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DETERMINANTS OF AGRICULTURAL OUTPUT IN NIGERIA

BY

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Abstract

Agriculture is seen as an important source of food for man and raw materials for agro-based industries. So as to provide bases for policies aimed at promoting agriculture, various empirical studies have been conducted with a view to identifying the determinants of agricultural production and output of the agricultural sector in Nigeria. But such studies still leave some gaps to be filled, including failure to test the the influence of government expenditure spent on agriculture (GEA) on the effect of agricultural capital stock on agricultural output. Data from the World Development Indicators, Food and Agriculture Organization and International Labour Organization were used for the estimation. The study aims to fill these gaps by adopting Cobb-Douglas production function, and we estimated two categories of equations. The study employed fully modified least squares (FMOLS) in estimating the agricultural output equations. The study found that government expenditure on agriculture (GEA), fertilizer consumption, financial development and trade openness has positive effect on agricultural output in Nigeria. Based on these findings, therefore, policy makers should target policies on inducing GEA, financial development and trade openness in order to achieve increase in agricultural output.

Keywords: FMOLS; GEA; Agricultural Output; Agricultural Capital Stock

Introduction

Nigeria occupies an important position in the sub-Sahara Africa as the largest country in the region, having a landmark of 923.768 square kilometers. Prior to the attainment of independent in Nigeria, the country's economy is agrarian in nature, which implies that agriculture is not only the core industry but the backbone of Nigeria economy. Nigeria is an agricultural power house with over 84 million hectares of arable land, of which no more than 40% is cultivated. The sector is fundamental to improving the living standard of the population by providing access to adequate and nutritious food which are essential for human development and industrial raw materials (Brown & Iyabode, 2020). The country was one of the world's highest producers of some agricultural products including palm oil, cocoa, groundnut, rubber and cotton amongst others. Consequently, these form the basis for government revenue and foreign exchange, thus, helping to meet the infrastructure and other social needs of the state. The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of the multifunctional nature of agriculture. For instance, record shows that the then revolutionary free education programme in the western region was funded entirely from cocoa, rubber and palm oil proceeds.

Also Ahmadu Bellow University (ABU), Zaria and University of Nigeria, Nsukka, (UNN), were built from the earnings of some agricultural product such as cotton, groundnuts, rubber and palm oil. But the oil boom of the 1970s created relative disincentives for agriculture in relation to other sectors of the economy resulting in the increased dependence on a mono-cultural economy based on oil (Paul et al., 2018). Agriculture primarily provides food for man and raw materials for agro-based industries. It consists of all the productive endeavors of man in collaboration with nature to rear plant and animal for a better harvest. It involves all aspects of farming, fishing, livestock rearing, poultry and forestry. Agriculture has been the main source of gainful employment from which the nations can feed its teeming population, providing the nation's industries with local raw materials and also as reliable source government revenue. Until the discovery of oil in Nigerian, agriculture was the most important sector of the economy accounting for more than two- thirds of colonial Nigeria's export earnings (Toheeb & Dabo, 2018).

Some of the main factors destabilizing agricultural production include low productivity due to poor planting material, climate change, and inadequate budget to agricultural sector amongst others. In addition, the decline in food production which has led to increasing food importation in Nigeria can be linked to farmer's difficulty to

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obtain fertilizer and patching access to credit. Consequently, food production profile in Nigeria has been at lower rate which lead to a rise in import of stable food per annum (Bidemi el al., 2018). Subsistence farming with rudimentary farming tools is the common practice that has constrained the development of the sector in Nigeria. Furthermore, the problem of poor transportation network can never be wished away, as transport cost escalates the prices of food stuff. Moreover, majority of the farmers are in the rural areas and due to inaccessible roads, many of them are unable to transport their produce to the market. Even when those that eventually get to the market through the efforts of middlemen, are sold at extreme prices in order to maximize profit (Brown & Iyabode, 2020). In response to the poor performance of agriculture in Nigeria, successive governments have evolved and implemented numerous policies and programs geared towards restoring the agricultural sector to its pride of place in the economy.

Several empirical studies have sought to shed light on the determinants of agricultural production and output of the agricultural sector in Nigeria with most reporting mixed results. Among these studies are: Toheeb & Dabo (2018) examine the impact of agricultural finance on agricultural output in Nigeria using annual time series data from 1983 to 2018. The methods of analysis used were the vector autoregressive model (VAR) for the estimation of the long run relationships and Granger Causality for the determination of causal relationships among variables. The findings of the study reveals that both government agricultural finance and financing from commercial banks have significant positive long run impact on agricultural output. Brown & Iyabode (2020) examined the determinant of agricultural production and agricultural sector output in Nigeria. The objective of the study is to determine the impact of agricultural production determinants on agricultural output. The study was carried out based on secondary data collected through the CBN statistical bulletin. The findings from the study based on the OLS results shows that agricultural funding, agricultural credit/loan as well as exchange rate have positive relationship with agricultural production output.

Subsequently, in the same year, another author join Brown & Iyabode (2020) to revisit the earlier topic of the study but with different method of analysis. Thereafter, Ado & Bello (2020) examines the economic determinants of agricultural productivity in Nigeria from 1981-2017. The outcome of the study confirms the long run linkage among the variables of the model. The estimated ARDL result reveals that the labor force and real exchange rate influence agricultural productivity positively, while the inflation rate influence it negatively. Hassan & Ciroma (2022) empirical examined the analysis of the determinants of agricultural productivity and its effect on agricultural output in Sokoto, Kebbi and Zamfara states. Data for the study were sourced primarily through questionnaire.

However, the study by Ukpe, et al. (2018) sourced of data and techniques of estimation is similar to the study by Brown & Iyabode (2020) but to some extent differs. Brown & Iyabode (2020) sourced data majorly from CBN whilst Ukpe, et al. (2018) sourced data majorly from Food Agriculture Organization (FAO) and National Bureau of Statistics (FOS). Despite the great task accomplished by these studies, there are still many grounds yet to be covered, because previous studies are bedevilled with certain methodological pitfalls. It would have been more informative, if tested by such studies, the influence of government expenditure spent on agriculture (GEA) on the effect of agricultural capital stock on agricultural output. To the best of our knowledge, most of the existing studies have failed to address this. So, it serves as the research gap that the present study endeavours to address.

Research Objectives

The objectives of this study are to:

1. empirically determine the determinants of agricultural output in Nigeria.
2. investigate whether government expenditure spent on agriculture (GEA) influence the effect of agricultural capital stock on agricultural output in Nigeria.

Research Questions

The following will be considered as the research questions:

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i. what are the determinants of agricultural output in Nigeria?
ii. does government expenditure spent on agriculture (GEA) influenced the effect of agricultural capital stock on agricultural output in Nigeria?

Methodology

Theoretical Framework

The theoretical foundations of the agricultural output equation can be found in Cobb-Douglas production function which is widely used in empirical studies. The derivation of the Cobb-Douglas production function goes thus:

$$Y = Af(K,\ N) \quad 3.1$$

From Equation 3.1, and following constant returns to scale assumption, we arrive at the Cobb-Douglas production function below:

$$Y = AK^{a}N^{1-a} \quad 3.2$$

where A= Total factor Productivity, K= Capital stock, N= Labour, and Y= Output.

Transforming Equation 3.11 to a linear function by taking the logarithm of each variable in the Equation gives Equation 3.12 below:

$$lnY = lnA + alnK + (1-a)lnN \quad 3.3$$

Let $a = B_1$ and $1 - a = B_2$, then the parameters B_1 *and* B_2 are output elasticity of capital stock or labour force respectively. The above equation can be re-specified below as;

$$lnY = lnA + B_1 lnK + B_2 lnN \quad 3.4$$

Y = Output proxied by agricultural output, K = Capital stock proxied by agricultural capital stock/agricultural machinery and tractors, N= labour force proxied by agricultural labour force/employment level in agricultural sector and A= Productivity level

The above is the derivation of the Cobb-Douglas production function, which shows that agricultural output is function of level of total factor productivity (A), agricultural capital stock (K) and agricultural labour force (N). The postulated determinants of total factor productivity level in this study are fertilizer consumption, financial development, trade openness, government expenditure on agriculture. These are as discussed below.

(a) Fertilizer Consumption (FC): An increase in fertilizer consumption is posited to lead to increase in the crop yield of farmers and thereby leading to increase in agricultural output. Inclusion of this variable was informed by the findings of Imahe & Alibi (2005) and Ahmad & Heng (2012) which included it and confirmed that fertilizer consumption has a positive effect on agricultural output in their estimation. Therefore, in the present study, fertilizer consumption is also expected to have positive effect on agricultural output.

(b) Financial Development (FD): FD is posited to have positive effect on agricultural output. Financial development enhances agricultural sector output through increase in savings, investments and bank credit activities which thereby alleviates the financial constraints in the agricultural sector, allows easy provision of credit to the farming community and enhance agricultural sector output. Some previous studies, e. g. Ogbanje et al. (2012), Agunuwa et al. (2015) and Chandio, Shah Sethi & Mushtaq (2021) and have tested for it and confirmed that it has a positive effect on agricultural output in their empirical studies. Therefore, in the present study, financial development is expected to have a positive effect on agricultural output.

c) Trade Openness (TO): Trade openness is posited to have positive effect on trade openness. It promotes economies of scale, specialization, technology usage and capacity utilization, which eventually enhances agricultural sector output. Inclusion of this variable is in line with the findings in some of previous studies such as, Verter (2016) and Inusa & Umaru (2021), which confirmed that trade openness has a positive effect on agricultural output in their results. Thus, trade openness is postulated to have a positive effect on agricultural output.

d) Government Expenditure on Agriculture (GEA): government expenditure on agriculture will impact agricultural output positively through government investment on agriculture such as; purchasing of tractors and

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other machineries for farmers, construction of roads for easy movement of farm produce, provision of loans for farmers to purchase proceeds, and etc. Some previous studies, e. g. Ngobeni & Muchopa (2022) have tested for it and confirmed that it has a positive effect on agricultural output in their empirical studies. Therefore, in the present study, government expenditure on agriculture is expected to have a positive effect on agricultural output.
Following the above, a linear time series databased equation for the total factor productivity is specified below:

$$InA = \beta_3 \mathrm{FC_t} + \beta_4 \mathrm{FD_t} + \beta_5 \mathrm{TO_t} + \beta_6 \mathrm{GEA}_t \quad 3.5$$

where: InA = Total factor productivity; FC = Fertilizer consumption; FD = Financial development proxied by credit to agricultural sector from commercial banks; TO = Trade openness; and GEA= Government expenditure on agriculture.
The above equation includes selected variables affecting total factor productivity, viz FC, FD, TO and GEA. These variables serve as the control variables, an absence of which may lead to some specification biases in the result. The selection of control variables included is motivated by those used in the existing empirical literature on agricultural output.

Model Specification

To achieve Objective 1 of this study, the Cobb-Douglas production in Equation 3.4 was re-specified. This is done by putting the expression in Equation 3.5 in Equation 3.4 and transform the result into an econometric model of agricultural output by adding intercept β_0, time and country subscripts (t and i) and the stochastic error term (U).

$$InY_t = \beta_0 + \beta_1 InK_t + \beta_2 InN_t + \beta_3 \mathrm{FC_t} + \beta_4 \mathrm{FD_t} + \beta_5 \mathrm{TO_t} + \beta_6 \mathrm{GEA}_t + U_t \quad 3.6$$

where: Y = output proxied by agricultural output; K = Capital stock proxied by agricultural capital stock/agricultural machinery and tractors; N = labour force proxied by agricultural labour force/employment level in agricultural sector; t subscripts = year subscripts; and U_t = Stochastic error term. β_0, β_1, β_2, β_3, β_4, β_5, and β_6 represent parameters to be estimated. Other notations are explained according to the Equation 3.5. Equation 3.6 shows that agricultural output is a function of agricultural capital stock, agricultural labour force and other control variables (fertilizer consumption, financial development, and government expenditure on agriculture). To achieve Objective 2 of this study, Equation 3.6 was re-specified. This is done by interacting the government expenditure on agriculture (GEA) with agricultural capital stock (K) in Equation 3.6 to arrive at Equation 3.7 below.

$$InY_t = \beta_0 + \beta_1 InK_t + \beta_2 InN_t + \beta_3 \mathrm{FC_t} + \beta_4 \mathrm{FD_t} + \beta_5 \mathrm{TO_t} + \beta_6 \mathrm{GEA}_t + \beta_7 \mathrm{GEA} * \mathrm{K} + U_t \quad 3.7$$

In Equations 3.7, the coefficient of β_7 shows the rate at which government expenditure on agriculture (GEA) influence the effect of agricultural capital stock (K) on agricultural output (Y).

Estimation Techniques

The estimation techniques in this study followed the following steps including: i) Descriptive statistics; ii) Pre-estimation tests (trend analysis, unit root test, ARDL bound test cointegration test); iii) estimation of the model with fully modified least squares (FMOLS); and lastly v) Post-estimation test: multicollinearity test using variance inflating factor (VIF); autocorrelation/serial correlation test using Breusch-Godfrey test; heteroscedasticity test using Breusch-Pagan test and normality test using Jague-Bera test).

The study examines the determinants of agricultural output in Nigeria with data spanning from 1980 to 2022. This coverage will be considered in the study because it provides longer observations of data which gives robust estimate. 1980 marked the begging of green revolution in Nigeria during the regime of Shehu Shagari. More so, year 2022 was included to capture the influence of national agricultural technology and innovation policy (NATIP) which was newly lunched May, 2022. The measurements of variables used for estimations are as follows: (1) **Agricultural output (Y)** is the agricultural value added which is measured as percentage of GDP and sourced from the World Bank's WDI, (2020). (2) **Agricultural capital stock (K)** is proxied by agricultural machinery is described in the data source as the number of wheel and crawler tractors (excluding garden tractors) in use in agriculture at the end of the calendar year specified or during the first quarter of the following year. Data are sourced from the Food and Agriculture Organization (FAO), (2022). (3) **Agricultural labour**

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force (N) is proxied by employment in agriculture measured as percentage of total employment and are sourced from International Labour Organization (ILO), (2022). (4) **Fertilizer consumption (FC)** according to the data source measures the quantity of plant nutrients used per unit of arable land. Data are measured in kilograms per hectare of arable land and are sourced from FAO, (2022). (5) **Financial development (FD)** is proxied by credit to agricultural sector. Data are measured as percentage of total credit and are sourced from FAO, (2022). (6) **Trade openness (TO)** is the sum of exports and imports of goods and services measured as a share of gross domestic product and is sourced from the World Bank's WDI, (2022). (7) **Government expenditure on agriculture (GEA)** according to the data source is the total government Expenditure and expenditure in: Economic affairs; Agriculture, Forestry, Fishing and Hunting, along with its three disaggregated subsectors of Agriculture, Forestry and Fishing; and Environmental Protection. Data are reported for the highest level of government available (Consolidated general government, consolidated central government or budgetary central government) and are sourced from FAO, (2022).

Results and Discussion

Pre-estimation Statistics

Trend Analysis

Table 1 below show the trend of each of the variables considered in this study over time. The table presents the p-values of the trend (year) coefficients for each variable used for estimation in the study.

Table 1: ***Trending Analysis***

Variables	Coefficient (Year)	Prob. Values (0.05 sig. value)	Comments
Y	0.1259	0.036	Upward trending
K	0.0658	0.000	Upward trending
N	-0.6263	0.000	Downward trending
FC	0.0343	0.587	Not trending
FD	-0.3413	0.000	Downward trending
TO	0.41	0.015	Upward trending
GEA	1.1925	0.000	Upward trending

Authors computations 2022.

Explanatory Note: FC= Fertilizer consumption, FD = Financial development, TO = Trade openness, GEA = Government expenditure on agriculture, Y = Agricultural output, K = Agricultural capital stock, N= agricultural labour force.

Table 1 shows that agricultural output (Y), agricultural capital stock (K), government expenditure on agriculture (GEA) and trade openness (TO) are upward trending. Agricultural labour force (N) and financial development (FD) exhibit downward trending. However, fertilizer consumption (FC) is not trending.

Descriptive statistics

The table below shows the descriptive statistics for each of the variables considered in this study. The table presents the mean, maximum, minimum, standard deviation, skewness and kurtosis for all dependent and explanatory variables. The descriptive analysis is presented to give a brief summary of the samples and measures done in the study.

Table 2: ***Descriptive Statistics***

	Y	K	N	FC	FD	TO	GEA
Mean	23.12217	5.412518	48.17000	9.102525	11.36858	31.27277	-17.26556
Maximum	36.96508	6.702703	50.57000	15.31561	19.65762	51.46101	5.270000
Minimum	12.24041	4.199569	43.66000	4.147590	1.956978	9.135846	-43.37000
Std. Dev.	5.500442	0.687103	2.358097	3.932026	5.193423	13.47928	15.67063

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Skewness	0.260470	0.356433	-0.692543	0.183407	-0.329423	-0.348496	-0.075314
Kurtosis	3.499790	2.229364	1.998370	1.515714	1.956037	1.915779	1.731173
Observations	40	40	40	40	40	40	40

Authors computations 2022.

Explanatory Note: FC= Fertilizer consumption, FD = Financial development, TO = Trade openness, GEA = Government expenditure on agriculture, Y = Agricultural output, K = Agricultural capital stock, N= agricultural labour force.

Table 2 reports that all the variables have average values mean. The mean of the variables measures the central tendency. However, the results above show that the mean values are not affected by outliers. The agricultural labour force has the highest mean value of 48.2 while government expenditure on agriculture has the lowest mean value of -17.3. The standard deviation for agricultural output (Y) is about 5.500 with a mean of 23.122. The standard deviation for agricultural capital stock (K) is about 0.687 with a mean of 5.412. Government expenditure on agriculture (GEA) standard deviation and mean values are 15.671 and -17.266 respectively. The trade openness (TO) respective mean and standard deviation values 31.273 and 13.479. The standard deviation and mean values for agricultural labour force (N) are 2.358 and 48.17 respectively. Financial development (FD) mean and standard deviation values are 11.369 and 5.193 respectively. Finally, the standard deviation and mean values for fertilizer consumption (FC) are 3.932 and 9.103 respectively.

Correlation Analysis

Table 3 shows the sample correlations between every pair of the variables. A correlation is interpreted to exist in this study if the p-value is not more than 5 percent, (i.e. 5% is the chosen cut-off significance level in the study).

Table 3: *Correlation Matrix*

Correlation Probability	**K**	**N**	**FC**	**FD**	**TO**	**GEA**
K	1.000000					
N	-0.968394	1.000000				
	0.0000					
FC	-0.438267	0.362527	1.000000			
	0.0785	0.1527				
FD	-0.883896	0.867021	0.457327	1.000000		
	0.0000	0.0000	0.0649			
TO	0.146492	-0.092683	-0.312033	-0.359031	1.000000	
	0.5748	0.7235	0.2227	0.1570		
GEA	0.959312	-0.929999	-0.603904	-0.912700	0.241530	1.000000
	0.0000	0.0000	0.0103	0.0000	0.3503	-----

Authors computations 2022.

Explanatory Note: FC= Fertilizer consumption, FD = Financial development, TO = Trade openness, GEA = Government expenditure on agriculture, Y = Agricultural output, K = Agricultural capital stock, N= agricultural labour force.

Table 3 shows the correlation analysis results. This reports that the coefficient of correlation for agricultural capital stock (K) is strongly and significantly related with agricultural labour force (N) negatively, with financial

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development (FD) negatively and with government expenditure on agriculture (GEA) positively at 5% significant level. K has a strong significant positive correlation with FD while it has strong significant negative correlation with GEA at 5% significant level. Moreover, fertilizer consumption (FC) has a strong significant negative relationship with GEA at 5% level of significance. Finally, FD also has a strong significant negative relationship with GEA.

Unit Root/Cointegration Test

The results of the Augumented Dickey Fuller (ADF) unit root test reveals that some variables were stationary at level and some at first difference at the chosen 5% significance level, judging from the p-values that are less than 0.05. Variables including N and GEA are stationary at level that is they regarded as I (0) series. Contrarily, variables at first difference are FC, Y, TO, K and FD. Also, the cointegration test was conducted using ARDL bound test approach and concludes that there is log run relationship among the variables since the F-statistics values of 29.42 is greater than I(1) bound value at 5% significance level.

Estimates of the Determinants of Agricultural Output Equations

The model examines the determinants of agricultural output and investigate the influence of GEA on the effect of agricultural capital stock on agricultural output.

Table 4: ***Fully Modified Least Square Results***

	Equation 3.6 Fully Modified Least Squares (FMOLS)				**Equation 3.7 Fully Modified Least Squares (FMOLS)**		
Variables	No. of obs. = 40			Variables	No. of obs. = 40		
	Coeff	T-stat	p-value		Coeff	T-stat	p-value
D(In(K))	-1.587	-1.643	0.139	D(In(K))	-2.649	-3.496	0.01
ln(N)	-2.246	-0.924	0.325	ln(N)	-12.397	-3.381	0.012
D(FC)	-0.026	-2.254	0.054	D(FC)	-0.021	-2.15	0.04
FD	0.0049	0.4299	0.679	FD	0.0081	0.947	0.375
TO	0.0054	1.206	0.262	TO	0.008	2.449	0.044
GEA	0.127	3.246	0.012	GEA	0.393	4.142	0.004
				GEA*K	-0.056	-2.998	0.02
Breusch-Godfrey test (P.value)	0.392 (0.752)			Breusch test (P.value)	0.423 (0.852)		
Breusch-Pagan test (P.value)	2.72 (0.257)			Breusch-Pagan test (P.value)	4.72 (0.457)		
VIF	1.42			VIF	2.42		
Jarque-Bera test (P.value)	0.472 (0.770)			Jarque-Bera test (P.value)	0.452 (0.670)		
R-squared	0.517			R-squared	0.713		

Authors computations 2022*. Explanatory Note: FC= Fertilizer consumption, FD = Financial development, TO = Trade openness, GEA = Government expenditure on agriculture, Y = Agricultural output, K = Agricultural capital stock, N= agricultural labour force.*

As it can be seen from the table, R-squared is above 50% in Equation 3.6 and Equation 3.7 indicating that the equations exhibit high goodness of fit. All the robustness test revealed that the two equations are free from serial

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correlation (Breusch-Godfrey test), variance inflating factor (VIF) and heteroscedasticity (Breusch-Pagan test). Equation 3.6 results revealed that only the coefficients of fertilizer consumption (FC) and government expenditure on agriculture (GEA) are negative and positive respectively. Therefore, they have negative and positive effect on agricultural output respectively. The coefficient of the former is significant at 10% significant level whilst the latter at 5% significant level. In Equation 3.7, agricultural capital stock (K), agricultural labour force (N) and fertilizer consumption has a diminishing negative effect on agricultural output. Whilst financial development (FD), GEA and trade openness has positive effect on agricultural output (Y). Government expenditure on agriculture influences the effect of agricultural capital stock (K) on agricultural output negatively.

Conclusion

Based on the findings that the coefficient of government expenditure on agriculture is positive effect and statistically significant, therefore, the study conclude that it has positive effect on agricultural output. The coefficient of fertilizer consumption is negative effect and statistically significant, then, the study conclude that fertilizer consumption has negative effect on agricultural output which might arises as a result of excess usage of fertilizers. The coefficient of agricultural capital stock is negative effect and statistically significant. Therefore, the study conclude that agricultural capital stock has a diminishing effect on agricultural output. The coefficient of agricultural labour force is negative effect and statistically significant. Hence, the study conclude that agricultural labour force has negative effect on agricultural output.

Recommendations

The study recommend the following based on the above findings and conclusion:

1. Policy makers should target policies on inducing government expenditure on agriculture in order to achieve increase in agricultural output.
2. Policy makers should also target policies towards organizing workshops to enlighten farmers on the proper usage/application of fertilizers to avoid negative effect of fertilizers on agricultural output.
3. Authorities should predict the appropriate capacity of agricultural capital stock that will be used to achieve an increase in agricultural output.
4. Authorities should also predict the appropriate size of agricultural labour force that will bring about improvement in agricultural output.

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