Agricultural Productivity and its Impact on Economic Development: A Comparative Analysis of Selected Countries

Sunil Kumar Kar

ABSTRACT

The main purpose of this paper is to examine the role of agriculture in economic development. In this study, we looked at the inter-linkages between agriculture and other economic sectors using a multiple linear regression model. We have used a dimension reduction technique called PCA to identify the factors influencing agricultural production, and we have used multiple linear regressions to show the impact. Finally, we have formulated another multiple linear regression model to assess the impact of agriculture on economic development through employment generation and demand creation. The study has taken 35 countries out of 193 member countries as per World Bank classification, and further we have categorized them into three groups such as high (10), middle (15), and low (10) income groups. This study used the human development index (HDI) as a proxy for economic development. For employment, we used employment in agriculture/total employment (EA/ ET) as a proxy and for demand, we used gross value added (GVA) in agriculture/total consumption expenditure.

Keywords: Agricultural production, Economic development, Employment, Agricultural demand

Author Details:
Sunil Kumar Kar is a Research Scholar in the Department of Analytical and Applied Economics, Utkal University, Bhubaneswar, Odisha, Email: karsunil792@gmail.com

I. INTRODUCTION

Nowadays, the contribution of agriculture to GDP has declined. Therefore, policies are implemented focusing heavily on export driven growth. However, the real contribution of agriculture to GDP is underestimated. Apart from providing employment, the sector also provides raw materials to the industrial sector and generates demand in the economy. A research activity that can capture all these aspects is the primary motivation of this study. The contribution of the agricultural sector to development is examined after which the contributions of non-agricultural sector to agricultural sector during development are discussed. First, attention is focused on recent shifts in the role of the agricultural sector in economic development.

In addition to having a direct impact on farmers' wages, there is sufficient evidence that agriculture can help reduce poverty. Economic growth outside of the agricultural sector can be stimulated by agricultural development, which will result in more job and economic growth. Increased agricultural productivity boosts farm incomes, expands food production, lowers food prices, and creates more jobs in both rural and urban areas. Higher earnings have the potential to boost consumer demand for products and services made by industries other than agriculture.

It has been a century since people began debating which industries are the most important in terms of being the main drivers of economic growth. Among development economists, there has been discussion on the role and significance of agriculture in economic growth. The majority of early development economists highlighted agriculture's qualitative contribution to economic growth. Most of the studies (Lewis, 1954; Fei and Ranis, 1961; Jorgenson, 1961) established a strong relationship between the agricultural and industrial sectors. According to 'Johnston and Mellor' and 'Mackie' Agriculture has a crucial part in economic growth, and it contributes in multiple ways. These are: (1) boosting industrial growth and, thus, employment in industries that process agricultural products and those that provide agricultural inputs; (2) encouraging industrial growth and, thus, lowering the cost of producing food and fiber above subsistence levels; and (3) providing management and labour resources to other economic sectors through increased application of technology and innovations in production, thereby raising productivity. (a portion of the population will have more income opportunities, which will increase production, specialization, and per capita income); (4) providing a source of capital for industrial growth and taxes to finance government services during the transition; (5) providing increased income opportunities for a segment of the population.

This paper describes the inter-linkages between the agriculture with other sectors of the economy and identifies the factors affecting agricultural productions. It also focused on assessing the impact of agriculture on economic development through employment generation and demand creation.

II. REVIEW OF LITERATURE

Inter-linkages between Agricultural Production and Output of Other Sectors

In development programs all sectors of the economy should grow simultaneously, so as to keep a proper balance between industry and agriculture, and between production for home consumption and production for export (Johnston & Mellor, 1961; Lewis, 1965). Improvements in agricultural productivity could accelerate the start of industrialization and economic growth, (Gollin et al., 2002). Under a proper condition, in which the revenue generation effect dominates the comparative advantage effect, higher agricultural productivity enhances industrialization and increases long-run economic growth (Chang et al., 2006). There is a bidirectional causal relationship between the sectoral outputs in the short run and a unidirectional causal relationship between the agricultural and industrial sectors and the service sector in the long run (Debnath & Roy, 2012). Positive cross price elasticities between the firm and industrial sectors suggest that there are some complementarities between the two (Gopinath & Roe, 1996). The expansion of the

agricultural sector has a favourable and considerable impact on the expansion of the industrial sector; this positive impact also operates indirectly, primarily through the expansion of GNP (Brempong, 1992).

Factors Affecting Agricultural Production

The agricultural industry invested a significant amount of human capital in the shift of farm workers to the non-farm sector, which also made it possible for non-agricultural enterprises to grow (Kao, 1965). The future environment for crop producers will be shaped by an expanding and diverse demand, rapid adoption of new technologies, limitations on the world's agricultural resources, and a society that expects agriculture to produce a safe, abundant, affordable and currently 'sustainable' supply of food, fiber, feed, and energy (Bechdol et al., 2010). The rise of total agricultural output is found to be 'significantly' and 'importantly' influenced by public expenditure in research and extension (Griliches, 1964; Jin, Huang, Hu, & Rozelle, 2002). Utilization of fertilizers, irrigation, and urban-industrial development all have a positive impact on land productivity variations, while population density has a negative impact (Dayal, 1984). At least in the short run, migration generates statistically significant lost-labour effects that depress yields (Rozelle et al., 1999). One would anticipate that the return to the productive sector would be far more favourable than before given the built infrastructure, the invested technology, and the rising level of education among the local populace (Akkad, 1990). Drought, flooding, hail stone, strong winds, and winter freezes are among the hazardous weather concerns that affect agricultural producers. Drought is critical due to its geographic reach, when it begins and ends, how long it lasts, and the size of any possible losses (Brusentsev & Vroman). The amount of commitment each farm operator has put in production is dependent on the productivity of the soil of that particular farm. However, there is a bad correlation between that metric and the modification of that attachment (Beck & Frymire, 1989). Regional dualism or inequality is much more extensive in agriculture than non-farm industries (Felix & Padfield, 1967).

Impact of Agriculture on Economic Development

Normally agriculture has three basic contributions which help to make an economic transformation from traditional to modern set-up. These are, product contribution, factor contribution, and market contribution (Johnston & Mellor, 1961; Kuznets, 1963; Christensen & Yee, 1964; Balisacan, 1989;). Any developing nation's economic development is greatly influenced by agricultural and rural development, which also accelerates the expansion of the industrial sector. By generating employment, this could divert surplus labour from the agricultural sector to the industrial sectors (Wilber, 1969; Bashir & Ahmad, 2000). Due to the agricultural sector's significance to the nation's GDP, employment, food safety, and political independence, it must never be disregarded. Without focusing on this sector, any economic reformation strategy will fail (Khorami & Pierof, 2013). The growth of agricultural output will also directly and indirectly increase total national product. Through keeping food prices low by increases in agricultural supply, we can realize economic growth (Barbiero & Brown, 1991). Low agricultural productivity can drastically delay industrialization. By delaying the onset of industrialization, poor agricultural technologies or policies result in a country's per capita income falling far behind (Gollin, Parente, & Rogerson, 2002). As agriculture receives more

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attention, it is also acknowledged that a new paradigm on the functions of agriculture for economic development shall emerge (Byerlee et al., 2009).

III. OBJECTIVES

The primary objectives of the study are:

1. To study the inter-linkages between agricultural production and output in other economic sectors
2. To identify the factors affecting agricultural production in a global scenario
3. To assess the impact of agriculture on economic development through employment generation and demand creation in a cross-country framework

IV. METHODOLOGY

Data

The data have been collected from secondary sources. We have selected 35 countries out of 193 member countries of the World Bank. And we have categorized these countries into three groups: high income (10), middle income (15) and low income (10) countries. As per the study requirements, to fulfill the objectives we have compiled data from World Development Indicators (WDI) and from United Nation Development Program (UNDP).

Methods

Using simple regression model, the inter-linkages between agricultural production and output of other sectors of the economy were estimated.

$$Q_A = \alpha_0 + \alpha_1 Q_S + U_i \qquad\qquad\qquad\qquad \text{.......... (1)}$$

$$Q_A = \alpha_0 + \alpha_2 Q_T + U_i \qquad\qquad\qquad\qquad \text{.......... (2)}$$

Q_A – Value added in agriculture
Q_S – Value added in secondary sector
Q_T – Value added in tertiary sector
α_0 – Intercept
U_i – Error term

We have used the dimension reduction method principal component analysis (PCA) to identify the factors affecting agricultural production. And then, to show the impact, we have formulated a multiple linear regression model using the components extracted from PCA**.**

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + U_i \qquad\qquad \text{.......... (3)}$$

Y_i – Gross Value Added in Agriculture
X_{1i} – Component 1 (National Income related variables)
X_{2i} – Component 2 (Employment related variables)
X_{3i} – Component 3 (Labour and Population related variables)
X_{4i} – Component 4 (Agricultural Machinery and Input related variables)

X_{5i} – Component 5 (Service sector related variables)
X_{6i} – Component 6 (Arable Land related variables)
Ui – Error term

To assess the role of agriculture in economic development we have used a multiple linear regression analysis. Where we have taken Human Development Index as a proxy for economic development and for employment, we used employment in agriculture/total employment (E_A / E_T) and for demand; we used GVA in agriculture/total consumption expenditure.

$$Devt = \beta_0 + \beta_1 EMP + \beta_2 D + Ui \qquad\qquad .... (4)$$

Devt – Economic Development
EMP – Employment (E_A / E_T), E_A: Employment in Agriculture, E_T: Total employment
D – Demand (GVA / total consumption expenditure), GVA: Gross value Added in Agriculture
U_i – Error term

V. ANALYSIS AND FINDINGS

Inter-linkages between Agricultural Production and Output in Other Economic Sectors

The present chapter makes an effort to analyze the inter-linkages between the agricultural production and output in other economic sectors by using tools like descriptive statistics and two different simple linear regression models, separately in all income groups. It is believed that there exists a positive relationship between value added in agriculture and value added in secondary sector in high and middle income countries. But there is negative relationship in case of low income countries. However, there is a significant relationship between the agriculture and service sectors only in high and middle-income countries; in low-income countries, there is no significant relationship between agriculture and the service sector.

Table-1: Value Added in Industry and Service as Independent Variables for High-Income Countries

Value Added in Industry Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variable	Beta	t-value	Significance	F value =29.7
Constant		-2.67	0.011	P- value =.000
Value added in industry	0.662	5.451	0	R2 = .43
Value Added in Service Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variables	Beta	t-value	Significance	F-value= 44.79
(Constant)		8.094	0	P- value = .000
Value added in service sector	-0.736	-6.693	0	R2 =.54

Source: Author's estimates from WDI data
Note: Value added in agriculture, industry and service sectors are significant at a 1 percent level of significance

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One unit increase in the value added in industry leads to a 66.2 percent increase in the value added in agriculture, and one unit increase in the value added in the service sector leads to a 73.6 percent decrease in the value added in agriculture confirming that the value added in industry has a positive relationship with value added in agriculture whereas the service sector has a negative relationship with agricultural sector. This is due to the fact that as the industrial sector grows, it necessitates more raw materials, which the agricultural sector provides. Furthermore, rapid industrialization results in more modern agricultural equipment, which raises productivity in the agricultural sector but service sector shows the negative relationship because most of the service sectors are exist in urban areas where as the agricultural activities mainly practices in rural areas.

Table-2: Value Added in Industry and Service as Independent Variables for Middle-Income Countries

Value Added in Industry Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variables	Beta	t-values	Significance	F value = 115.4
(Constant)		-7.831	0	P - value =.000
Value added in industry	0.867	10.744	0	R2 = .75
Value Added in Service Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variables	Beta	t-values	Significance	F- value =497.7
(Constant)		29.069	0	P -value =.000
Value added in service sector	-0.964	-22.311	0	R2 = 0.92

Source: Author's estimates from WDI data
Note: Value added in agriculture, industry and service sectors are significant at a 1 percent level of significance

The study found that the value added in industry and agriculture are positively correlated in middle income countries is supported by the fact that an increase in industry value added results in an increase in agriculture value added of 86.7 percent. This is because as the industrial sector expands, it requires more raw materials to run the sector, which are produced by agricultural sector. Additionally, quick industrialization produces more advanced agricultural machinery, which helps to raise the productivity of agricultural sector. Around 75 percent variation in agricultural sector is explained by the value added in industrial sector and rest influenced by other activities.

If we analyze the relationship between agriculture and service sector in middle income countries we find that value added in service sector has a negative relationship with value added in agriculture is confirmed by the finding that one unit increase in the value added in the service sector results in a 96.4 percent decrease in the value added in agriculture. The value added in the service sector, which has an r-squared value of .92 implies that 92 percent of the variation in agricultural sector explained by service sector and error term accounting for the remaining portion.

Table-3: Value Added in Industry and Service as Independent Variables for Low-Income Countries

Value Added in Industry Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variables	Beta	t- values	Significance	F-value= 425.01
(Constant)		38.036	0	P-value = 0.000
Value added in industry	-0.958	-20.616	0	R2 = .91
Value Added in Service Value Added in Agriculture (Forestry and Fishing) as the Dependent Variable				
Variables	Beta	t- values	Significance	F value =.000
(Constant)		0.988	0.329	P Value =.984
Value added in service sector	-0.003	-0.02	0.984	R2=.000

Source: Author's estimates from WDI data
Note: Value added in agriculture, industry and service sectors are significant at a 1 percent level of significance

One unit rise in industry value added causes a decline in agriculture value added by 95.8 percent, on the other hand, one unit increase in the value added in the service sector results in less than a one percent increase in the value added in agriculture, supports the current analysis finding that value added in industry and agriculture is adversely connected in low-income nations where as value added in service sector has no meaningful relationship with value added in agriculture. This might be because low-income nations have less industrial practices and the service sector operates mostly in urban areas while agricultural activities are carried out in rural areas in low income countries. Additionally, as a low-income country begins to expand industrially, it hires more labour by paying high wages to meet its needs. It can result in a labour shortage in the farming industry. When low-income countries begin to industrialize, agricultural productivity decreases because of its significant reliance on labour.

Factors Affecting Agricultural Production in a Global Scenario

Here we have identified the factors affecting agricultural production in a global scenario. Principal component analysis has been undertaken to identify the factors, and a multiple linear regression has been used to show the impact. First, we have used data reduction strategies to obtain some factor scores. And then we have used a multiple linear regression analysis, taking these factor scores as explained variables. In this analysis, we extracted six components for each income group.

Here we have introduced a multiple linear regression model of the factor scores which are substantiated from PCA analysis. Here we got six factor scores and we have used those six factors as independent variables and value added from agriculture (agricultural production) as dependent variable. We found that except factor-4 all factors significantly affect the agricultural production. Except factor-4 the other factor scores obtained by PCA in this study are significant at the 1 percent level of significance. Therefore, we can conclude that all of the components taken from PCA have a large impact on agricultural production in high-income countries. But when we look at r-square values in high-income countries, we get a

low r-square value of 0.194, which means that 19 percent of the variation in agricultural production can be explained by the components extracted in PCA. We can say that the variables we used are to blame for the low r-square; these variables may not be very effective in high-income countries and may not appropriate also.

Table-4: Multiple Linear Regression Analysis for High-Income Countries

Model	Beta	T	SIG
(Constant)		26.346	0
Component-1	0.213	4.319	0
Component-2	0.146	3.01	0.003
Component-3	0.122	2.516	0.012
Component-4	-0.093	-1.887	0.06
Component-5	0.277	5.743	0
Component-6	0.134	2.761	0.006
R- square	0.194		

Source: Author estimates using components extracted from PCA

Table-5: Multiple Linear Regression Analysis for Middle-Income Countries

Model	Beta	T	SIG
(Constant)		49.734	0
Component-1	0.95	87.203	0
Component-2	0.171	18.08	0
Component-3	0.034	3.728	0
Componrnt-4	-0.011	-1.089	0.277
Component-5	0.001	0.11	0.913
Component-6	-0.088	-8.541	0
R-squared	0.955		

Source: Author estimates using components extracted from PCA

Table-6: Multiple Linear Regression Analysis for Low-Income Countries

Model	Beta	T	SIG
(Constant)		38.222	0
Component-1	0.681	26.931	0
Component-2	0.114	5.176	0
Component-3	0.368	15.944	0
Component-4	0.009	0.424	0.672
Component-5	0.097	4.712	0
Component-6	-0.117	-5.356	0
R-square	0.856		

Source: Author estimates using components extracted from PCA

In case of middle-income countries, we have also extracted six factor scores from PCA. Furthermore, we used multiple linear regression of these six factor scores as independent variables and value added from agriculture as a dependent variable. We found that except two factors 4 and 5 all other factors have a significant impact on agricultural production. Except of these two components, all other components are statistically significant at the 1 percent level of significance. If we look at the R square value of this analysis, we can see that 95 percent variation in agricultural

production explained by these six components. In this case, we can say that the variables we chose are suitable for middle-income countries.

We have taken six components from PCA in the instance of low-income nations. Additionally, we used multiple linear regressions using value added from agriculture as the dependent variable and these six factor scores as the independent variables. Except the component 4, we discovered that all other components significantly affect the agricultural production. We can observe from this analysis R square value of the model described 85 percent of the variation in agricultural production. In this instance, we can conclude that the variables we selected are appropriate for low-income nations.

The Impact of Agriculture on Economic Development through Employment Generation and Demand Creation in a Cross-Country Framework

An effort is made here to assess the impact of agriculture on economic development through employment generation and demand creation in a cross-country framework by using tools like descriptive statistics and multiple linear regression analysis. The study has used economic development as a dependent variable and employment and agricultural demand as independent variables. In this study, we have used HDI as a proxy for economic development, and for employment, we have taken employment in agriculture out of total employment as a proxy. For agricultural demand, we have used GVA in agriculture with respect to total consumption expenditure.

Table-7: Multiple Linear Regression Analysis for Economic Development of High-Income Countries

Variables	Beta	T- values	Significance
(Constant)		124.126	0
Employment in agriculture (% of total employment)	-1.037	-11.999	0
GVA/Final consumption expenditure	-0.065	0.756	0.455
R Square	0.955		
F value	396.707		

Source: Author's estimates using data from WDI and UNDP

Employment in agriculture has a negative impact on economic development in high-income countries and agricultural demand has negligible impact. This is due to industrialized countries' heavy reliance on industrial goods, as a result, individuals in these countries have a larger inclination to consume manufacturing goods than agricultural ones, which explains when income of the people rises they buy manufacturing goods rather than agricultural ones. This is the reason of fewer agricultural practices in high income countries.

Table-8: Multiple Linear Regression Analysis for Economic Development of Middle-Income Countries

Variables	Beta	T- values	Significance
(Constant)		141.024	0
Employment in agriculture (% of total employment)	-0.875	-21.724	0
GVA/Final consumption	0.131	-3.251	0.002
R square	0.988		
F value	1555.765		

Source: Author's estimates using data from WDI and UNDP

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The other two variables, with the exception of agricultural demand, are significant at the 1 percent level of significance. In terms of the model's goodness of fit, we discovered that 95 percent of the variation in economic development is explained by both employment and agricultural demand and rest by the error term.

One unit increase in employment in agriculture leads to an 87 percent decrease in economic development and one unit increase in agricultural demand leads to a 13 percent increase in the human development index. This proportion is negligible, so if we consider the data, we can find that over the years there has been a positive relationship between agricultural demand and economic development in middle-income countries.

If we look at agricultural employment in middle-income countries over the years, it has declined. It could be because there are many high-wage jobs available in the manufacturing and service sectors in middle-income countries, and the low wage rate in the agriculture sector is also responsible for the decline in employment rates in agriculture. Although employment in agriculture has declined, it still provides a significant amount of employment with respect to other sectors.

All variables are significant at the 1 percent level of significance. In terms of the model's R squared value, we discovered that the employment and agricultural demand explained 98 percent of the variation and the error term explained the remaining portion.

Table-9: Multiple Linear Regression Analysis for Economic Development of Low-Income Countries

Variables	Beta	T- values	Significance
(Constant)		44.05	0
Employment in agriculture (% of total employment)	0.917	-19.007	0
GVA/Final Consumption	0.086	-1.776	0.087
R squared	0.984		
F value	842.351		

Source: Author's estimates using data from WDI and UNDP

The current analysis found that economic development has a positive connection with agricultural employment and agricultural demand in low-income countries, because in low-income countries agriculture is the biggest source of income. Here we can clearly see that agricultural demand has a positive impact on economic development, but this is not at a significant level because it provides food only for sustenance.

VI. CONCLUSION

Agricultural production and industrial output are positively related to each other in high- and middle-income countries. This is due to the fact that as the industrial sector grows, it necessitates more raw materials, which the agricultural sector provides. Furthermore, rapid industrialization results in more modern agricultural equipment, which helps raise productivity in the agricultural sector. And there is a negative correlation between industrial output and agriculture in low-income countries. This might be because low-income nations have fewer industrial

practices. Additionally, as a low-income country begins to expand industrially, it hires more labour, paying high rates to meet its needs. It can result in a labour shortage in the farming sector. When low-income countries began to industrialize, agricultural production decreased because in low income countries agricultural activities are labour-intensive. Due to a significant reliance on labour, industrialization in low-income countries reduces gross farming production. And agricultural production and the service sector are negatively correlated in all income groups.

There are a wide range of factors that affect agricultural production. Firstly, national income-related factors, employment-related factors, saving and investment-related factors, the service sector, and agricultural machinery all have a positive impact on agricultural production in high-income countries, whereas factors related to population and labour have a negative impact on it. Factors related to population, national income, employment, exports of agricultural raw materials, and agricultural machinery positively affect agricultural production in middle-income countries, whereas imports of agricultural raw materials have a negative impact on it. In low-income countries, agricultural production is positively affected by factors related to employment, labour, and population, but the availability of arable land has a negative impact on agricultural production. However, the service sector does not have a significant impact on agricultural production in low-income countries.

It is clear from the analysis that employment in agriculture and agricultural demand have a negative impact on HDI (economic development) in high-income countries. This is because citizens in industrialized countries have a strong preference for consuming manufactured items over agricultural products. Middle-income countries also experience the negative impact of agricultural employment. According to the research, there has been a positive impact of agricultural demand on economic development in middle-income countries over time, and agricultural employment and demand have a direct impact on economic development in low-income countries.

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