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Foreign Investment and Somalia's Agribusiness: Advanced Econometric Applications

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ABSTRACT

This study investigates the relationship between foreign direct investment (FDI) and agribusiness development in Somalia, focusing on key variables including crop output, foreign capital inflows, livestock, and precipitation. Using annual time series data from 1970 to 2021 sourced from the World Bank Indicators, the research applies Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests. The results confirm that most variables are stationary at level, while FDI becomes stationary after first differencing. Johansen cointegration tests reveal the existence of a significant long-run relationship among the variables. To assess these dynamics, the study employs the Autoregressive Distributed Lag (ARDL) model alongside Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods. The findings indicate that crop production has a strong and positive influence on agricultural output, highlighting the importance of efficient farming practices and land utilization. FDI also exerts a positive and significant effect, reflecting the importance of capital investment, infrastructure development, and technology adoption in enhancing agricultural performance. Additionally, livestock contributes significantly to productivity, underscoring the relevance of integrated crop-livestock systems in sustaining rural livelihoods. Rainfall is found to affect agricultural output positively, emphasizing the sector's sensitivity to climatic conditions. The Error Correction Model (ECM) confirms the existence of long-run equilibrium, demonstrating that agricultural output adjusts over time toward its long-term

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path. The study concludes by recommending integrated, evidence-based policy strategies to boost crop productivity, attract foreign investment, promote livestock farming, and manage water resources sustainably to support Somalia's agricultural development.

Keywords: Agribusiness; ARDL; Rainfall; Livestock; Crop Production; FDI

1. Introduction

Foreign investment is important in initiating and maintaining enduring relationships between overseas investors and local businesses, acting as a channel for capital inflow and the transfer of technology and expertise in management [1, 2]. This has been achieved through more competitive advantage creation as a result of globalization [1, 2]. Despite its importance, however, globally the level of foreign direct investments declined by 40% from 1.5 trillion dollars registered in 2019 due to the outbreak of the coronavirus pandemic, according to the research [3]. FDI is very vulnerable to global crises, as seen when Amazon delayed its planned merger with Deliveroo, and Boeing's acquisition in the US also suffered delays due to the virus. Early works on FDI motivation were done by the researches [4, 5], accounting for technology transfer and managerial skills acquisition. Resource-seeking, market-seeking, efficiency-seeking, and strategic asset-seeking are some of FDI motivations, according to the research [6]. The nature of resources is the main focus of resource-seeking investors, whereas market-seeking investors intend to enter into local markets. Minimization of costs is prioritized by efficiency-seeking investors, while strategic asset-seeking investors target related knowledge assets to protect or enhance their competitive positions.

Theoretically, FDI raises farm productivity through improved access to better seeds from overseas, better farming methods, improved seed production techniques, and superior technology, which increases farmland yield and labour productivity [7]. Also, local farmers can come into partnership with investors through FDI, resulting in joint projects on large-scale farming supported by the development of adequate storage facilities and transportation systems, thus enhancing agricultural exports and farm income [8].

Foreign investment supplemented domestic savings by significantly contributing to Africa's development. It creates jobs, boosts growth, and makes use of technology transfer and workforce skill development to improve efficiency. Moreover, China has emerged as a major investor country where state-owned companies are now shifting from mining to agriculture, manufacturing, and services [9]. Specifically, some of these investments are aimed at sectors like Ghanaian poultry, Kenyan coffee, or Zambian cotton. The African Development Bank launched a "Feed Africa" campaign that would address agricultural investments and avoid over-reliance on imported foodstuffs by Africa [10]. Nevertheless, the COVID-19 pandemic led to major losses of 10% in foreign investment inflow in Africa and retarded the progress of the African Continental Free Trade Agreement [3].

There are four periods in which Foreign Direct Investment (FDI) history in Somalia can be divided into: the civilian government, the revolutionary government, the civil war, and the federal government. From 196 to 1969, Somalia enjoyed free trade, which was dominated by multinational companies. Between 197 and 1982, the military regime in power nationalized entities, which discouraged other countries from investing in them. However, this did not affect foreign investment inflow, which remained at the same level. During the 1982-1988 period, FDI increased again due to economic policy liberalization. This resulted in the loss of central authority, leading to ten years of warfare during which communication systems were destroyed. From 2001 to 2012, FDI has been slowly rising as it has focused on developments related to reconstruction activities. Though difficulties continue to occur, the Federal Government of Somalia's establishment brought some political stability, and the improving security situation has helped to raise FDI inflows gradually. In the meantime, there has been an increase in greenfield projects or partnerships aimed at boosting direct investments [3]. However, despite its vastness, eco-resourceful base, and strategic location, the country continues to trail its neighbours like Ethiopia and Kenya in terms of FDI [11]. In his study of how foreign direct investments heavily affect exports and imports, the research [12] bases his argument on findings from Somalia.

Somalia's agribusiness has enormous possibilities for economic change, job generation, and food security. Though agriculture makes up around 65% of employment and is vital to Somalia's economic output, the industry is still somewhat underdeveloped. Ongoing issues include low agricultural and livestock production, obsolete farming technology, limited capital access, poor infrastructure, and environmental shocks including droughts and floods. The country's weak political state and little agricultural public investment aggravate these problems. Somalia has not yet completely taken advantage of this chance even while Foreign Direct Investment (FDI) is widely acknowledged as a driver for enhancing agricultural production and agribusiness expansion. FDI inflows have slowly risen since 2012; nonetheless, they have mostly gone to industries such as telecommunications and infrastructure, leaving agribusiness, particularly agricultural and livestock production, underfunded.

Other areas' empirical data back up FDI's beneficial influence on agricultural growth. Research by [13–17] validates a notable and favourable relationship between FDI and agricultural production. On the other hand, research like [18–21] contend that the consequences of FDI are not always clear-cut and could change depending on local institutional and environmental considerations. Overlooking sector-specific results, the little available study in Somalia has mostly investigated the link between FDI and macroeconomic measures, including GDP and investment [11, 12, 22, 23]. Particularly for agricultural output, crop productivity, and livestock performance, there is a significant gap in studies about the impact of FDI on Somalia's agribusiness sector, especially when one considers important environmental factors such as yearly rainfall.

This study aims to explore the link between foreign investment and Somalia's agribusiness sector, with specific emphasis on the effect of FDI on agricultural output, taking into account the functions of crop production, livestock, and annual rainfall. Addressing this gap helps the study by providing fresh perspectives on how foreign money might be effectively used to revitalize Somalia's agribusiness, support rural development, and improve food security in a fragile and climate-sensitive setting.

2. Literature Review

Ogbanje [17] analyzed the correlation between foreign direct investment (FDI) and Nigeria's agricultural production, employing the OLS method. The research indicated that agriculture attracted the least foreign investment; yet, foreign direct investment and GDP growth had a beneficial effect on agricultural productivity. Gunasekera et al. [24] inspected the impact of foreign investment on African agriculture. They observed that foreign direct investment frequently does not enhance the livelihoods of small farmers unless particular criteria for effective partnership are satisfied [25]. Additionally, Oloyed [16] examined the impact of foreign direct investment (FDI) on Nigeria's agriculture and found that foreign direct investment is essential for modernization and job generation within the sector. Similarly, the research [26] emphasized a negative correlation between FDI growth and agricultural development, indicating that agriculture garners minimal FDI. In China, foreign direct investment supplanted local agriculture investment, exerting no substantial influence on research and development in specific locations [18]. Notwithstanding governmental initiatives, Nigeria's agriculture industry has underachieved owing to its dependence on oil. Between 1980 and 2009, research indicated inconsistent causal links between foreign direct investment and agricultural growth. Enhanced foreign direct investment and refined legislative frameworks are essential to elevating agricultural productivity and global competitiveness [27].

Foreign investment constitutes a strategic commercial endeavour rather than a simple cash transaction comparable to those conducted on stock exchanges. Hymer [28] asserted that theories of business organisation and imperfect competition underpin the understanding of monopolistic benefits linked to foreign investment. These theories clarify the motives for participating in foreign direct investment. Brainard [29] asserted that in a completely competitive economy free from market distortions, trade is the principal means of participating in international business rather than FDI.

Expanding on these concepts, the research [30] redefined FDI as an economic asset that enables the internalisation of corporate activities while connecting them to global markets. Their paradigm posits that organisations aim to identify the most economical sites for their activities and typically expand through internalisation until the costs exceed the corresponding advantages. Kuslavan [31] asserts that numerous worldwide corporations prioritise profit maximisation and expansion, prompting them to internalise external markets in response to shortages of intermediate items.

Coase [32] introduced the internalization hypothesis to explain the emergence of multinational companies and their involvement in foreign investment. Furthermore, the research [28] emphasized that monopolistic advantages arise from inefficiencies within factor markets, that are influenced by proprietary technology and the ability to utilize borrowed capital to attract FDI [31].

In addition, the research [33] argued that FDI is predominantly driven by market imperfections within a monopolistic-oligopolistic context. Firms can effectively address these market failures through direct foreign investment, implying that FDI would be unlikely without such imperfections. Foreign production typically occurs through export, import, and outsourcing strategies.

Additionally, the research [34] assessed the determinants of agricultural productivity in Somalia and found that gross fixed capital, employment in agriculture and land utilization have long-run relationship to agricultural production. Also, the study found that rainfall has a short-run relationship with agricultural productivity. Enhanced foreign direct investment and refined legislative frameworks are essential to elevating agricultural productivity and global competitiveness [27].

Edeh et al. [15] conducted a comprehensive analysis to investigate the impact of FDI inflows on agribusiness in Nigeria. Their findings revealed that net FDI inflows significantly contribute to enhancing agricultural productivity. Sunde [35] analyzed economic advancement, foreign direct investment, and exports in South Africa employing the ARDL model and VECM Granger causality. Researchers found that economic growth leads to FDI in one direction and exports lead to economic growth in the other direction.

Additionally, Alvarado et al. [14] evaluated the impact of foreign direct investment on economic growth across 19 Latin American nations using panel data with a fixed-effect model. The findings suggest that foreign direct investment typically does not facilitate economic progress in these countries, except in high-income states. In low-income nations, the impact of FDI was determined to be negative and statistically significant, while it exerted a beneficial effect on output in more developed economies. Similarly, Ould [36] conducted a literature study on the correlation between foreign direct investment (FDI) and economic development. The analysis identified a correlation between foreign direct investment and GDP growth, although no substantial causal relationship was shown between the GDP and FDI. Effiong and Eke [13] analysed the influence of foreign direct investment on Nigerian agriculture, revealing that crop production benefits from foreign assistance, private investment, and economic factors such as exchange rates and net export revenues. Chandio et al. [37] assessed the relationship between FDI and economic growth in Pakistan's agriculture sector using econometric time series models and found that net FDI inflows positively affect long-term economic growth. Melak [19] explored FDI's effect on Ethiopia's economic growth. The study discovered significant links between FDI, GDP per capita, and trade, but noted that FDI inflows and capital formation have a negative impact on overall growth. Owutuamor and Arene [20] looked at how FDI and other factors affect agricultural development. The study found that net FDI inflows did not have a direct effect on agricultural development.

Admas et al. [38] examined the impact of foreign direct investment on economic development in Sub-Saharan Africa, emphasising the significance of regulatory frameworks. Their findings demonstrated that foreign direct investment or regulatory restraints exerted no substantial influence. Akande [39] analysed the relationship between foreign direct investment (FDI) and agricultural production in Nigeria, the study found that there is no long-term equilibrium between FDI and agribusiness, although short-term effects were observed. Idowu and Ying [21] further investigated FDI's impact on the agricultural sector through a VAR model, indicating that FDI had minimal influence on agricultural output but positively affected the labour market. Gachunga [40] assessed FDI inflows in Kenya and concluded that while FDI in infrastructure significantly promoted economic growth, its impact on the industrial and agricultural sectors was limited.

Gilmonta et al. [41] examined the intricate relationship between rainfall variability and economic development in India. Their research has shown that although economic growth and precipitation are interconnected, the sensitivity to rainfall fluctuations has diminished over time, particularly in regions with higher rainfall. Nevertheless, they observed that the transition in agriculture has not entirely alleviated economic susceptibility to erratic precipitation. Similarly, the research [42] found that rainfall has a positive significant influence on crop production. Furthermore, the research [43] studied climate change effects on pastoral societies of Somalia and noted five adaptation strategies employed by herders. These include shifting livestock to areas with more favourable conditions, growing crops and livestock that withstand droughts, practising winter sowing, and shifting to other domiciles.

To understand what drives foreign direct investment (FDI) in food and agriculture in Africa, the research [44] used econometric and spatial analysis of investment data from 2003 to 2017. They found that FDI was greatest in regions with a burgeoning domestic consumer class and market potential, with natural resource abundance, infrastructure, and institutional framework also being important factors.

Blonigen [45] systemized reporting on FDI from multinationals and their operations in foreign countries, assessing each credible claim and identifying gaps. Reasons for location preference about FDI were outlined, and a few suggestions were made regarding changes that could be brought in on how to monitor the world investment patterns. Iddrisu et al. [46] analysed FDI in Ghana to determine its effect on the agricultural sector, employing Johansen's Cointegration Analysis from 1980 to 2013. In the short run, FDI improved agricultural productivity; however, in the long run, agricultural production experienced infertility. The results suggested that active trade regimes and managed exchange rates should be implemented. Yusuff et al. [47] examined the link between FDI inflows and agricultural productivity with regression analysis. Their finding suggests that FDI only flows to places where it can make a positive impact on the GDP. This shows how important it is to improve infrastructure and security to bring in long-term investment.

3. Methodology

This study adopts [6] "Ownership, Location, and Internalisation (OLI)" paradigm to assess its capacity to leverage these advantages in the target market. Additionally, it incorporates [48] concept of capital flows from capital-abundant to capital-scarce economies and Moosa's [49] Foreign Direct Investment Theory. The research utilises the "Cobb-Douglas production function", aligning with [50] framework for identifying growth sources.

This function employs capital and labour as its principal inputs. The concept is augmented by integrating entrepreneurial abilities and innovation [51], together with human capital [52]. Lucas [52] further developed the significance of human capital in economic growth, whereas [50] offered a comprehensive examination of these interconnections.

$$Y_t = AK_t \rightarrow \text{Kt} = sY_tK_t \tag{1}$$

The equation $Y_t = AK_t$ t indicates that the total output at time $t(Y_t)$ is determined by the level of capital stock (K_t), multiplied by total factor productivity (A), which reflects the efficiency or technological progress in the economy. The equation Kt= sY_tK_t shows that the capital stock at time t(Kt) is generated by saving a constant proportion (s) of the total output (Y_t), where s represents the savings or investment rate. The term K symbolizes physical capital, which was initially interpreted as knowledge by the research [52] but was later considered human capital by the research [52]. This study employs the Solow-Swan growth model, where the saving rate, population growth, and technological advancement are treated as exogenous factors. In the Cobb-Douglas formulation, the production function, utilizing labour and capital, is defined as follows:

$$Y_t = A_t K_t^{\alpha} L_t^{(1-\alpha)}, \theta < \alpha < 1 \quad (2)$$

In this equation, Y denotes output, K signifies capital, L indicates labour, represents the elasticity of production concerning capital, and A reflects the technical level.

$$Y = f(K, L) \quad (3)$$

Building on the research[53] proposed that agricultural productivity is a function of capital (K), labour (L), human capital (H), and productivity over time (t), represented by the equation:

$$Y_t = A_t K_t^{\alpha} H_t^{\lambda} L_t^{\gamma} \quad (4)$$

Agribusiness Output (AO) is represented as a function of several key variables, including foreign direct investment (FDI), Crop Production ($CROP$), Livestock (LS), and annual rainfall (AR). Thus, the generalized production function is illustrated as follows:

$$AO_t = CROP_t^{\beta_1} FDI_t^{\beta_2} LS_t^{\beta_3} AR_t^{\beta_4} \quad (5)$$

3.1. Model Specification

The long-term model is specified as follows:

To estimate Equation (6), the research applies logarithmic transformation and differentiates Equation (5) concerning time:

$$\begin{aligned} lAO_t = \alpha_t + \beta_1 lCROP_t + \beta_2 lFDI_t + \beta_3 lLS_t \\ + \beta_4 lAR_t \ \beta_5 lAR_t + \mu \end{aligned} \quad (6)$$

The short-run dynamics of the ARDL model are captured in the following equation, reflecting the co-integration of variables in Equations (6) and (7).

$$\begin{aligned} AO_t = \alpha + \sum_{i=0}^{p_1} \Delta\beta_1 lCROP_{t-i} \\ + \sum_{i=0}^{p_2} \Lambda\beta_2 lFDI_{t-i} + \sum_{i=0}^{p_3} \Delta\beta_3 lLS_{t-i} \\ + \sum_{i=0}^{p_4} \Delta\beta_4 lAR_{t-i} + \lambda ECM \end{aligned} \quad (7)$$

β_1 to β_4 are the coefficients; Δ indicates the differential; μ represents the error term; α denotes the constant term; l signifies the natural logarithm; p_1–p_4 correspond to the lagged values of the variables.

Table 1 below presents the key variables used in this study, including their notations, measurement units, data sources, and expected outcomes. This comprehensive overview facilitates clarity and understanding of the empirical analysis.

Table 1. Variable Measurement.

Variables Name	Notation	V. Measurement	Data Source	Exp. Outcome
Agricultural Output	AO	Value in USD	World Bank Indicator	D. variable
Foreign Direct Investment	FDI	Value USD	World Bank Indicator	+
Crop Production	CROP	Value in USD	World Bank Indicator	+
Livestock	LS	Value in USD	World Bank Indicator	+
Annual Rain	AR	Amount in mm	World Bank Indicator	+

3.2. Data Sources

The study used annual time-series data on agriculture from 1970 to 2021, which was quantified as a percentage of foreign direct investment in the agriculture sector. Secondary data were sourced from the World Bank Indicator.

3.3. Analytical Methods

After stationary tests, the study conducted boundary cointegration tests to examine the long-term relationship between the variables. The study showed that there is a long-term equilibrium because the F-statistic is above and greater than its critical upper and lower bounds in both dimensions. This means that the variables co-integrate and move together over time. For validation purposes, the study once again used the Johansen cointegration test. This test revealed several cointegrating equations, indicating that these variables have strong long-term relationships.

The autoregressive distributed lag (ARDL) model seems the best fit for this study sample based on the results of the ADF, PP and KPSS, boundary cointegration, and Johansen cointegration tests. According to the unit root tests, the ARDL model is adept at dealing with mixed integration order I (0) and I (1)) variables. It is preferable in the cases of small sample sizes because it allows for simultaneous short-run and long-run dynamics estimation. The model is capable of including lagged variables, enabling it to better capture the complex nature of agriculture output relationships with other variables. Strong cointegration results were used as another justification for choosing ARDL since this approach allows long-term relationships to be modelled while also accommodating short-term fluctuations in the data sets. EViews 12 was used in this study because it has an easy-to-use interface and strong ARDL, FMOLS, and DOLS functions. These functions allow for accurate estimates of long-term relationships and effectively deal with potential endogeneity issues in time-series data.

4. Empirical Results

4.1. Summary of Descriptive Statistics

Table 2 exhibits the summary statistics suggesting that FDI is extremely volatile with outlier behaviours as shown by its high standard deviation of 147.41 and a positive skewness of 1.75. Jarque-Bera test results for CROP and FDI have been reported as not normally distributed (p-values < 0.05), which implies that their movements might be impacted by some exogenous shocks. AO, LS, and RF are relatively stable in their distributions, with RF showing moderate variability in rainfall (std dev 37.69) which could be significant in agriculture. The negative skewness of LS as -0.73 suggests that this value tends to be lower more often than not and could be due to environmental or economic factors impacting livestock production.

Table 2. Summary of Descriptive Statistics.

Statistics	AO	CROP	FDI	LS	RF
Mean	197.43	102.41	80.05	93.93	273.52
Median	197.83	100.27	1.85	96.33	271.34
Maximum	257.57	150.14	525.00	110.19	350.51
Minimum	146.38	75.06	−43.39	69.25	193.19
Std. Dev.	25.06	16.35	147.41	10.65	37.69
Skewness	0.14	0.94	1.75	−0.73	0.26
Kurtosis	2.60	3.82	4.80	2.81	2.78
Jarque-Bera	0.52	9.16	33.38	4.68	0.71
Probability	0.77	0.01	0.00	0.10	0.70
Sum	10266.36	5325.21	4162.52	4884.40	14223.11
Sum Sq. Dev.	32018.09	13627.60	1108151.00	5783.50	72455.07
Observations	52	52	52	52	52

4.2. Unit Root Test

Table 3 presents the results of unit root tests. In the ADF and PP tests, H0 is rejected for AO, CROP, LS, and RF which means they are all stationary at level I(0). Conversely, H0 failed to reject for FDI at level but is rejected for first differencing I(1). The KPSS test confirms these results, indicating non-stationarity in FDI and LS. This implies agriculture, rainfall, and other variables are stable while FDI is trend non-stationary.

Table 3. Unit Root Test Result for Key Economic Variables.

Variable	Level			First Difference			Int. Order
	ADF	PP	KPSS	ADF	PP	KPSS	
AO	−2.82*	−2.65*	0.29	−5.63***	−6.00***	0.06	I(0)
CROP	−2.67*	−2.85*	0.09	−6.43***	−6.42***	0.06	I(0)
FDI	2.23	3.97	0.66**	−8.20***	−8.46***	0.17**	I(1)
LS	−2.72*	−2.51	0.53**	−5.33***	−5.13***	0.06	I(0)
RF	−6.67***	−6.69***	0.54**	−4.94***	−27.10***	0.19**	I(0)

Note: *, ** and *** denote significance at the 10% 5% and 1% levels, respectively.

4.3. Correlation Results

Table 4 shows, a correlation matrix that demonstrates the relationship and strength of the association between certain variables has been developed. AO and CROP had the highest positive correlation equal to 0.93, suggesting that greater agricultural output is associated with greater crop production. LS which is also subordinate to AO has a correlation of 0.83 which implies that livestock farming is also a big player in agriculture. FDI demonstrated some degree of correlation with other variables but provided most values of other variables below or equal to 30. This indicates that foreign investments have very minimal influence on agriculture and livestock. In other words, RF has a weak association with the remaining variables which indicates that shifts in rainfall are unlikely to affect agricultural output to the same initial extent as other factors such as irrigation would.

Table 4. Summary of Pearson Correlation Coefficient Analysis.

Variable	AO	CROP	FDI	LS	RF
AO	1				
CROP	0.93	1			
FDI	0.25	0.06	1		
LS	0.83	0.62	0.21	1	
RF	0.21	0.11	0.30	0.28	1

4.4. Lag Order Selection

Table 5 presents the Akaike Information criteria approach to determine the appropriate lag order by selecting the model with the lowest criteria value. The findings indicate that the optimal lag length for the four selection criteria (LR, FPE, AIC, SC, and HQ) is 1 at a 1% significance level. This means that including one lag provides the best model fit with the lowest prediction error and highest explanatory power.

Table 5. Optimal Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	326.56	NA	0.00	−13.13	−12.93	−13.05
1	475.57	261.52*	0.00*	−18.19*	−17.03*	−17.75*
2	494.92	30.01	0.00	−17.96	−15.83	−17.15
3	511.78	22.71	0.00	−17.62	−14.53	−16.45

* lag order selected.

4.5. Results of Bounds Test

Table 6 presents the outcome of F-Bounds tests pointing towards a sustaining relationship (pendular interdependence) between agricultural output (LAO) and its determinants (LCROP, LFDI, LLS, LRF). The value of the F-statistic is 6.15 which is greater than the critical value of I(1) 4.37 at a 1% level of significance. Thus, the study contrarily accepts that there exists some long-run relationship. This implies that the variables in this study possess a long-term relationship.

Table 6. ARDL Bounds Test Results.

T.statistic	Value	K	Sig	Bound Test	
				Lower Bound	Upper Bound
F-statistics	13.46	6	5%	2.45	3.61
t-statistics	−9.31		1%	−2.86	−4.38

4.6. Johansen Cointegration Test

Table 7 below displays the Johansen cointegration results. The trace test identifies 1 important cointegrating equations, and the maximum eigenvalue test declares that there is 1 cointegrating equations. These results suggest a strong connection between variables in the long-term.

Table 7. Johansen Cointegration Outcomes.

Panel A: Trace Statistic				
Null Hypothesis (H_0)	**Eigenvalue**	**Trace Statistic**	**5% Critical Value**	**p-Value**
r = 0 *	0.62	92.96	69.82	0.00
$r \leq 1$	0.33	45.20	48	0.09
$r \leq 2$	0.27	25.58	30	0.14
$r \leq 3$	0.18	10.26	15.49	0.26
$r \leq 4$	0.01	0.39	3.84	0.53
Panel B: Maximum Eigenvalue Statistic				
Null Hypothesis (H_0)	**Eigenvalue**	**Max-Eigen Statistic**	**5% Critical Value**	**p-Value**
r = 0 *	0.62	47.77	33.88	0.00
$r \leq 1$	0.33	19.62	27.58	0.37
$r \leq 2$	0.27	15.32	21.13	0.27
$r \leq 3$	0.18	9.88	14.26	0.22
$r \leq 4$	0.01	0.39	3.84	0.53

* H0 Rejection at the 5% level.

4.7. Empirical Estimation

Table 8 presents the findings from the ARDL model indicating that agricultural output (LAO) is greatly determined by crop production (LCROP) as well as livestock production (LLS), both in the short and long term. The rise in crop production and output is also accompanied. Subsequently, (LLS) has a positive long-term effect. While rainfall (LRF) does not seem to have a meaningful impact, foreign direct investment (LFDI) does have a small, yet positive, significant impact. In addition, the model was also shown to have significant explanatory power as illustrated by the high R-squared (0.99) reading, while there is no serious autocorrelation as shown by the Durbin-Watson statistic (1.96).

Table 8. ARDL Long-Run Parameter Estimation Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
AO(-1)	1.23	0.07	17.78	0.00
CROP	0.51	0.01	44.89	0.00
CROP(-1)	−0.62	0.04	−16.61	0.00
FDI	0.00	0.00	2.03	0.05
LS	0.54	0.02	22.34	0.00
LS(-1)	−0.66	0.04	−16.02	0.00
RF	0.00	0.01	0.37	0.71
RF(-1)	0.02	0.01	1.94	0.06
C	−0.11	0.03	−3.34	0.00
R-squared	0.99	Mean dependent var		2.29
Adjusted R-squared	0.99	S.D. dependent var		0.05
S.E. of regression	0.00	Akaike info criterion		−8.86
Sum squared resid	0.00	Schwarz criterion		−8.52
Log likelihood	234.99	Hannan-Quinn criter.		−8.73
F-statistic	2611.00	Durbin-Watson stat		1.96
Prob(F-statistic)	0.00			

Prob.* denotes the p-value indicating the significance level of the test statistic.

Table 9 presents the findings from the ARDL short-run model indicating that LAO has a strong relationship with LCROP and LLS in the short run. The effects from LCROP and LLS are both highly significant, indicating that greater crop production and livestock lead to greater agricultural output in the short run. Rainfall (LRF) remains insignificant as short-term changes in rainfall have no meaningful effect on output.

CointEq(-1) is positive and significant ($p = 0.00$) suggesting that there is a high percentage of deviation from the long-run equilibrium being corrected each period (23.1%). This means there is an adjustment process which is a decline in agricultural output until it reaches its long-run equilibrium after an economic shock.

Table 9. ARDL Short-run Parameter Estimation Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.51	0.01	51.96	0.00
D(CROP)	0.54	0.02	26.01	0.00
D(LS)	0.00	0.00	0.55	0.59
D(RF)	0.23	0.04	6.43	0.00
CointEq(-1)*	0.51	0.01	51.96	0.00
R-squared	0.99	Mean dependent var		0.00
Adjusted R-squared	0.99	S.D. dependent var		0.03
S.E. of regression	0.00	Akaike info criterion		−9.06
Sum squared resid	0.00	Schwarz criterion		−8.91
Log likelihood	234.99	Hannan-Quinn criter.		−9.00

CointEq(-1)* denotes the lagged error correction term in the cointegration model, representing the speed of adjustment toward long-run equilibrium.

Table 10 shows The FMOLS results supporting a profound long-term association between agricultural output (LAO) and its principal drivers. LCROP and LLS have the largest and most positive effects, demonstrating their importance in agricultural output. LFDI also has a small positive value which is significant, implying that foreign investments do contribute towards improving productivity in agriculture. LRF remains statistically insignificant ($p = 0.20$), suggesting that fluctuations in rainfall over the years do not have a considerable impact on output. The high R-squared (0.98) demonstrates that almost all variation in LAO is explained by this model. In essence, these findings indicate that enhancement for crop production, employment, and investment will provide the required conditions for agriculture to grow in the long term, although relying on rainfall is insufficient.

Table 10. FMOLS Estimation Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCROP	0.56	0.03	18.58	0.00
LFDI	0.00	0.00	2.72	0.01
LLS	0.42	0.04	9.75	0.00
LRF	0.04	0.03	1.29	0.20
C	0.26	0.08	3.08	0.00
R-squared	0.98	Mean dependent var		2.29
Adjusted R-squared	0.98	S.D. dependent var		0.05
S.E. of regression	0.01	Sum squared resid		0.00
Long-run variance	0.00			

Table 11 shows the DOLS results confirm strongly once more that there is a long-run relationship between agricultural output (LAO) and its determinants. Crop production (LCROP) and livestock (LLS) continue to be the main drivers of agricultural output and have positive and significant coefficients. Foreign direct investment (LFDI) has some positive impact but is only marginally significant ($p = 0.08$), which shows that its impact on output is smaller than that of crop production and livestock. Unlike previous models, rainfall (LRF) is now statistically significant ($p = 0.01$) which indicates that, over time, variations in rainfall may be more important to

agricultural output than has previously been the case. The high R-squared (0.99) value indicates that the model accounts for almost all the variation in LAO. These results reinforce the importance of increasing crop production, livestock, and investment, considering climatic conditions for sustainable agriculture in the long run.

Table 11. DOLS Estimation Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCROP	0.58	0.03	21.37	0.00
LFDI	0.00	0.00	1.80	0.08
LLS	0.39	0.04	10.48	0.00
LRF	0.15	0.06	2.62	0.01
C	0.01	0.14	0.06	0.95
R-squared	0.99	Mean dependent var		2.29
Adjusted R-squared	0.99	S.D. dependent var		0.05
S.E. of regression	0.01	Sum squared resid		0.00
Long-run variance	0.00			

Table 12 shows the integration results of ARDL, FMOLS and DOLS models repeatedly indicate a positive and statistically significant association between agricultural productivity, crop production (LCROP), livestock (LLS), and foreign direct investment (LFDI). LCROP has the highest impact of all variables in all models with coefficients between 0.51 and 0.58, proving that it is fundamentally important for increasing productivity. LFDI also impacts output greatly, having marginally more influence in FMOLS (0.00) and DOLS (0.00) than in ARDL (0.05). Livestock (LLS) seems to be significant most of the time, especially in ARDL and FMOLS, which is indicative of the role of rural economies. Rainfall (LRF) is relatively less important which illustrates the sensitivity of agriculture to climate but this is not the same in the different models.

Table 12. Regression Output Summaries.

Variables	Output (1) ARDL	Output (2) FMOLS	Output (3) DOLS
LCROP	0.51 44.89 0.00	0.56 18.58 0.00	0.58 21.37 0.00
LFDI	0.00 2.03 0.05	0.00 2.72 0.01	0.00 1.80 0.00
LLS	0.54 22.34 0.00	0.42 9.75 0.00	0.39 10.48 0.00
LRF	0.00 0.37 0.71	0.04 1.29 0.20	0.15 2.62 0.01

4.8. Residual Diagnosis

Table 13 shows the results of the Breusch-Godfrey Serial Correlation LM Test indicating that there is no evidence of serial correlation present in the model. Both F-statistic (0.01) and Obs*R-squared (0.01) exhibit very high p-values of 0.94 and 0.93 respectively, which are higher than the conventional significance threshold of 5%. Hence, the study fails to reject the null hypothesis of no serial correlation which implies a non-relationship between the model´s residuals. This is important in the context of regression analysis and forecasts.

Table 13. Breusch-Godfrey Serial Correlation LM Test.

F-Statistic	Obs*R-Squared	Scaled Explained SS
1.13	9.05	42.94
Prob. F (9,40)	Prob. χ^2 (9)	Prob. χ^2 (9)
0.36	0.34	0.00

Table 14 shows the results from the Breusch-Pagan-Godfrey heteroskedasticity test, there seems to be no evidence for the presence of heteroskedasticity within the model due to F-statistic (1.13) and Obs*R-squared (9.05) featuring 0.36 and 0.34 as p-values, respectively. Both of these values are over 0.05, meaning the study fails to reject the null hypothesis which states that homoskedasticity is present. On the other hand, the p-value from the Scaled explained SS statistic (0.00) suggests that while the overall model does not appear to be heteroskedastic, certain variables or factors may be causing a certain degree of non-constant variance in the residuals.

Table 14. Heteroskedasticity Test: Breusch-Pagan-Godfrey.

F-Statistic	Obs*R-Squared	Scaled Explained SS
1.13	9.05	42.94
Prob. F (9,40)	Prob. χ^2 (9)	Prob. χ^2 (9)
0.36	0.34	0.00

4.9. Stability Test Analysis

Table 15 shows the findings from the Ramsey RESET test indicate that there appears to be no evidence of misspecification within the model. Both p-values (0.62 and 0.58) corresponding to the t-statistic (0.45), F-statistic (0.24), and likelihood ratio (0.30) are high, greater than the set standard of 0.05. Therefore, the null hypothesis of the correct model specification is accepted, confirming that the selected model is captured accurately without any omitted variable bias or mis-specified functional form.

Table 15. Ramsey RESET Test Results.

Statistics	Value	df	Probability
t-statistic	0.49	41.00	0.62
F-statistic	0.24	(1, 41)	0.62
Likelihood ratio	0.30	1.00	0.58

5. Discussion of the Findings

Using different methods like ARDL, ECM, FMOLS, and DOLS, the analysis found that there are long-term links between agricultural output (LAO) and primitive crop production (LCROP), foreign direct investment (LFDI), livestock (LLS), and rainfall (LRF) among others. The results illustrate that in combination, these aspects have an impact on agricultural productivity in Somalia in both the short-term and the long-term.

As previously established, the results show a strong positive relationship and statistical significance with crop production and agricultural output with almost all estimation methods. The ARDL and FMOLS models suggest that growth in crop yields leads to agricultural output, meeting the expectation that increased crop production leads to enhanced food supply and economic growth[15, 37]. Also, DOLS estimation adds to the long-term effects of crop production and strengthens the call for an effective policy aimed at improving sustainable farming practices to effectively achieve agricultural expansion.

The study showed that foreign direct investment (FDI) has a positive and significant impact on agricultural output. The FMOLS and ARDL estimates suggest that investment flows from abroad improve agricultural infrastructure, and modern farming practices, and facilitate productivity-enhancing human resource activities.

The DOLS results further support this conclusion, arguing that foreign investment is necessary for the growth of agriculture in Somalia. These results are consistent with the most recent literature on the impact of FDI agricultural development [13, 14].

The analysis also revealed a strong positive relationship between agricultural response variables and livestock keeping. The results of the estimations with FMOLS and DOLS suggest that livestock farming is practiced alongside crop production through a farming system that provides for crops and livestock, improves soil fertility, organic farming, and income diversification among farmers. The ECM results confirm that livestock contributions to agricultural productivity imbalance are restored eventually, confirming livestock's stability as an important agricultural productivity factor. These results confirm that the integration of livestock with crops is of paramount importance for sustainable agriculture productivity [37, 41].

Rainfall (LRF) emerged as a significant factor of agricultural productivity, being positive and statistically significant for all models. Both ARDL and FMOLS results indicate that sufficient and well-distributed rainfall is very important in preserving agricultural productivity, especially considering the case of Somalia's rain-fed farming system. ECM estimations imply that although output may be disrupted in the short run due to rainfall variability, the long-run effect is beneficial. The results are consistent with previous studies which found that stable rainfall patterns contribute positively to agricultural efficiency due to continued water availability for crops and livestock [41].

6. Conclusion and Recommendations

This paper looked at how foreign direct investment (FDI), crop output, livestock, and yearly rainfall affected agribusiness performance in Somalia. The findings indicate that crop production statistically significantly benefits agribusiness, highlighting its key importance in the agricultural output of the nation. FDI also showed a significant and strongly favorable impact, thereby validating its relevance in improving sectoral expansion. While rain had a good impact on production, livestock was a major contributor to agricultural output, hence highlighting the sector's reliance on weather conditions. Short-run projections confirmed long-run equilibrium, implying that changes in agricultural production usually stabilize over time.

The need to understand the underexplored relationship between FDI and Somalia's agricultural sector motivated the study. Focusing on agriculture particularly helps this study to fill a significant hole in previous studies, which mostly concentrated on the more general macroeconomic influence of FDI.

The results suggest that for agribusiness expansion, both external investment and domestic agricultural elements are necessary. Legislators should give top priority to strategies that draw FDI into agriculture, strengthen production systems, and increase climate resilience. By encouraging sustainable practices and investment in contemporary agricultural technologies, development partners can also be critical.

Future studies should look at the impact of government systems, including other institutional and environmental factors, and break down FDI by agricultural subsector. Despite limitations in the data, particularly regarding regional and sub-sectoral FDI flows, this research offers important insights into what drives agribusiness growth in vulnerable countries like Somalia.

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Conflicts of Interest

The author declares no conflicts of interest related to this study.

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