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*Original Article*

# Impact of Urbanisation & Agriculture sector on Industrialisation in Rwanda

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***Abstract*** *- This paper examines the association between urbanization, the agricultural sector, and industrialization in Rwanda. Vector Auto-Regressive (VAR) model and Granger causality were used based on time series data from 1980 to 2018. The authors concluded that there is no long-run association between urbanization, agricultural sector, and industrial sector in Rwanda. On the other hand, we realized that there is evidence of bidirectional causality moving from agricultural sector to industrial sector and from urbanization to the industrial sector. On the other hand, we realized that there is a Uni-Directional Causality running from Urbanisation to Agriculture.*

*Moreover, the results support a policy made in Rwanda, as it encourages the industrial sector. We recommend the government of Rwanda focus on and increase the budget allocated in the agricultural sector to boost production, which will lead to agro-processing industrial development as well as food security to satisfy the urban increasing demand instead of depending on food imports.*

***Keywords*** *- Vector Auto-Regressive (VAR) model, Granger causality, urbanization, agriculture, industrial sector.*

## I. INTRODUCTION

In the last century, there was a big change in the world about the increase in urban population. In 1950, only 30% of the population in the world was in urban areas, but in 2014, the world population in urban areas was about 54%. According to United Nations, by 2050, about 66% of the population in the world is estimated to be urban areas (UN, 2014).

In Africa, in the third United Nations Conference on Housing and Sustainable Urban Development (HABITAT-III), African leaders projected that about half of Africa's population, by 2035, will be living in urban areas.

In developing countries, at the heart of the economies, there is the agricultural sector. The agricultural sector counts between 30% to 60% of GDP, and it employs between 40% to 90% of the labor force (UNFAO, 2002).

The industrial sector has a crucial role in the economic development and economic growth of countries all over the world. The industrial sector generates $ 2,500 GDP per capita in Latin America, $3,400 GDP per capita in East Asia, and $ 700 of GDP per capita in Africa. It is in this context that, African Development Bank is committed to capital mobilization, private sector investment de-risking, and financial markets leveraging (African Development Bank, 2018).

In Rwanda, the National Institute of Statistics of Rwanda (NISR), in its annual report of 2018, the industrial sector has experienced a high growth compared to other sectors. In general, the economy of Rwanda grew 8.6% in 2018, the agriculture sector grew 6%, the industrial sector grew 10%, and the services sector grew by 9%, in industries, the locally made products increased by 26% as a result of Made in Rwanda strategy (NISR, 2018).

Urbanization in Rwanda is experiencing demographic growth and the movement of people to urban areas. Currently, the urban population growth rate is 4.1%, and 17.21% of the total population lives in urban areas. This is a result of urbanization policy which targets 35% of the urbanization rate in 2024 (MININFRA, 2017).

Briefly, in Rwanda, from 1980 to 2018, there was an increase in agricultural output; there was an increase in industrial output as well as an increase in urbanization (World Bank Report, 2018). Therefore, the purpose of this paper is to econometrically examine the linkages between the agriculture sector, urbanization, and industrial sector, using annual data for the period 1980-2018.

This work aims to answer the question of whether urbanization affects positively or negatively industrial sector or the agriculture sector affects positively or negatively industrial sector. The study is structured in the following ways. In part one, the review of related literature. In part two; Methodology, Model Specification, and data used. In part three, the empirical results and findings interpretation. Finally, part four deals with policy recommendations and a conclusion.

## II. REVIEW OF RELATED LITERATURE

Several studies have been conducted on the relationship between urbanization, agriculture, and industrial sector development, but the previous studies and researches have shown different results. Our literature review is limited to the partial relationship between each independent variable and the dependent variable because there is no other research that has investigated the relationship between urbanization and agriculture sector to industrial sector development jointly. The following paragraphs describe some related studies conducted by different authors, in different periods of time, in different countries using different econometrics techniques and their key findings.

Lin and Koo (1990), in China, examined "Interdependency between China's agricultural and industrial sector" during the period between 1952 to 1988; using Granger causality, the study found the presence of unidirectional causality moving from agriculture sector to industrial sector.

Sakiru (2017), in Nigeria, investigated "the role of urbanization in the economic development process", using the ARDL approach, FMOLS, and DOLS, the researcher, found the existence of long-run causality from urbanization to industrialization during the period of study between1961-2012.

Souleymane (2007), in Turk (65 provinces in 81 provinces), using panel-granger causality studied about "Urbanization and productivity", within the period between1980-2000, the findings obtained have been Existence of a causation link moving from urbanization to industrial development.

Mirza (2019), in Bangladesh, conducted research on "Causal relationship between agriculture, industries, and services for GDP growth" within the period of 1980-2013; the researcher found out the Existence of Bidirectional causality between agriculture and industrial sector, using the Vector-Auto-Regressive Model and Granger causality.

Eze (2020), in Nigeria, using Co-integration analysis, VECM, and Granger causality, conducted a study on "Empirical evidence of a long-run relationship between agriculture and manufacturing industry output" during the period between 1982-2017; the study concluded that there is a bidirectional relationship between agriculture productivity and manufacturing industry output.

Koo and Lou (1997), in China, using Johansen co-integration test and VECM econometrics techniques, investigated the "Interdependence between China's agricultural and industrial sector" within the period between 1960-1995; the research found that there is a significant relationship between agricultural growth and industrial income at 5% level of significance.

Vijay and Michael (2009), within the period between 1974-2008, have conducted a study in Poland and Romania about "Agricultural inter-sectoral linkages and its contribution to economic growth in the transition countries", using VECM, they have found the presence of long-run relationship among sectors, but the role of agriculture is not significant to the other sectors in short-run in both Poland and Romania.

Tiffin and Irz (2016), in 85 countries, using Panel co-integration analysis, have done a study entitled "Is agriculture the engine of growth?" within the period between 1995-2005; the study reveals that a percentage increase in agriculture raises manufacturing output 0.47%.

Kanwar, S (2000), in India, using Co-integration of the different sectors in a multivariate Vector-Auto-Regressive framework, has done a study entitled "Co-integration of Indian agriculture with non-agriculture", for the period of 1963-1998, the key findings of the study have been the presence of Positive relationship between Indian agriculture and non-agriculture sectors.

Cingano and Shivardi (2004), in Italy, have conducted a study entitled "Identifying the sources of local productivity", using Panel-co-integration for the period between1994-2003; the study demonstrated that there is a positive long-run impact of city employment on firms productivity.

Ottaviano and Pinelli (2006), in Finnish regions, using New Economic Geography (NEG) Model, they have conducted research entitled "Market potential and productivity", for the period between1977-2002, they have found that Urbanization increases the firms' demand.

## III. DATA, METHODOLOGY AND MODEL SPECIFICATION

With the above discussion in mind, this section aims to elaborate on the appropriate methodology to explore the Industrial-Agricultural-Urbanisation relationship. Despite various countries' focused case studies, different econometric approaches, and numerous uses of large time series and cross-country data sets, the relationship between these variables remains inconclusive.

### *A. Data*

The study used quantitative data obtained from the World Bank data set of the period 1980 to 2018. The data were time series describing Urban population growth (annual %), Agriculture, forestry, and fishing, value added (% of GDP), Industry (including construction), value added (% of GDP) in Rwanda within the specified period.

### *B. Methodology*

We conducted the unit root test to investigate the order of integration of the variables. All the variables were not integrated into the level; for this reason, we have conducted the first difference, then all variables were stationary after the first difference. As well as our variables failing to be co-integrated, our econometrics techniques have been VAR estimation and Granger causality test.

### *C. Model Specification*

$Industry_t$ = f(Agriculture, urbanisation,) (1)

After log transformation the model becomes:

$$\textbf{Log (Indust)}_t = \alpha + \beta \log(\textbf{Agricult})_t + \chi \log(\textbf{Urbanis})_t + \mu_t \quad (2)$$

Where;

$Indust_{ry}$: Industrial outputs expressed in % of GDP in period t

$Agricult_{ure}$: Agricultural outputs expressed in % of GDP in period t

$Urbanis_t$: Urban population growth, annual % in period t

$\alpha$: The Intercept.

$\beta$ and $\chi$: The coefficient of the model of regression.

$\mu_t$: Error term at period t.

t: Period of time from 1980 to 2018

## III. EMPIRICAL ANALYSIS

The empirical investigations of this study use annual data for Rwanda, one of the East African countries, from secondary data sources of World Development Indicators (World Bank). Below are econometric test findings

### *A. Stationarity Test Using Augmented-Dickey Fuller Test and Phillips-Peron Test*

#### *a) Test of Stationarity at Level*

The unit root test was conducted using the Augmented-Dickey Fuller test and Phillips-Peron test. The results indicated that all variables (dependent variable and independent variables) are non-stationary at levels. This is because $ADF_{cal} > ADF_{crit}$, $PP_{cal} > PP_{crit,}$ and all the probabilities are greater than 5%. Then, we have to test stationarity at first difference.

**Table 1. Test of Stationarity at Level**

| Variables | ADF | | PP | | Conclusion |
|---|---|---|---|---|---|
| | Test statistic | Probability | Test statistic | Probability | |
| Urbanization | -1.692349 | 0.7351 | -1.952687 | 0.6076 | Not I(0) |
| Agriculture | -2.718054 | 0.2355 | -2.724819 | 0.2329 | Not I(0) |
| Industry | -2.831888 | 0.1954 | -2.845357 | 0.1910 | Not I(0) |

*Source: Authors' computation using E-views.*

### *B. Test of Stationarity at First Difference*

The outputs of the stationarity test at the first difference showed that all the variables are stationary after the first difference. This is because $ADF_{cal} < ADF_{crit}$, $PP_{cal} < PP_{crit,}$ and all the probabilities are lesser than 5%. In this case, we have to determine the VAR Lag selection criteria.

**Table 2. Test of Stationarity at First Difference**

| Variables | ADF | | PP | | Conclusion |
|---|---|---|---|---|---|
| | Test Statistic | Probability | Test Statistic | Probability | |
| Urbanization | -5.151533 | 0.0009 | -5.149951 | 0.0009 | I(1) |
| Agriculture | -7.055515 | 0.0000 | -7.090331 | 0.0000 | I(1) |
| Industry | -4.265445 | 0.0099 | -15.42134 | 0.0000 | I(1) |

*Source: Authors' computation using E-views.*

### *B. VAR Lag order Selection Criteria*

The VAR Lag order selection criteria indicated that the chosen delay number is equal to 1. The optimum lags are

Decided with a requirement of the lower case of an information criterion, the better the results (14.41449*< 14.93695*). In this case, we have to conduct a co-integration analysis by the Johansen test.

**Table 3. Lag order Selection Criteria**

| Lag | Log L | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -308.4624 | NA | 4114.257 | 16.83581 | 16.96642 | 16.88185 |
| 1 | -254.6680 | 95.95760* | 366.2805* | 14.41449* | 14.93695* | 14.59868* |
| 2 | -245.4191 | 14.99814 | 365.4921 | 14.40103 | 15.31534 | 14.72337 |

*Source: Authors' computation using Eviews*

### *C. Co-Integration Analysis by Johansen Test*

The Johansen analysis indicates that; both Trace Statistic and maximum Eigenvalues are less than their critical values. This implies the absence of co-integration relation between the variables. In this case, we had to estimate using the VAR model and the Granger causality test.

**Table 4. Johansen Co-integration Test**

| **Unrestricted Cointegration Rank Test (Trace)** | | | | |
|---|---|---|---|---|
| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
| None | 0.306025 | 27.68938 | 29.79707 | 0.0859 |
| At most 1 | 0.268959 | 14.17254 | 15.49471 | 0.0783 |
| At most 2 | 0.067379 | 2.580972 | 3.841466 | 0.1082 |
| **Unrestricted Cointegration Rank Test (Maximum Eigenvalue)** | | | | |
| Hypothesized No. of CE(s) | Max-Eigen | Statistic Eigenvalue | 0.05 Critical Value | Prob.** |
| None | 0.306025 | 13.51684 | 21.13162 | 0.4059 |
| At most 1 | 0.268959 | 11.59157 | 14.26460 | 0.1269 |
| At most 2 | 0.067379 | 2.580972 | 3.841466 | 0.1082 |

*Source: Authors' computation using E-views.*

### *D. VAR Estimation*

The objective of this model estimation is to justify if there are positive or negative effects between independent variables and dependent variables. The outputs of the VAR model estimate indicate that all independent variables (agriculture and urbanization) have a positive effect on the industry, but none has a significant probability.

**Table 5. Vector Autoregression Estimates**

| | Log(INDUST) | Log(AGRI) | URBAN |
|---|---|---|---|
| LOG(INDUST(-1)) | 0.736354 | 0.208973 | 0.1285 |
| | (0.11462) | (0.19295) | (0.122) |
| | [ 6.42454] | [ 1.08306] | [ 1.052] |
| LOG(AGRI(-1)) | 0.047925 | 0.585227 | 0.0559 |
| | (0.07945) | (0.13375) | (0.0847) |
| | [ 0.60318] | [ 4.37542] | [ 0.6601] |
| LOG(URBANIS(-1)) | 0.094177 | 0.380978 | 0.82547 |
| | (0.10575) | (0.17802) | (0.1127) |
| | [-0.89056] | [ 2.14004] | [ 7.3257] |
| C | 3.338754 | 8.721350 | -3.35207 |
| | (2.54589) | (4.28581) | (2.7127) |
| | [ 1.31143] | [ 2.03493] | [-1.2357] |

**Industry = C (4) + C (1)*Industry (-1) + C (2)*Agriculture (-1) + C (3)*Urbanis (-1)** (3)

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 0.736354 | 0.114616 | 6.424536 | 0.0000 |
| C(2) | 0.047925 | 0.079453 | 0.603185 | 0.5477 |
| C(3) | -0.094177 | 0.105751 | -0.890556 | 0.3753 |
| C(4) | 3.338754 | 2.545894 | 1.311427 | 0.1927 |

*Source: Authors' computation using E-view*

### *E. Granger Causality Test*

The purpose of conducting the Granger causality is to prove whether there is a causal relationship among the various variables that exist in our empirical study. The Granger causality test shows that a bi-directional causality between agriculture, urbanization, and industrialization in Rwanda. It implies that the agricultural sector and urbanization granger cause industrialization and vice-versa. Differently, there is a unidirectional Granger causality running from urbanization to the Agricultural sector in Rwanda. This implies urbanization is a pushing factor of the agricultural sector in Rwanda, holding other factors constant.

**Table 6. Pairwise Granger Causality Tests**

| Null Hypothesis: | Obs. | F-Statistic | Prob. | Inference |
|---|---|---|---|---|
| Agriculture does not Granger Cause Industry | 38 | 7.4E-05 | 0.0232 | **Bi-Directional Causality** Agr. ⟺ Ind. |
| The industry does not Granger Cause Agriculture | | 0.19156 | 0.0443 | |
| Urbanization does not Granger Cause Industry | 38 | 0.43728 | 0.0128 | **Bi-Directional Causality** Urb. ⟺ Ind. |
| The industry does not Granger Cause Urbanisation | | 2.13718 | 0.0327 | |
| Urbanization does not Granger Cause Agriculture | 38 | 3.60009 | 0.0661 | **Uni-Directional Causality** Urb. ⟹ Agr. |
| Agriculture does not Granger Cause Urbanisation | | 1.42679 | 0.2403 | |

*Source: Authors' computation using E-views.*

### *F. Residual Diagnostic Tests*

To ensure that our work is acceptable and our estimates are very well presented. We conducted different residual diagnostic tests.

### *A. Serial correlation test (Breusch-Godfrey Serial Correlation LM Test)*

Provided that probability Chi-square 23.4% is higher than the 10% level of significance, we reject $H_1$, we accept $H_0$, and then there is no serial correlation.

**Table 7. Breusch-Godfrey Serial Correlation LM Test**

| | | | |
|---|---|---|---|
| F-statistic | 1.367047 | Prob. F(2,33) | 0.2689 |
| Obs*R-squared | 2.902022 | Prob. Chi-Square(2) | 0.2343 |

*Source: Authors' computation using E-views.*

### *B. Heteroscedasticity Test (Breusch-Pagan-Godfrey)*

As well as the Obs*R-squared 78.5% is higher than the 10% level of significance; we accept the null hypothesis, and the Alternative hypothesis is rejected. Then, it is clear that the variance of the residuals is constant, which means that there is no heteroscedasticity.

**Table 8. Heteroskedasticity Test: Breusch-Pagan-Godfrey**

| | | | |
|---|---|---|---|
| F-statistic | 0.326935 | Prob. F(3,34) | 0.8059 |
| Obs*R-squared | 1.065458 | Prob. Chi-Square(3) | 0.7854 |
| Scaled explained SS | 2.256560 | Prob. Chi-Square(3) | 0.5209 |

*Source: Authors' computation using E-views.*

### *C. Normality Test (Jarque-Bera Test)*

The Jarque-Bera probability (96%) is greater than the 10% level of significance firms that the residuals are normally distributed.

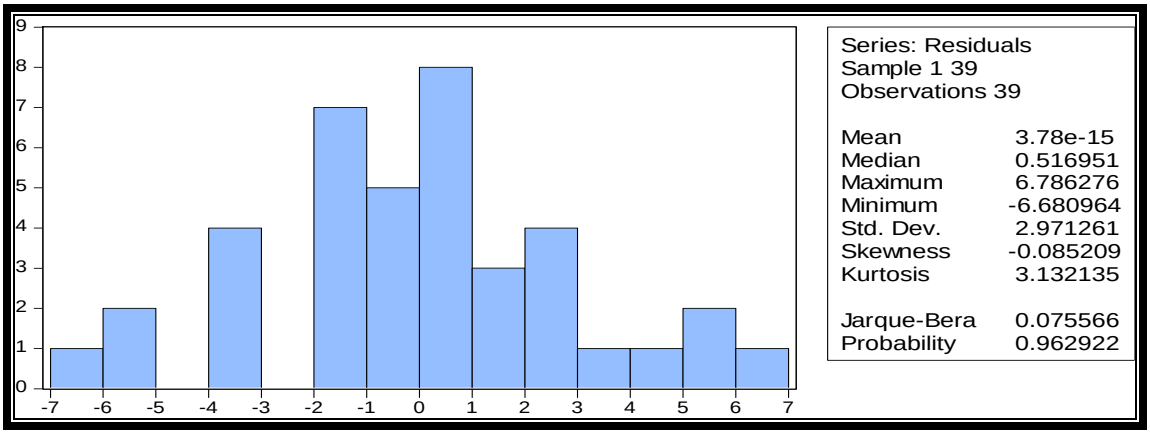


**Fig. 1 Normality Test**

*Source: Authors' Computation Using E-views.*

### *G. Misspecification Test (Ramsey RESET Test)*

Based on the results presented in table 9, the Likelihood ratio probability of 54% is greater than the 10% level of significance. The authors concluded that there are no omitted variables, and the estimated model is not wrong.

**Table 9. Ramsey RESET Test**

| | Value | df | Probability |
|---|---|---|---|
| t-statistic | 0.568157 | 35 | 0.5736 |
| F-statistic | 0.322802 | (1, 35) | 0.5736 |
| Likelihood ratio | 0.358046 | 1 | 0.5496 |

*Source: Authors' Computation Using E-views.*

### *H. Stability Test (CUSUM test)*

The CUSUM test figure indicates that parameters are stable because the blue line is not crossing the red lines that are the borders.

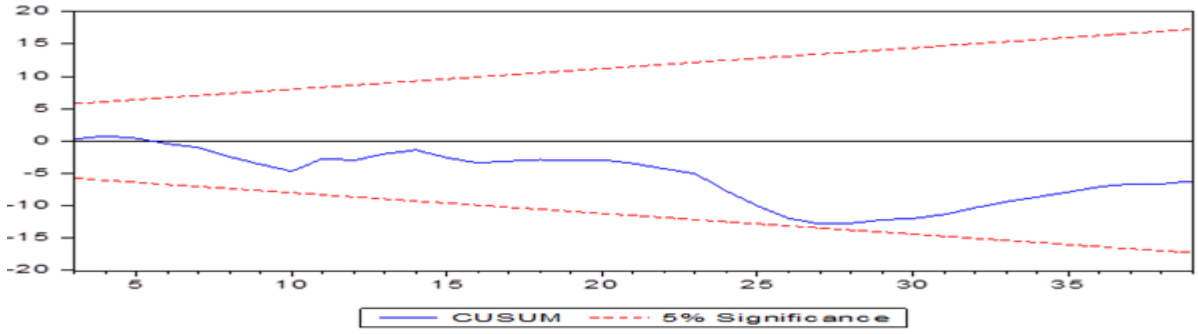


**Fig. 2 The CUSUM Test**

*Source: Authors' Computation Using Eviews*

## IV. CONCLUSION AND POLICY RECOMMENDATION

The purpose of this study was to find out the relationship between urbanization, agriculture sector, and industrial sector in Rwanda in the period 1980-2018. The test of cointegration, VAR model, and tests of Granger causality was used to investigate the association between these variables. The stationarity test was inspected carefully and critically using the Augmented Dicker Fuller test and Philips Peron test, and then we conducted cointegration and causality tests. The results of the cointegration test indicated the absence of long-run association among the variables that is why the authors used the VAR model.

The VAR estimation model shows that both agriculture and urbanization have a positive effect on the industrial sector in Rwanda. Ultimately, in the short run, the granger causality test shows that agriculture and urbanization cause the industrial sector and agriculture does not cause urbanization, and urbanization does not also cause agriculture.

Our findings indicate that the agriculture sector is vital to the agricultural sector, and the industrial sector is also vital to the agricultural sector in Rwanda. On the other hand, rural-urban migration does neither have a negative impact on the agriculture sector nor on the industrial sector in Rwanda.

### *A. Agriculture Sector-Related Policy and Recommendations*

The VAR estimated model and short-run causality analysis using the Granger causality test have indicated that the agriculture sector is very important for industrialization in Rwanda. These results are also backed up by many strategies; the first strategy is in the trade policy to promote made in Rwanda.

Because of this made in Rwanda, many industries in Rwanda use some of the raw materials from the agricultural sector. The main objective of made in Rwanda should be job creation, control over a trade deficit by promoting exports as well as imports substitution, and it should not only be quantity oriented but also on quality to win the international market competition.

That's why we recommend the government of Rwanda and other developing countries to promote efficient and effective R&D in the Agricultural sector.

The second back up to the current results is the national agricultural policy of 2004 and adjusted 2017, which states that "Using modern technologies in agribusiness, commercialization and professionalizing farming sector by creating a competitive agricultural sector". Within this period of study, rural to urban migration affected agriculture positively because the rural areas in Rwanda are very populated; then, the agriculture sector did not experience a shortage of labor, and the urban development will increase food demand in urban areas.

Based on the findings of this study, the authors recommend Rwanda's policymakers rethink the value addition and prioritization of the agricultural sector to improve production in order to supply the industrial sector for transformation so that export promotion and imports substitution strategy can take place.

This will be led by technological-based agriculture, so the Government needs to train agricultural sector workers not to be born farmers; as per the population mindset that everyone who did not attend education is considered as a farmer even if he or she is not practicing it.

This misconception is the result of a mismatch of the results with the agricultural economic theories whereby a good agricultural sector feeds the industrial sector.

### *B. Rural-urban Migration-related Policy and Recommendations*

The findings indicated that rural-urban migration positively affects the agricultural sector and industrial sector in Rwanda. This is because the agricultural sector in Rwanda has enough workers, and then if the excess unemployed laborers go into towns, there is no problem. On the other hand, when they get into towns, the industries will benefit from cheap labor.

The Economic Development and Poverty Reduction Strategy (2008-2017) is projected to add at least 200,000 off-farm jobs annually in its strategic program known as National Employment Programme (NEP); the reports state that most of the created jobs were in service, and few of them in industrial sectors. This increased rural-urban exodus.

We recommend the government of Rwanda to add more efforts (Technically & Financially) in its competence-based adopted school curricula and add more extra-curricular activities to enable the youths to be more competitive and serve the industrial sector more than the service sector, which was found inefficient and highly affected by New-Corona Virus Pandemic.

### *C. Industrial Sector-related Policy and Recommendations*

The results indicated that the industrial sector needs the agriculture sector and urbanization.

Firstly, based on the findings, we recommend the policymakers of Rwanda and other developing countries to increase the budget allocated in the agriculture sector so that they will shift from subsistence agriculture to market, industrial oriented agriculture and to promote R& D.

Lastly, but not least, the government of Rwanda needs to empower the industrial sector by providing a good policy and

technical support based on research as well as by attracting and keep on facilitating FDI in the industrial sector.

This should be based on a strong administration as well as competency-based institutions, specifically in the agencies affiliated to Ministry of Trade and Industry and to the ministry of agriculture and Animal Resources, such as the National Industrial Research and Development Agency (NIRDA), which is a key pillar toward Industrial Development in Rwanda as well as its stakeholder in Agriculture; Rwanda Agricultural Board (RAB) so that there will be a successful long-run linkage between the agricultural sector and industrialization in Rwanda.

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