportion (approximately two thirds) of rural income is generated from on-farm activities (World Bank, 2020b). In Sub-Saharan Africa, the agricultural sector provides jobs to more than 60 percent of the population (AGRA, 2018).

Within Sub-Saharan Africa, the agricultural economy accounts for 15 percent of GDP, which ranges from below 3 percent in Botswana and South Africa to more than 50 percent in Chad (FAO, 2016). While the growth of the sector is two to four times more effective in reducing poverty on the global scale (World Bank, 2020), in Sub-Saharan Africa it is estimated to be 11 times more compared to the other sectors of the economy (World Economic Forum, 2020). This places agriculture as the key to transforming economies in Sub-Saharan Africa, as it contributes towards poverty alleviation and job creation among vulnerable rural populations and urban dwellers with limited job opportunities (World Economic Forum, 2020).

Agricultural Production and employment in South Africa

Data compiled by Statistics South Africa (StatsSA) from 2008 to 2018 shows that total employment in the country's agricultural sector declined from 838,060 during the first quarter of 2008, reaching its lowest level of 698,860 during the third quarter of 2012. Since then, there was a modest upward trend from 875,060 during the last quarter of 2012, peaking at 919,390 in the fourth quarter of 2016. In 2017, total employment in agriculture was about 800,000, and by the last quarter of 2018, it had risen to 849,300. A breakdown of the figures by gender shows that agricultural employment in the country is biased in favour of males. For example, during the first quarter of 2008, there were 294,070 females compared to 543,990 males; in the last quarter of 2013, there were 210,380 females and 503,110 males; and in the last quarter of 2018, there were 284,950 females and 564,350 males employed in the agricultural sector.

The South African agricultural sector is characterised by a dual economy, which comprises well-developed commercial farming with established supply chains and small-scale subsistence farming (New Agriculturist, 2020). There were 40,122 commercial farms in 2017 (StatsSA, 2020), mostly in livestock farming (13,639 or 33.9 percent), followed by mixed farming (12,458 or 31.1 percent) and field crops at (8,559 or 21.3 percent) (StatsSA, 2020).

The total income generated from commercial agriculture was about R332.8 billion in 2017 (StatsSA, 2020). The major contributor to total agricultural income (2017 estimates) is livestock farming (R120.8 billion or 36.2 percent) followed by mixed farming (R95 billion or 28.6 percent) and horticulture (R65.7 billion or 19.8 percent) (StatsSA, 2020). According to StasSA (2020), commercial agriculture employed 757,628 as at the end of June 2018. The horticulture sector accounted for 35 percent (268,740) of the employment, while mixed and animal farming accounted for 24.5 percent (185,863) and 21.4 percent (162,116) respectively (StatsSA, 2020).

White (2012) reveals that small-scale agriculture in developing countries is the single largest source of employment. If appropriately supported, it can offer a sustainable and productive alternative to the expansion of large-scale, capital-intensive, labour-displacing commercial farming (White, 2012). In South Africa, there are approximately 2.7 million farmers who are engaged in subsistence agriculture (New Agriculturist, 2020). The majority of the people involved in small-scale farming are women, who are considered to be vulnerable in society. Women produce between 60 and 80 percent of food consumed in Africa (Mehra & Rojas, 2008) and it is unknown whether this contribution is captured in official agricultural production data.

The Gendered Agricultural Sector

Worldwide, women are more active in the agricultural sector than men (AGRA, 2018; Lastarria-Cornhiel, 2006). Global statistics show that there is a 38 percent participation rate of women in the agricultural sector compared to 33 percent among men (AGRA, 2018). The proportion of women employed in the sector is over 50 percent in Africa and Asia (Lastarria-Cornhiel, 2006). Women have expanded and solidified their involvement in agricultural production, as they continue to take responsibility for household consumption and respond to the economic opportunities that emanate in agribusinesses (Lastarria-Cornhiel, 2006). Researchers refer to this as the feminisation of agriculture (see Lastarria-Cornhiel, 2006; Dolan & Sorby, 2003).

Lastarria-Cornhiel (2006) and Dolan and Sorby (2003) define the feminisation of agriculture as the increasing participation of women in agriculture as labourers, independent producers, and as unremunerated family workers. This trend holds for developing regions, in particular Sub-Saharan Africa, where the rate of female participation is among the highest in the world (AGRA, 2018). However, the labour force statistics for South Africa do not reflect this pattern, as the figures show that the employment of males is higher than that of females. This is mainly explained by the fact that while women have increased their involvement in agricultural production, there has been little, or no change in the gender division of labour within the household, particularly reproductive work (Lastarria-Cornhiel, 2006). Even though women have expanded their on-farming and off-farming productive activities, on top of their domestic and reproductive duties, the responsibilities of men, have not (Lastarria-Cornhiel, 2006). This increase in women's responsibilities brings in the gendered nature of the agricultural sector, both in commercial and subsistence farming where women's contribution has been underrepresented. For example, women tend to aim for contract or seasonal farm employment due to their desire to balance family and work responsibilities, which may not be applicable to men.

Gender relations occupy an integral role in women's involvement in agriculture production in several ways. The gender relations dictate their level of participation in the sector, as they are often excluded from high-value agricultural production activities such as livestock and horticulture farming and agriculture exports as both owners of factors of production and as labourers (see Lastarria-Cornhiel, 2006). When they are involved, they operate at the peripheries of high-value agriculture activities. With the dominant patriarchal system in South Africa, women often do not own factors of production such as land. Land ownership and property arrangements favour men over women (Derera, 2020), such that women own less than 15 percent of land globally (FAO, 2018).

As labourers, women are at a disadvantaged position (Kabeer, 2005; Dolan & Sorby, 2003). Their wages are lower than their male counterparts, and their employment is often of a temporary nature (Kabeer, 2005; Dolan & Sorby, 2003). The working conditions of women are more undesirable in rural areas. Yet, women's incomes exercise a considerable impact on the wellbeing of families. In South Africa, Sihlobo (2018) points out that every Rand earned by a woman achieves the same impact as R11 earned by a man. Their engagement as employees in the industry is gendered as their duties mirror that of domestic responsibilities (Kabeer, 2005). Within horticulture, for example, they are assigned delicate roles that require a feminine touch such as packing of fruits and delicate flowers. Barrientos (2001) concurs that women are preferred in the processing of agricultural products because they have "nimble fingers" and are better positioned to handle more delicate labour-intensive work. For example, 53 percent of fruit pickers in South Africa are females who are mainly employed as seasonal, temporary or contract workers (Kabeer, 2005).

Methodology

Data and Data Sources and Descriptive Statistics

To examine the relationship between agricultural production and employment in the agricultural sector disaggregated by gender and draw Covid-19 implications, the study employs quarterly frequency data covering the period 2008:Q1 to 2019:Q1 obtained from the Quarterly and Regional National Accounts and the Quarterly Labour Force Survey compiled by Statistics South Africa; and from the World Development Indicators, a World Bank database of economic and demographic indicators. The cut-off dates are dictated by data availability. The analysis starts with an examination of descriptive statistics followed by regression results.

Model Specification

We assume agricultural output is given by a simple Cobb-Douglas production function of the following form:

$$Y_t = F(K_t, A_t L_t) \quad (1)$$

where Y is real agricultural output, K is physical capital stock, A is an index of labour augmenting technology and L is labour. Taking total differentials of equation (1) with respect to time, we obtain:

$$\frac{dY_t}{dt} = \frac{\partial Y_t}{\partial K_t}\frac{dK_t}{dt} + \left(\frac{\partial Y_t}{\partial (A_t L_t)}\right) L_t \frac{dA_t}{dt} + \left(\frac{\partial Y_t}{\partial (A_t L_t)}\right) A_t \frac{dL_t}{dt} \quad (2)$$

which can be re-written as:

$$\frac{dY_t}{dt} = \frac{\partial Y_t}{\partial K_t}\frac{dK_t}{dt} + \frac{\partial Y_t}{\partial A_t}\frac{dA_t}{dt} + \frac{\partial Y_t}{\partial L_t}\frac{dL_t}{dt} \quad (3)$$

Dividing through by Y_t and multiplying the first, second and third parts of the right-hand side by $\frac{K_t}{K_t}, \frac{A_t}{A_t}, \frac{L_t}{L_t}$, respectively and re-arranging, provides the growth equation of agricultural production:

$$\frac{dY_t}{Y_t dt} = \frac{K_t}{Y_t}\frac{\partial Y_t}{\partial K_t}\frac{dK_t}{K_t dt} + \frac{A_t}{Y_t}\frac{\partial Y_t}{\partial A_t}\frac{dA_t}{A_t dt} + \frac{L_t}{Y_t}\frac{\partial Y_t}{\partial L_t}\frac{dL_t}{L_t dt} \quad (4)$$

where $\frac{dY_t}{Y_t dt}$ is growth of agricultural output (*Agric*); $\frac{dK_t}{K_t dt}$ is the growth of physical capital stock (*Capital*); $\frac{dL_t}{L_t dt}$ is growth of labour (*Labour*); $\frac{dA_t}{A_t dt}$ is technological development; $\frac{K_t}{Y_t}\frac{\partial Y_t}{\partial K_t}$ is the elasticity of agricultural output with respect to physical capital stock (β_1); $\frac{L_t}{Y_t}\frac{\partial Y_t}{\partial L_t}$ is the elasticity of agricultural output with respect to labour (β_2); and $\frac{A_t}{Y_t}\frac{\partial Y_t}{\partial A_t}$ is the elasticity of agricultural output with respect to technological advancements (β_3). We assume that, in South Africa, technological advancements are explained by trade openness *(open),* measured by the sum of imports and exports as a ratio of GDP. Accordingly, we proxy technological progress by trade openness. Adding a constant term (β_0), an error term (μ_t), and allowing for lags, equation (4) can be rewritten as follows:

$$Agric_t = \beta_0 + \beta_1 Capital_{t-i} + \beta_2 Labour_{t-i} + \beta_3 Open_{t-i} + \mu_t \quad (5)$$

Equation (5) is the baseline model. To account for the contribution of women (relative to men) to agricultural production, we decompose labour by gender and estimate the following equation:

$$Agric_t = \phi_0 + \phi_1 Capital_{t-i} + \phi_2 Male_{t-i} + \phi_3 Female_{t-i} + \phi_4 Open_{t-i} + \mu_t$$
(6)

Estimation Technique

The study employs the autoregressive distributed lag (ARDL) model for analysis. This approach can be used for variables integrated of either order zero (I(0)) or order one (I(1)) but not order two (I(2)). We commence by carrying out a Phillips-Perron Test for Stationarity to establish the order of integration for each variable used in the model. Subsequently, we test for cointegration using the ARDL bounds testing procedure developed by Pesaran and Shin (1999) and extended by Pesaran et al (2001). The ARDL approach to cointegration is popular because it is robust in small samples and it minimises endogeneity bias. In addition, the technique can be used with variables integrated of different orders (i.e. I(0), I(1) or both I(0) and I(1)) (see Solarin and Shahbaz, 2013). The ARDL presentation of equations (5) and (6) is given by corresponding equations (5A) and (6A), in that order:

$$\Delta Agric_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i}\, \Delta Agric_{t-i} + \sum_{i=0}^{n} \delta_{2i}\, \Delta Capital_{t-i} + \sum_{i=0}^{n} \delta_{3i}\, \Delta Labour_{t-i} + \sum_{i=0}^{n} \delta_{4i}\, \Delta Open_{t-i} + \delta_5 \Delta Agric_{t-i} + \delta_6 Capital_{t-i} + \delta_7 Labour_{t-i} + \delta_8 Open_{t-i} + \upsilon_{1t}$$

(5A)

$$\Delta Agric_t = \psi_0 + \sum_{j=1}^{k} \psi_{1j}\, \Delta Agric_{t-j} + \sum_{j=0}^{k} \psi_{2j}\, \Delta Capital_{t-j} + \sum_{j=0}^{k} \psi_{3j}\, \Delta Male_{t-j} + \sum_{j=0}^{k} \psi_{4j}\, \Delta Female_{t-j} + \sum_{j=0}^{k} \psi_{5j}\, \Delta Open_{t-j} + \psi_6 \Delta Agric_{t-i} + \psi_7 Capital_{t-i} + \psi_8 Male_{t-i} + \psi_9 Female_{t-i} + \psi_{10} Open_{t-i} + \varpi_{1t}$$

(6A)

The test for cointegration for the variables in equations (5A) and (6A) involves testing the null hypotheses (5B) and (6B) of no cointegration, respectively:

$$H_0 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$$

(5B)

$$H_0 = \psi_6 = \psi_7 = \psi_8 = \psi_9 = \psi_{10} = 0$$

(6B)

After establishing whether a cointegration relationship exists or not, the next step is to estimate the long run and short run relationships, depending on whether the variables are cointegrated or not. Due to the absence of any theoretical basis for its determination, the lag length is empirically determined using the Shwartz Information Criteria.

Study Results

Descriptive Statistics

Table 1 presents a zero order correlation matrix to examine the relationship between the variables and detect early signs of serial correlation in our regression analyses. As a rule of thumb, Gujarati (2003) states that if a pairwise or zero order correlation coefficient between two regressors is in excess of 0.8, then multicollinearity is a problem and regression results may be unreliable. Table 1 shows that two sets of variables have correlation coefficients greater than 0.8, namely, *labour* and *women*; and *labour* and *men*. The former has a correlation coefficient of 0.9068 while the latter has a correlation coefficient of 0.9771. This is expected because *women* and *men* are components of *labour*. In our model, *labour* on the one hand, and *men* and *women* on the other hand, are not used together in equations. Accordingly, we do not expect the observed high correlations to pose an estimation problem. Table 1 also shows that the correlation between *men* and *women* is 0.7964, which is nearly 0.8. To circumvent the multicollinearity problem pointed out by Gujarati (2003), we break equation 6(A) into two separate equations where *male* and *female* are used separately.

Table 1: Zero Order Correlation Matrix

	Agric	**Labour**	**Women**	**Men**	**Capital**	**Openness**
Agric	1.0000					
Labour	0.2076	1.0000				
Women	0.1116	0.9068	1.0000			
Men	0.2415	0.9771	0.7964	1.0000		
Capital	0.4966	0.4952	0.4052	0.5060	1.0000	
Openness	0.1529	0.5153	0.5175	0.4782	0.6740	1.0000

Source: Computed by authors

Table 2 presents the mean, standard deviation, and minimum and maximum observations from the six variables in the model. The table shows that total employment in agriculture between 2008 and 2018 varied from a low of 0.626 million to a high of 0.919 million with a mean of 0.766 million and a standard deviation of 0.088 million. Over the sample period, the mean of women employed in agriculture (0.256 million) was relatively low compared to that of men (0.520 million). Similarly, the minimum and maximum number of women employed in agriculture (0.199 million and 0.308 million, respectively), was small in comparison to the minimum and maximum number of men employed in the sector (0.412 million and 0.626 million, in that order). Agricultural production varied from a low of

R62.477 billion to a high of R89.121 billion with a mean of R69.859 billion and a standard deviation of R5.537 billion. Gross capital formation varied significantly from a minimum of R52.386 billion to a maximum of R659.473 billion with a standard deviation of R38.624 billion and a mean of R597.241 billion.

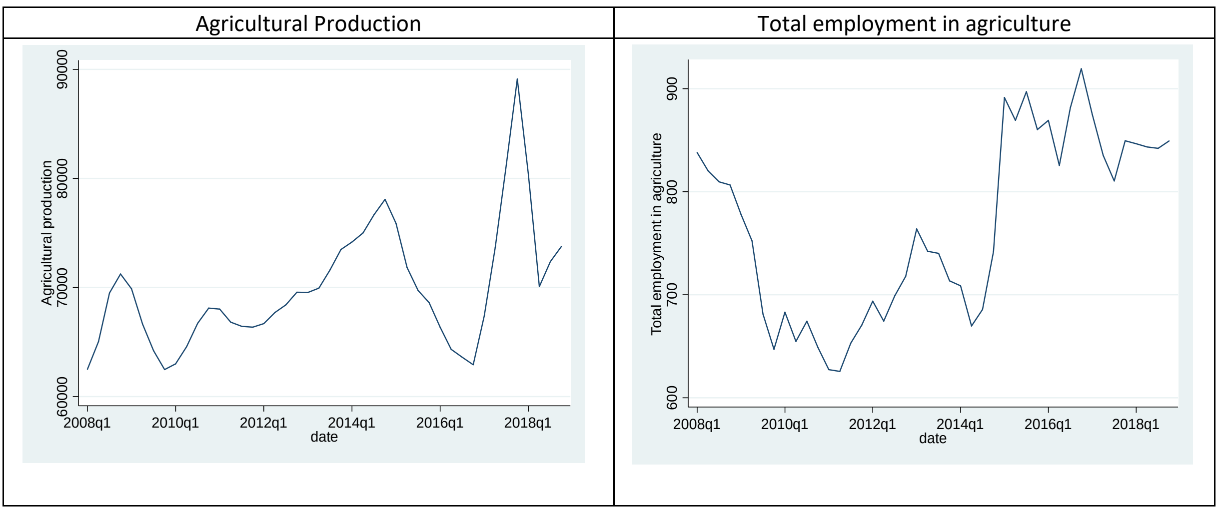
Table 2: Descriptive statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Agric	44	69,858.66	5,536.753	62,477.34	89,120.92
Labour	44	765.6152	88.11915	625.62	919.39
Women	44	245.6652	30.98277	199.44	308.11
Men	44	519.9509	61.43014	412.14	626.74
Capital	44	597,241.4	38,624.46	52,3862.4	659,472.8
Openness	44	58.92933	2.984105	51.94433	69.60717

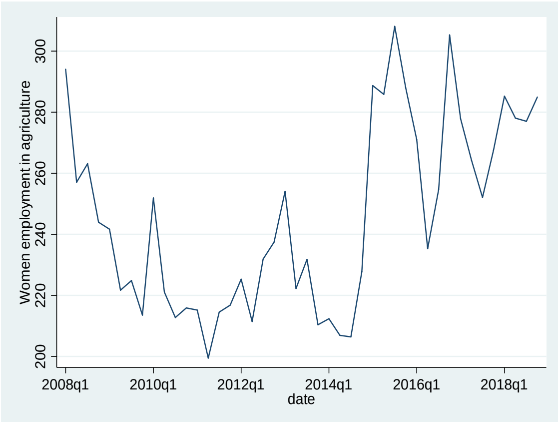
Source: Computed by authors

Figure 1 presents charts depicting trends of the six variables used in the study. Except for a sustained decline between 2015 and 2017, agricultural production shows a general upward trend. Total employment in the agricultural sector, however, appears to have declined from 2008 to the end of 2010 before it started rising (on the average). This trend is mirrored by men employment in agriculture. Women employment in the sector, on the other hand, shows a general decline from 2008, bottoming out around 2011, and remaining at a relatively low level until about 2015 when it started picking up, taking a general upward trend.

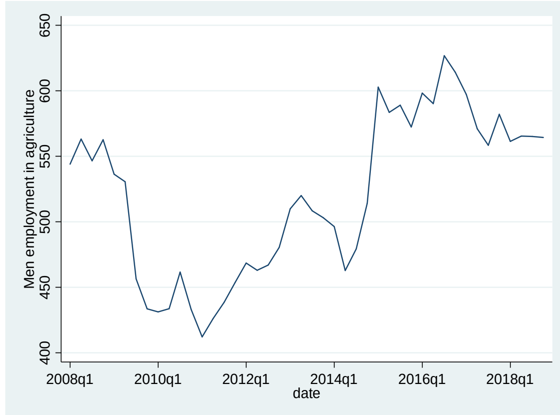
Figure 1: Variable Trends



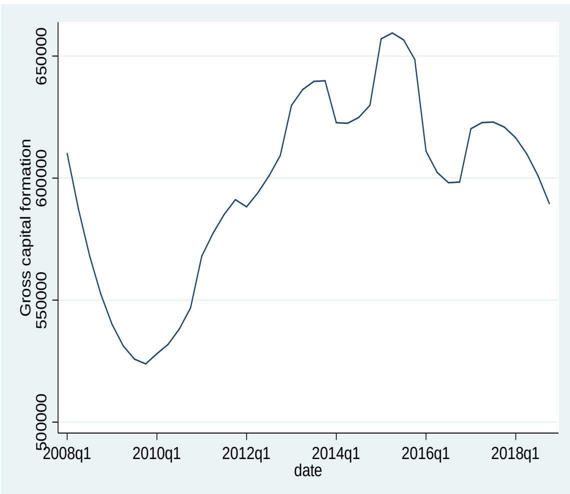
Women employment in agriculture



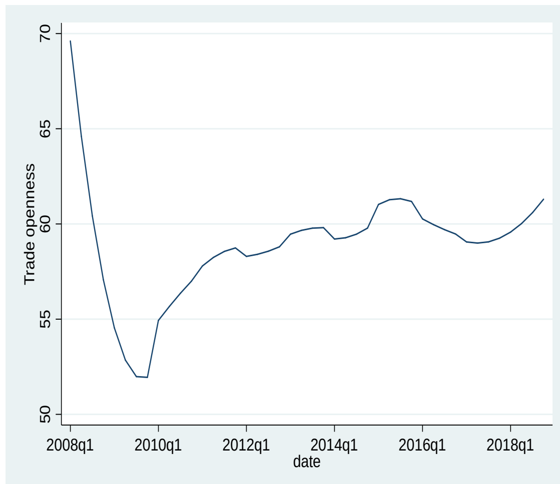
Men employment in agriculture



Gross capital formation



Trade opennness



Source: Authors

Stationarity Test

We conduct a test for unit roots to establish the order of integration for each of the variables. The ARDL estimation approach adopted in this study allows for variables integrated of either order zero (I(0)), order one (I(1)) or both I(0) and I(1) only but not I(2). The stationarity test is used to verify that there are only I(0) and/or I(1) variables in the model and no variables integrated of any higher order. The Phillips-Perron (PP) Test is used to test for the presence of the unit roots. If the P-value for a PP t-statistic of a variable is less than 0.01, 0.05, 0.1, then the variable is accepted as stationary (has no unit roots) with the test verified at 1 percent, 5 percent or10 percent critical values.

Table 3 presents the unit roots test results for each of the six variables used in the study. The table shows that with the exception of trade openness, which is integrated of order zero ((I(0)), the rest of the variables are integrated of order one (I(1)). This means that trade openness is stationary at levels while the rest of the variables have unit roots at levels and they only become stationary after first differencing.

Table 3: Phillips-Perron Test for Stationarity

Variable	Levels		First differences		Order of integration
	PP t-statistic	P-Value	PP t-statistic	P-Value	
Agric	-2.8511	0.1880	-3.5893	0.0429**	I(1)
Labour	-1.4962	0.5260	-5.7024	0.0000***	I(1)
Women	-2.5763	0.1056	-8.8598	0.0000***	I(1)
Men	-1.4024	0.5723	-5.8480	0.0000***	I(1)
Capital	-1.4995	0.5243	-3.7226	0.0072***	I(1)
Openness	-3.9688	0.0036***			I(0)

NB: Test critical values: *,**,*** represent 10 percent, 5 percent and 1 percent, respectively.
Source: Computed by the authors

Test for Cointegration

Following the test for stationarity, where it was established that all variables are I(1) except openness, which is I(0), we carry out a test for cointegration using the autoregressive distributed lag (ARDL) bounds testing procedure of Pesaran and Shin (1999) and Pesaran *et al*. (2001). The ARDL representation of the dynamic impact models is given by equations 5(A) and 6(A). In both equations - all criteria for the determination of lag length (Akaike Information, Schwarz, Hannan-Quinn and Final Prediction Error Criteria) suggest four as the optimal lag length for all variables.

Prior to checking for cointegration, we test for serial correlation and stability of the two models. Using the LM-Test, the P-Values associated with the Chi-Square are 0.1647 and 0.3617 for models 5(A) and 6(A), respectively, revealing the absence of evidence for serial correlation. A cumulative sum of residuals (CUSUM) test is also carried out and the results reveal that both models are stable. Following estimation of equations 5(A) and 6(A) (the latter separately with male and female labour), we find that all three relationships are Cointegrated (at 1 percent for equation 5(A); 1 percent for equation 6(A) (with male labour only) and 5% for equation 6(A) (with female labour only) (see Table 4 for details).

Table 4: Cointegration Test Results

Test Statistic	Value	Cointegration Status	Level of Significance
		Equation 5A (with total labour)	
F-Statistic	21.8517	Cointegrated	1%
Chi-Square	87.4066		
		Equation 6A (with Male Labour)	
F-Statistic	9.4234	Cointegrated	1%
Chi-Square	37.6935		
		Equation 6A (with Male Labour)	
F-Statistic	4.7344	Cointegrated	5%
Chi-Square	18.9377		

Pesaran, Shin and Smith (2001:300) critical values (unrestricted intercept and no trend)		
1%	I(0)	4.29
	I(1)	5.61
5%	I(0)	3.23
	I(1)	4.35
10%	I(0)	2.72
	I(1)	3.77

Regression Results

Long run and short run estimation results of equation (5A) (with total labour), equation (6A) (with male labour) and equation (6A) (with female labour) are presented in Tables 5, 6 and 7, respectively. In all three regressions, the dependent variable is growth of agricultural production, and all variables are in growth rates. Table 5 shows that in the short run, an increase in aggregate (both male and female) labour in the agricultural sector (lagged one, two, three and four times) has a positive and statistically significant effect on agricultural production (at 1 percent significance level in all cases). This is consistent with growth theory (see Romer, 2012). In the short run, labour is a variable resource that can be easily increased (decreased) to support an expected increase (decrease) in agricultural production arising from different factors including drought and sudden changes in demand. This may be achieved by using the existing capital more (less) intensively while employing more (less) labour.

Separating aggregate labour into male and female labour in the agricultural sector, we observe that in the short run, male labour (lagged one, two and three times) has a positive and statistically significant effect on agricultural output (at 1, 5 and 1 percent levels of significance, respectively) (see Table 6), while female labour has an insignificant effect on agricultural production (with 0, 1, 2, 3 and 4 lags) (see Table 7). This suggests that the positive and significant contribution of aggregate labour in the agricultural sector to agricultural production mirrors the contribution of male labour in the sector. The evidence suggests that despite their efforts, the contribution of female labour to agricultural production in the short run is not significantly different from zero. One of the implications of this finding is that women are predominantly occupied with household activities to the detriment of their productivity at work while men are able to concentrate on their jobs. Accordingly, they tend to make a relatively small contribution to formal agriculture in comparison to their male counterparts. Other studies maintain that women's contributions to agriculture is 'hidden' because the overwhelming majority of adult females spend a considerable proportion of their time producing food crops for household consumption on small household plots (see Department of Agriculture, 1997; Aliber & Hart, 2009; 2010).

While the estimation results show that women occupy an insignificant role in increasing agricultural production in the short run, studies reveal that women agriculturalists outnumber male agriculturists (see Aliber & Hart, 2010). Gender differences in various spheres occupy a key role in determining the contribution of male and female labour to agricultural production. Aliber and Hart (2010) reveal that a male-headed farming household is approximately 14 percent more likely to receive a limited amount of support service than a female-headed household and that a male-headed household is three times more likely to benefit from a state grant than a female-headed household. The insignificant contribution of female labour to total agricultural production may be attributed to unaccounted for small-scale food production for household consumption that women engage in and lack of gendered support from various institutions.

In numerous instances where both state and non-governmental organisations have taken the initiative to promote women in the agricultural sector, they have failed to recognise the significance of gender and gender dynamics inherent in the agricultural sector, consequently failing to understand the farming system (see Njoroge, 2004). Without a gender dimension as part of the intervention plan, the women are accepted as preferred beneficiaries. Sadie and Loots (1998) explain that state agricultural grants tend to be gender-neutral. Without taking into consideration the specific needs of, and constraints faced by women, these initiatives are expected to fail. According to Sadie and Loots (2008), a gendered initiative cannot achieve the intended objective if women are considered in isolation of men.

A viable intervention is to provide women with similar opportunities as their male counterparts. This is an erstwhile approach that has been implemented by governments for decades, where women are given preferential treatment so that they can eventually equate to men. To the extent that the approach has not borne the expected results suggest that probably policymakers have been missing the point. Before giving women preferential treatment, there is a need to tackle factors in the home that prevent women from reaching their potential in the same way as men. Examples include cultural factors (for example, traditions that, firstly, confine the role of women to the kitchen and childcare) and redefinition of the role of men in the home. Secondly, policies should be gendered, taking into consideration gender differences. The issuance of state loans, the transfer of technology, and other interventions aimed at promoting women should focus on gender roles in agricultural production; and should consequently consider diversity and the associated dynamics in the two genders

Tables 5, 6 and 7 show that increasing capital formation in the short run has adverse effects on agricultural production. The negative marginal product of capital may suggest that there is excessive pressure on fixed capital in the short run to increase agricultural production. Other scholars attribute the poor performance of capital to the fact that technology transfer and development in the country have been generic, with no consideration for socio-economic and environmental diversity of farmers, and the impact of these variables on the ability to use the technology (see Hart & Aliber, 2010). Other researchers attribute the post-1994 policies as having shifted away from supporting the poor, who are a majority, and, instead, focusing on the better resourced and more commercially-oriented minority black farmers (Hall et al, 2003).

The short-run results further indicate that agricultural production lagged once (Tables 5, 6 and 7) and thrice (Tables 5 and 6) has a statistically significant positive impact on current production. This suggests that there is inertia in agricultural production. For example, agricultural production has a memory that goes back at least three years. It is also observed that trade openness, a proxy for technological development, has a positive and statistically significant effect on agricultural production, which is consistent with *a priori* theoretical expectations (lagged once (Tables 5, 6 and 7), twice (Tables 5), and four times (Tables 5, 6 and 7).

The estimation results in Tables 5, 6 and 7 further show that in the long run, aggregate (both female and male) labour employed in the agricultural sector makes a statistically significant albeit negative contribution to agricultural production. This finding mirrors the contribution of male and female labour, separately, to agricultural production, which is negative and statistically significant. The negative marginal product of labour in the long run suggests that the agricultural sector in South Africa may be saturated to the extent that additional units of labour (either male or female) make negative contributions to total production (see Perloff, 2008).

The long run results consistently show that agricultural production lagged once, has a statistically significant negative effect on current production. This is consistent with theoretical expectations. If agricultural production is high in the current period, prices are likely to be supressed because of the additional supply (assuming demand and everything else remains constant). This demotivates farmers from increasing production in the follow-up period. As a result, output in the next period declines. Similarly, if agricultural production in the current period is relatively low, prices will rise following the decline in supply (assuming demand and other factors remain the same). The high agricultural prices prompt farmers to increase production, leading to higher agricultural yields in the following year.

Table 5: Regression Results of Growth of Agricultural Production with Total Labour

Panel A: Short Run Coefficients			
Variable	**Coefficient**	**Standard error**	**P-value**
ΔAgric(-1)	1.2971***	0.1841	0.0001
ΔAgric(-2)	0.0268	0.1538	0.8656
ΔAgric(-3)	0.6007***	0.1429	0.0023
ΔAgric(-4)	-0.2024	0.2584	0.4536
ΔCapital	-0.9562*	0.4959	0.0859
ΔCapital(-1)	-3.0256***	0.4954	0.0002
ΔCapital(-2)	-1.0627**	0.3839	0.0218
ΔCapital(-3)	0.6155	0.4254	0.1818
ΔCapital(-4)	-1.0796**	0.4596	0.0434
ΔLabour	-0.0555	0.0654	0.4182
ΔLabour(-1)	1.2547***	0.1919	0.0001
ΔLabour(-2)	0.8825***	0.1602	0.0004
ΔLabour(-3)	0.6398***	0.1122	0.0003
ΔLabour(-4)	0.3282***	0.0758	0.0019
ΔOpenness	-1.6033**	0.5934	0.0243
ΔOpenness(-1)	5.7857***	1.2280	0.0011
ΔOpenness(-2)	2.9391**	0.9121	0.0105
ΔOpenness(-3)	0.2883	0.6698	0.6770
ΔOpenness(-4)	0.1846**	0.3895	0.0140
Panel B: Long run coefficients			
Agric(-1)	-1.687543***	0.2319	0.0000
Capital(-1)	2.7194***	0.4627	0.0002
Labour(-1)	-1.4584***	0.1693	0.0000
Openness(-1)	-7.3680***	0.9403	0.0000

Notes

- *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.
- Δ is the first difference indicator

Table 6: Regression Results of Growth of Agricultural Production with Male Labour

Panel A: Short Run Coefficients			
Variable	**Coefficient**	**Standard error**	**P-value**
ΔAgric(-1)	1.3532***	0.1746	0.0000
ΔAgric(-2)	-0.2503	0.1825	0.1952
ΔAgric(-3)	0.9258***	0.1579	0.0001

ΔAgric(-4)	-0.0492	0.2568	0.8514
ΔCapital	-3.2011***	0.4780	0.0000
ΔCapital(-1)	-0.9986**	0.3277	0.0101
ΔCapital(-2)	0.4336	0.2909	0.1619
ΔCapital(-3)	0.2737	0.2497	0.2945
ΔCapital(-4)	-4.0706***	0.5159	0.0000
ΔMale	0.0856	0.0856	0.3367
ΔMale(-1)	0.6158***	0.1667	0.0031
ΔMale(-2)	0.3753**	0.1299	0.0136
ΔMale(-3)	0.4156***	0.0932	0.0008
ΔMale(-4)	-0.0397	0.0860	0.6526
ΔOpenness	-0.5928	0.4102	0.1741
ΔOpenness(-1)	0.9175**	0.3364	0.0183
ΔOpenness(-2)	-0.5177	0.3839	0.2023
ΔOpenness(-3)	0.0364	0.3760	0.9244
ΔOpenness(-4)	1.6918***	0.4186	0.0016
Panel B: Long run coefficients			
Agric(-1)	-0.7897***	0.2007	0.0020
Capital(-1)	0.9636***	0.3559	0.0019
Male(-1)	-0.7898***	0.1379	0.0001
Openness(-1)	-1.7634***	0.4674	0.0027

Notes

- *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.
- Δ is the first difference indicator

Table 7: Regression Results of Growth of Agricultural Production with Female Labour

Panel A: Short Run Coefficients			
Variable	**Coefficient**	**Standard error**	**P-value**
ΔAgric(-1)	0.8250*	0.4317	0.0783
ΔAgric(-2)	-0.3981	0.3636	0.2935
ΔAgric(-3)	0.1838	0.2889	0.5355
ΔAgric(-4)	-0.2678	0.2581	0.3184
ΔCapital	1.9368	1.0947	0.1003
ΔCapital(-1)	-3.1625**	1.1675	0.0179
ΔCapital(-2)	-1.0923	0.9404	0.2663
ΔCapital(-3)	0.7978	0.5005	0.1349
ΔCapital(-4)	-0.2294	0.5231	0.6683
ΔFemale	-0.0675	0.0505	0.2036
ΔFemale(-1)	0.3083	0.1958	0.1393
ΔFemale(-2)	0.2745	0.1724	0.1354
ΔFemale(-3)	0.1976	0.1381	0.1761
ΔFemale(-4)	0.0651	0.0838	0.4512
ΔOpenness	-1.9048	1.1235	0.1138
ΔOpenness(-1)	9.2114***	2.7041	0.0047
ΔOpenness(-2)	4.0195	2.5417	0.1378

ΔOpenness(-3)	-1.2146	1.4834	0.4276
ΔOpenness(-4)	5.7534**	2.4650	0.0363
Panel B: Long run coefficients			
Agric(-1)	-1.1411*	0.5364	0.0530
Capital(-1)	2.8545***	0.7858	0.0030
Female(-1)	-0.4468*	0.2168	0.0599
Openness(-1)	-9.0597	2.2637	0.0015

Notes

- *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.
- Δ is the first difference indicator

Tables 5, 6 and 7 show that the marginal product of capital is positive and statistically significant in the long run. This is consistent with theoretical expectations in growth accounting. It is further observed in Tables 5 and 6 that openness, the proxy for technological advancement, is negative and statistically significant, while in Table 7, it is insignificant. While technological development is expected to have a positive effect on agricultural production, poor technological transfers may have adverse effects. Trip (2001) states that the development and delivery of technology does not guarantee an increase in agricultural production. He maintains that there is a need to distinguish between farmers that engage in agriculture as a safety net for their diversified livelihood portfolios and commercial farmers that need technology to enhance their competitiveness and productivity. Hart and Aliber (2010) reveal that government services in South Africa have pursued a service delivery approach based on outdated transfer of technology models. They mention that in most cases, technology transfers involve the introduction of modern infrastructure and technology without sufficient pre-introduction assessment and post-introductory support. Mazibuko et al. (2008) point out that the most common technologies are spill over technologies that had originally been developed for large-scale and commercially oriented farming in the temperate climates of the north.

Covid-19 Implications

The Covid-19 pandemic has several implications for the contribution of agricultural production to aggregate output in South Africa as well as the role of gender in the agricultural sector. Presently, it is unpredictable when this pandemic will be contained and how the post Covid-19 configuration will manifest. What is, therefore, required is for government to re-strategise and ensure that basic needs are met (such as food and health care). While South Africa has a diversified economy, unlike numerous countries in Sub-Saharan Africa, its contribution to food security on the continent is not comparable to other countries in Africa. Agriculture contributes less than 3 percent to GDP compared to an average of 15 percent in the sub Saharan Africa (FAO, 2016)

The ratio of Agricultural output to national output in South Africa is modest and has been declining over the past decades. This compromises food security not just in South Africa, but also in Africa as a whole. A decline of food supplies below sustainable levels in the middle of the Covid-19 restrictions would entail a cataclysm. To maintain adequate food supplies, government needs to find ways of engendering agricultural production by incentivising more women to engage in the agricultural sector, while not losing sight of the distinguishing gender roles of male and female labour. This intervention, however, needs to be complemented with capital accumulation at a rate that is higher than that at which labour is growing in the sector.

Taking into account the whole food supply chain, if more people participate in the agricultural sector, more jobs will be created, leading to poverty alleviation in vulnerable rural communities. This is essential in the midst of the Covid-19 pandemic when most sectors are straining. The agricultural sector can serve as a cushion, limiting the extent to which the economy is declining. This is essential because the industry absorbs unemployed people with low skills levels that are challenging to incorporate in other sectors of the economy. Ultimately, this ensures a sustained flow of food supplies, transferring attention to more pressing challenges in the future.

The study results show that there is an insignificant contribution of female labour to agricultural production in the short run, yet, for men, it is significant and positive. This reflects the predominance of gender relations in the sector, as more women are operating in small scale farming (Lastarria-Cornhiel, 2006). While women's contributions are hidden or underestimated in national output statistics, they occupy a key role in providing food for consumption in homes (Mehra & Rojas, 2008). This requires new thinking in terms of how gender roles can be reconfigured during and post the Covid-19 pandemic to lessen the negative impact of such crises on women. The responsibilities of providing food in the household is a necessity with or without the Covid-19 pandemic.

The insignificant contribution of female labour to agricultural production can be explained by domestic and reproduction responsibilities that limit the potential of women in the sector. This implies that women can produce more output if they can balance home and remunerated work obligations at levels equivalent to their male counterparts. This means that introducing childcare facilities in rural areas, post the Covid-19 pandemic, for example, would provide time for them to participate in remunerative work. During the pre- and post-Covid-19 pandemic, it signifies that the government should place increased emphasis of reducing the gender imbalances in rural areas. The women in small-scale farming need support in the form of inputs, machinery, access to technology, agriculture extension services, better education and training for them to produce more food. During the Covid-19 pandemic, emphasis should be directed towards achieving short-term gains such as input support mechanisms. The existence of gendered divisions of labour in the sector, where women participate in low-value chain systems, raises the need for measures to encourage them to operate at the core of high value chains, with better income and wages, post the Covid-19 pandemic. In addition, women should be exposed and trained to meet the demands of high-value chain systems, such as participating in export markets.

The study findings show a negative contribution to agricultural production in the long run for both females and males. The observed negative marginal product of labour, in the long run, may indicate that the agricultural sector in South Africa is saturated to the extent that additional units of labour add negative contributions to total production (see Perloff, 2008). Following the observed negative impact of Covid-19 to the economy, business establishments need to find ways of optimising factors of production so that they improve profitability and sustainability in the long run. The profitability of a farming enterprise is compromised if it employs more labour relative to capital (and land) than required. This requires more advanced entrepreneurial skills sets for businesses to survive post Covid-19. Increased profitability increases retained profits, which are necessary for companies to survive in future crises.

Summary and Conclusion

This paper sought to investigate the relationship between agricultural production and employment disaggregated by gender within the short- and long run. The study estimates an autoregressive distributed lag framework of a growth model of agricultural production using quarterly frequency data from 2008:Q1 to 2019:Q1 obtained from Statistics South Africa's Labour Force Survey and National Accounts and World Bank's World Development Indicators.

The study results reveal that in the short run, an increase in aggregate (both male and female) labour in the agricultural sector (lagged one, two, three and four times) has a positive and significant effect on agricultural production. Separating aggregate labour in the agricultural sector into male and female labour, we observe that in the short run, lagged male labour has a positive and significant effect on agricultural output while female labour has an insignificant effect on agricultural production.

This finding indicates that the positive contribution of aggregate labour in the agricultural sector to agricultural production mirrors the contribution of male labour in the sector. One of the explanations for the insignificant contribution of female labour to agricultural production in the short run is that women are predominantly occupied with household activities to the detriment of their productivity at work while men concentrate on their jobs. The lack of gendered support from various institutions, including the state, may also explain the insignificant contribution of female labour in the agricultural sector to total agricultural production in the short run.

The observed insignificant contribution of female labour to total agricultural production can be attributed to unaccounted for small-scale food production for household consumption that women engage in. Aliber and Hart (2009, 2010) maintain that the contribution of female labour in the agricultural sector to total agricultural production is 'hidden' because the overwhelming majority of adult females spend a considerable proportion of their time producing food crops for household consumption on small household plots.

Gender differences occupy a key role in determining the relative contribution of male and female labour to agricultural production. Aliber and Hart (2010), for example, show that a male-headed farming household is approximately 14 percent more likely to receive a limited support service than a female-headed household and that a male-headed household is three times more likely to benefit from a state grant than a female headed household.

In cases where interventions have been undertaken to enhance the contribution of female labour in the agricultural sector, the intervening institutions have failed to recognise the significance of gender dynamics inherent in the agricultural sector and, in the absence of a gender dimension as part of the intervention plan, the characteristic functions of female labour that distinguish them from male labour are not considered leading to a high failure rate of these projects.

The estimation results further indicate that, in the long run, aggregate (both female and male) labour employed in the agricultural sector makes a significant albeit negative contribution to agricultural production. This finding is mirrored by the contribution of male and female labour, separately, to agricultural production, which is also negative and significant. The observed negative marginal product of labour in the long run may indicate that the agricultural sector in South Africa is saturated to the extent that additional units of labour (either male or female) contribute negatively to total production (see Perloff, 2008). This may be a result of labour having grown faster than the rate of capital accumulation.

The study recommends the adoption of a ruralisation policy to absorb the excess labour in the rural and peri-urban communities. This should entail systematic development towards rural functionality that would change the rural infrastructure to provide effective conditions for improved livelihoods and, consequently enhance their contribution to aggregate output. This should reverse some of the adverse effects of Covid-19 and improve labour utilisation in agriculture.

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