# AGRICULTURE PRODUCTIVITY AND ECONOMIC GROWTH IN INDIA: AN ARDL MODEL


## *Abstract*

**Purpose:** The research aims to investigate agricultural production and its influence on India's economic growth.

**Method:** The ADF test has been used to determine variable stationarity. Using secondary data from 1991 to 2020, the ARDL Model was used to estimate the long-run and short-run links between agricultural production and economic growth.

**Findings:** Our empirical findings reveal that the GCF and inflation rate are negatively correlated with economic growth in the short and long term. In contrast, all other factors have a positive link with economic growth.

**Research Implication:** We believe that the government should increase its investment in agriculture and adopt new technology to boost production.

**Future Research Suggestion:** The research has certain flaws because it only looks at five different crops and evaluates their influence on economic expansion over the previous three decades. The new study, with its many variables and long year, presents an opportunity to boost India's agricultural output, despite the fact that it has several flaws



***Keywords:*** *economic growth, agricultural productivity, ADF, ARDL, GCF*


## *1. INTRODUCTION*

### *Agricultural Productivity Overview*

India is the world's largest populated country, with 1.27 billion people. With a size of 3.288 million square kilometres**,** it is the world's sixth-biggest country. It has a 7,500-KM-long coastline. India is a varied country with more than 22 main languages and 415 dialects. The nation is home to great agro-ecological variety, with the tallest mountain range in the world, the Himalayas, in the north, the Thar sands in the occident, the Gangetic delta in the occident, and the Deccan Plateau to the south. India is the world's most fabulous milk, pulses, and jute manufacturer. Ranks second in rice, wheat, sugarcane, groundnut, vegetables, fruit, and cotton production. It's also a significant producer of spices, seafood, poultry, cattle, and plantation crops. With a GDP of $ 2.1 trillion, India is the world's third-largest economy after the United States and China.

India's economic growth is predicted to rise by 8.0 or 8.5 per cent in the fiscal year 2022-23, (Economic Survey, 2021-22) due to stronger performance in both industry and services. India

has the world's fifth-largest economy in nominal GDP ($ 2.94 trillion) and third-largest in terms of purchasing power parity ($ 10.51 trillion). Agriculture accounted for 16.07 % of GDP in 2021 (WDI, 2021) and employed 59% of the country's overall workforce. Agriculture, along with its linked sectors, is India's most important source of income. 70% of its rural families are still largely dependent on agriculture for a living, with 82 percent of farmers being small and marginal. Total food grain production was predicted to be 315 million tonnes MT in 2020-21 (Indiastat, 2021). India is the world's greatest producer (25 percent of global production), the world's greatest consumer (27 percent of global consumption), and the world's greatest importer (14%). India's annual milk output was 165 million tonnes (MT) in 2017-18, making it the world's greatest producer of milk, jute, and pulses and home to the world's second-largest cow population of 190 million in 2012. It is the world's second-largest manufacturer of rice, wheat, sugarcane, cotton, and groundnuts. The second-largest manufacturer of fruits and vegetables in China, accounting for 10.9 percent and 8.6 percent, respectively.

## 2 REVIEWS OF LITERATURE

**Ahmad (2012)** The researcher studied Pakistan's agricultural productivity. ARDL determined total factor productivity's impact (TFP). This study included five variables from 1965-2009 Pakistan economic surveys. Fertilizer, human capital, and agricultural funding can enhance productivity. Short- and long-term data show cropped area did not grow. Human capital and fertiliser affect long- and short-term production flexibility. Research concluded that increasing farm productivity requires qualified personnel and food security.

**Ali (2012)** Agriculture is crucial to Pakistan's economic success. A simple regression approach changed the relevance of livestock, main crops, fisheries, minor crops, and GDP. Agriculture sub-sector and economic growth were studied using OLS. This study used seven variables. Statistics show a strong link between forestry and GDP. All independent factors were significantly related to GDP. They boosted GDP. 90% of crops and animals contribute to agricultural production, whereas fisheries and forests contribute less due to lack of investment.

**Awan and Aslam (2015)** Pakistan's agriculture impact was measured. They said Pakistan has low output due to little investment, insufficient food due to population, and ineffective management due to a low education system. Low output and bad quality make Pakistan's exports worthless. Pakistan should eliminate agrarian difficulties. Mechanization, irrigation, and packing quality should be improved

**Kulshrestha & Agrawal (2019)** This study looked at agricultural production and its influence on India's economic growth. The study found that if the agricultural output (explanatory variables) in India had not increased, the country's economic growth would have suffered.

**Faridi (2012).** Researchers studied agricultural exports' impact on Pakistan's economy. Researchers examined the impact of agricultural exports on economic growth using secondary data from 1972 to 2008. Increasing agricultural exports would hamper economic growth, the

study found. Exports boost agriculture. Agricultural exports inhibit economic growth and development, but non-agricultural exports boost economic growth. The study recommended promoting non-agricultural and textile products.

**Awan and Naseem (2018)** The researcher explained government spending's impact on Pakistan's economy. They used 2005-2015 data. The OLS technique and linear regression model were used to analyse and interpret the data. Health, education, investment, and saving rates were independent variables. Since educated workers (human capital) are unemployed, education and health severely affect Pakistan's GDP. Investing and saving still help. Skill development improves human capital's efficiency and production, boosting economic growth.

**Chandio et al. (2016)** Analyzed Pakistan's agriculture sector's share and GDP growth rate from 1971 to 2015. Agriculture affects all sectors and GDP, as shown by ARDL. The link between agricultural production and economic growth affected GDP. They stressed the need for innovative technology in Pakistan's agriculture industry. This will strengthen Pakistan's economy.

**Khan et al. (2014)** researchers studied agricultural value addition and poverty alleviation. Increasing agricultural output reduces poverty. From 1972 until 2013, secondary data was used. The Johansen co-integration model examined agriculture, poverty alleviation, and their determinants with GDP. According to the study, livestock and labour reduce poverty. Poverty hurts economic growth. Agricultural value-added boosts economic growth, according to the study.

**Muhammad (2016)** Assessed Pakistan's agriculture sector's GDP growth. In his investigation, he found that livestock, important crops, and other crops make for 23.5% of agriculture's GDP. His studies showed a strong link between agriculture and GDP growth since the business offers farmers jobs and incentives. It affects food and pesticide supplies. Agriculture positively affects economic growth.

**Awan and Mukhtiar (2020)** This research study examines agriculture's impact on Pakistan's economy. ADF tests variable stationarity. The ARDL Model was used to evaluate long- and short-run relationships between agricultural production and economic growth from 1994 to 2017. The GCF and inflation rate are inversely connected with short- and long-term economic growth. All other elements are pro-growth. We think the government should raise farm spending and employ new technology to boost production..

As shown in a review of literature, economic growth depends on agriculture's positive and negative impact. We've studied the relationship between agriculture and economic growth in India, where agriculture is a substantial contributor to GDP but where GPD is low.

## 3. RESEARCH METHODOLOGY

**Data types and sources**:

This study relied on secondary data. The information was gathered from the World Development Indicator, the Indian Economic Survey, and the Handbook of Statistics. The study's sampling period spans 30 years, from 1991 through 2020.

**Variables identified and their meanings:**

GDP (Gross Domestic Product) Dependent variable

INF (Inflation Rate) Independent variable

GCF (Gross Capital Formation) Independent variable

CC (Coarse cereal) Independent variable

TFG (Total Foodgrain) Independent variable

**Formulation of Hypotheses**

H0 = Agriculture productivity in India has no positive association with economic growth.

H1: Agriculture productivity has **a favorable** association with India's economic growth.

**Econometric Model:**

This study's econometric model is as follows:

$GDP = \beta 0 + \beta 1\ (INF) + \beta 2\ (GCF) + \beta 3\ (CC) + \beta 4\ (TFG) + \mu$ …… 1

Where

GDP stands for Gross Domestic Product.

INF stands for Inflation.

GCF stands for Gross Capital Formation.

TFC stands for Total foodgrain.

CC is abbreviated as coarse cereal.

β0 = Interception

Slope Coeficient = β1, β2, β2, β3, β4, β5

Error Term = μ

**Autoregressive Distributed Lag Model:**

The ARDL technique is being used to examine Pakistan's agricultural production and economic growth. The ARDL bounds testing technique established by Pesaran et al. (1996), Pesaran and Ship (1990), and Pesaran et al. (2001) is elastic, requiring that variables in the model specification be integrated at order 0 or 1, that is, I (0) or I (1). (1). Even with tiny samples, this estimate methodology produces effective results. In the model, variables can be assigned varying leg lengths. The following is the ARDL equation:

Yt=β0+β1 Yt-1+…βq Yt-P + α0 Xt+α1Xt-1+α2Xt-2+…αkXt-k+εt ……2

The unconstrained vector error model, on the other hand, is shown below

$$\Delta GDP_t = \gamma_0 + \sum_{I=1}^{P} \gamma_1 GDP_{t-1} + \sum_{I=1}^{P} \gamma_2 INFL_{t-1} + \sum_{I=1}^{P} \gamma_3 GFC_{t-1} + \sum_{I=1}^{P} \gamma_4 COARSE_{t-1} + \sum_{I=1}^{P} \gamma_5 TFG_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots 3$$

The ARDL model, shown in Equation (3), demonstrates the long-run and short run connection between the dependent and independent variables. The intercept term is 0. The short-run coefficients of variables are γ0, γ1 γ2, γ3, γ4, explanatory variables, whereas the long run co-efficients of variables , and t is the stochastic error, which includes all missing variables in the equation.

**Short-Run Relationship Error Correction Model**

This approach determines the short-run relationship between the GDP and other independent variables. The following is the short-run error correction equation:

$$\Delta GDP_t = \partial_0 + \sum_{I=1}^{P} \partial_{1i} GDP_{t-1} + \sum_{I=1}^{P} \partial_{2i} INFL_{t-1} + \sum_{I=1}^{P} \partial_{3i} GFC_{t-1} + \sum_{I=1}^{P} \partial_{4i} COARE_{t-1} + \sum_{I=1}^{P} \partial_{5i} TFG_{t-1} + \lambda(ECM)t\text{-}i + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots 5$$

(ECM-i) The ECM illustrates the short-run influence on the x and y variables and the adjustment rate.

ΔYt = η + δt-i + λ(ECMT-I) + μt ……(6)

In the equation, (δ) denotes the short-run effect and (λ) denotes the adjustment speed. Table 6 displays the ECM findings.

## 4 DATA ANALYSIS:

### Descriptive Statistics:

**Table 1: Dependent and Independent variable**

| | GDP | GCF | COARSE_CEREAL | INFLATIO | TFG |
|---|---|---|---|---|---|
| **Mean** | 5.812037 | 31.78306 | 362.2567 | 7.238491 | 2221.330 |
| **Median** | 6.595957 | 30.41839 | 340.9000 | 6.498159 | 2130.200 |
| **Maximum** | 8.845756 | 41.93083 | 477.5000 | 13.87025 | 2975.000 |
| **Minimum** | -7.251755 | 23.97167 | 259.9000 | 3.328173 | 1683.800 |
| **Std. Dev.** | 3.117367 | 5.468224 | 61.18395 | 3.238860 | 371.1860 |
| **Skewness** | -2.597284 | 0.391392 | 0.190637 | 0.507116 | 0.443524 |
| **Kurtosis** | 11.36188 | 1.794223 | 1.941070 | 1.961468 | 2.051051 |
| **Jarque-Bera** | 121.1308 | 2.583314 | 1.583379 | 2.634018 | 2.109197 |
| **Probability** | 0.000000 | 0.274815 | 0.453079 | 0.267935 | 0.348332 |

**Source: Auther's calculate Eview-10**

Table 1 reveals that the average GDP growth rate is 5.81 percent, with a standard deviation of 3.11 percent. The average inflation rate (INF) is 7.23, with a standard deviation of 3.23. The mean or average value of gross capital formation (GCF) is 31.78, with a standard deviation of 5.46. The mean value of cereal is 362.25, with a standard deviation of 61.81, and the mean total food grain value is 2221.33, with a standard deviation of 371.18. Other variables are **favorably** skewed except for GDP, which is negatively skewed, including Inflation, GCF, cereals, and TFG. The variables' kurtosis statistics show that GCF, core cereal inflation, and total foodgrain are platykurtic (lower peak or short-tailed) since their values are smaller than 3. GDP is leptokurtic (long-tailed or high peak) since its value is greater than three. The results show that the Jarque-Bera P (probability) value of GDP is 0.00, less than 10%; hence, we reject the null hypothesis, indicating that the data is not normally distributed. Because the Jarque-Bera P-value of Inflation is 0.26, greater than 10%, we accept the null hypothesis because it indicates that the data is normally distributed. As a result, because the Jarque-Bera P-value of all the other variables is greater than 10%, we accept the null hypothesis because the data is normally distributed.

### Correlation Analysis: Table 2 Dependent and Independent Variable

| | GDP | Inflation | Gross Capital Formation | Coarse Cereal | Total Food grain |
|---|---|---|---|---|---|
| GDP | 1.00 | -0.07 | 0.30 | -0.29 | -0.25 |
| INFLATION | -0.07 | 1.00 | -0.02 | -0.22 | -0.29 |
| GCF | 0.30 | -0.02 | 1.00 | 0.40 | 0.38 |
| COARE | -0.29 | -0.22 | 0.40 | 1.00 | 0.91 |

| | | | | | |
|---|---|---|---|---|---|
| CEREAL | | | | | |
| TOTAL FOOD GRAIN | -0.25 | -0.29 | 0.38 | 0’91 | 1.00 |

**Source: Auther's calculate Eview-10**

Except for GCF, all variables are strongly negatively linked with GDP. The variable "gross domestic product" (GDP) is associated positively and combined with INF cereal and total food grain. Only the GCF is positively associated with the GDP (GDP). The identical variables, GCF and GCF, completely depend on one another. Because r > 0.30, the relationship between GDP and inflation is negative (-0.07). The connection coefficient between gross capital creation and cereal force is 0.30, and the correlation is moderate from 0.30 < r < 0.40.

**displays the results of the ADF test:**

**ADF Test Results Table 3**

| Variable | level | | First difference | | Second difference | | decision |
|---|---|---|---|---|---|---|---|
| | intercept | Trend & intercept | intercep | Trend & intercep | intercep | Trend & intercep | |
| GDP | $\frac{-2.10}{0.24*}$ | $\frac{-1.66}{0.73*}$ | $\frac{-4.37}{0.00**}$ | $\frac{-4.37}{0.00**}$ | $\frac{-7.73}{0.00**}$ | $\frac{-7.69}{0.00**}$ | 1 |
| INF. | $\frac{-5.99}{0.00**}$ | $\frac{-2.48}{0.33*}$ | $\frac{-6.76}{0.00**}$ | $\frac{-6.71}{0.00**}$ | $\frac{-7.52}{0.00**}$ | $\frac{-7.31}{0.00**}$ | 1 |
| GCF | $\frac{-1.58}{0.48*}$ | $\frac{-0.82}{0.95*}$ | $\frac{-5.12}{0.00**}$ | $\frac{-5.41}{0.00**}$ | $\frac{-10.39}{0.00**}$ | $\frac{-10.22}{0.00**}$ | 1 |
| COARE CEREAL | $\frac{-1.23}{0.99*}$ | $\frac{-6.28}{0.00**}$ | $\frac{-6.25}{0.00**}$ | $\frac{-7.03}{0.00**}$ | $\frac{-7.34}{0.00**}$ | $\frac{-7.14}{0.00**}$ | 1 |
| TFG | $\frac{0.28}{0.97*}$ | $\frac{-3.86}{0.027*}$ | $\frac{-9.93}{0.00**}$ | $\frac{-9.90}{0.00*}$ | $\frac{-7.51}{0.00**}$ | $\frac{-4.96}{0.00**}$ | 1 |

**Source: Auther's calculate Eview-10**

Table 3 shows the stationary and non-stationary characteristics of the various variables. Time series data must be stationary to avoid erroneous regression analysis since it is impossible to obtain excellent findings and forecasts with a non-stationary series. The augmented Dickey-Fuller test revealed that certain variables are stationary at the level, and others are stationary at the first difference. This means that GDP is integrated at the first difference, and the t-statistic value is -4.37 with a probability value of 0.002. Inflation is likewise stationary at the level with a t-statistic of -5.99 and a probability of 0.00. The gross capital formation (GCF) is integrated at the first difference with the t-statistic value of -5.12, with a probability value of 0.00. The Care cereal is stagnant at level (trend and intercept), with a t-statistic of -6.257 and a probability of 0.00. The total foodgrain is stationary at the first difference, with a t-statistic of -9.93 and a possibility of 0.00. Time series analysis reveals that all variables are integrated with distinct orders, implying no co-integration among variables so that the ARDL model may be used.

The bound test for co-integration demonstrates the long-run relationship between the variables. Table 4 displays the results.

**Bound Test Results**

**Table 4**

| F-Bounds Test | | | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 11.59754 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

The critical values of the upper and lower bounds, I (1) and I(0), are shown in the table above. Because the observed F-statistics value is bigger than the upper bound of F-Statistics, we reject the null hypothesis and thus accept the alternative hypothesis, which states a long-run link between the variables.

**The ARDL Model's Long-Term Relationship**

The long term relationship between the dependent and independent variables is expressed as an equation.

$$\Delta GDP_t = \sigma_0 + \sum_{I=1}^{P} \sigma_1 GDP_{t-1} + \sum_{I=1}^{P} \sigma_2 INFL_{t-1} + \sum_{I=1}^{P} \sigma_3 GFC_{t-1} + \sum_{I=1}^{P} \sigma_4 COARE_{t-1} + \sum_{I=1}^{P} \sigma_5 TFG_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots 4$$

Where's σ is the coefficient of the lagged X term. The long-term relationship is provided in

**Table 5 shows the findings of the ARDL model**

| Case 2: long run relationship | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| INFLATION | -0.548552 | 0.316392 | -1.733773 | 0.1266 |
| GCF | -0.539742 | 0.273312 | -1.974819 | 0.0889 |
| COARE_CEREAL | 0.009788 | 0.025494 | 0.383947 | 0.7124 |
| TFG | 0.006186 | 0.004798 | 1.289218 | 0.2383 |
| C | 11.53503 | 6.645551 | 1.735752 | 0.1262 |

EC = GDP - (-0.5486*INFLATION -0.5397*GCF + 0.0098*COARSE_CEREAL + 0.0062*TFG + 11.5350 )

Table 5 shows the findings of the ARDL model, which reveals that the co-efficient value of Inflation is substantial in the long term. It indicates a negative relationship with the GDP annual growth rate, which means that if the inflation rate rises by one unit, the GDP annual growth rate will likely decline by 0.54 per cent. The co-efficient value of gross capital formation (GCF) is statistically significant and adversely connected to GDP yearly growth in the long term. The explanation for the substantial and hostile relationship, in the long run, is a lack of investment owing to a lack of power, which harms GDP. Core cereal has a positive and statistically insignificant coefficient value in the long term. The total food grain coefficient is statistically insignificant in the long term, but it positively correlates with the GDP annual growth rate.

**Table 6 : Short-Run Relationship Error Correction Model**

ECM Regression

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(INFLATION) | 0.067962 | 0.134219 | 0.506347 | 0.6282 |
| D(GCF) | 1.409859 | 0.135825 | 10.38000 | 0.0000 |
| D(TFG) | -0.009508 | 0.001630 | -5.834596 | 0.0006 |
| CointEq(-1)* | 0.990076 | 0.090650 | 10.92197 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.952029 | Mean dependent var | -0.535026 |
| Adjusted R-squared | 0.900060 | S.D. dependent var | 3.187645 |
| S.E. of regression | 1.007717 | Akaike info criterion | 3.156986 |
| Sum squared resid | 12.18593 | Schwarz criterion | 3.834422 |
| Log likelihood | -27.04081 | Hannan-Quinn criter. | 3.352063 |
| Durbin-Watson stat | 2.262389 | | |

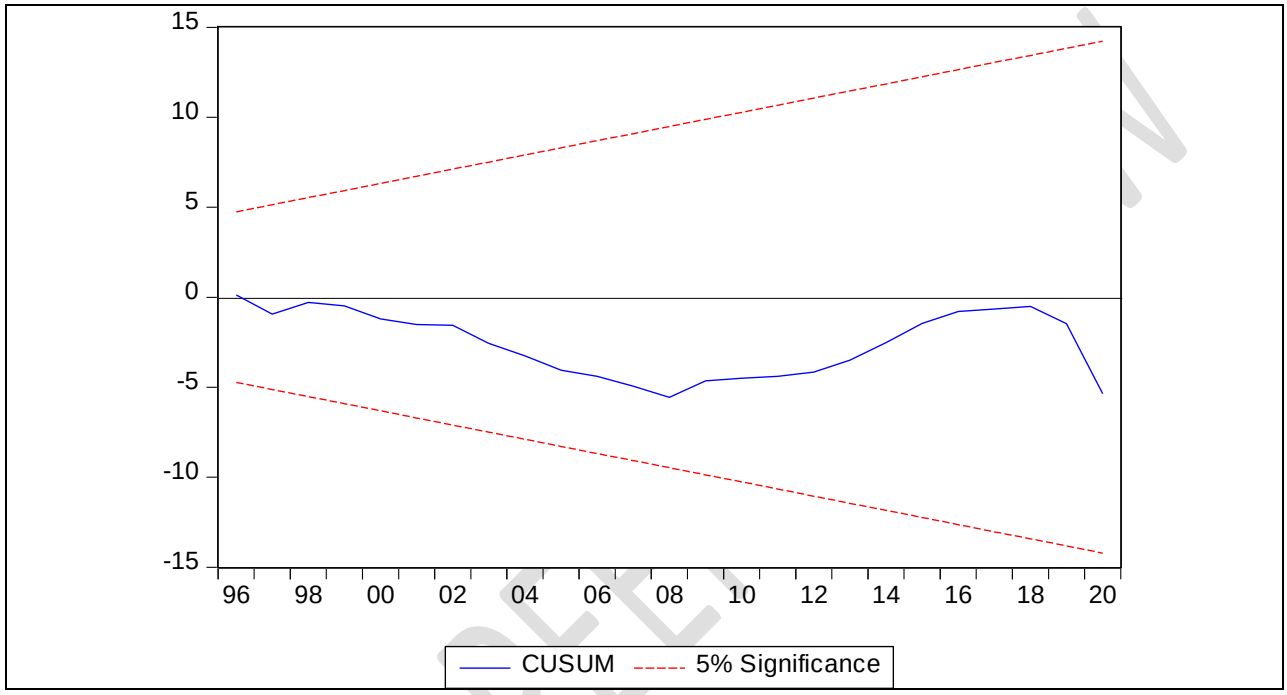
Author's calculation based on Eviews-10

According to the table above, total foodgrain is the most relevant variable in the long and short run. The ECM coefficient is -0.009, which is both negative and substantial. This negative and large error correction model coefficient suggests a long-run causal link. The value of ECM reflects the rate at which the system adjusts from disequilibrium to equilibrium. The corrected R2 value is 0.95, indicating a 95% variance in GDP (Dependent variable) due to changes in independent factors. The likelihood of the F-statistic is likewise statistically significant at the 5% level of significance, supporting the model's goodness of fit.

**Model Stability:**

The cumulative sum of recursive residuals (CUSUM) indicates the model's stability in short-and long-run connections between variables. The cumulative total of the recursive residuals graph is shown below.

**FIGURE 1 : Model's stability in short-and long-run connections**




Author's calculation based on Eviews-10

CUSUM Test examines the model's stability by plotting time series on the horizontal axis and residuals on the vertical axis. Figure 1 demonstrates that CUSUM is inside the 5% critical line range. The graph does not pass this essential limit. As a result, we may infer that the model is stable and there are no significant gaps. At the 5% significance level, this accurate specification model supports the null hypothesis.

**Conclusion and Suggestion**

First, explain GDP. ARDL predicts negative and low inflation. TFG is small and positive compared to GCF. Moderate inflation, positive GCF, negative TFG. R-square means the independent variable affects the dependent variable and the model fits. India's growth depends on agriculture. Agriculture provides domestic necessities and foreign revenue. Agriculture and land use improve hunger and poverty. Our analyses demonstrate that inflation and GCA slowed India's GDP. Due to inflation and feudalism, most farmers can't afford seeds or equipment.Food inflation hurts India's economy. GCF hurts India's economy because it's a developing nation. Industrial expansion is favoured. Commerce, transportation, and education infrastructure attract greater investment than agricultural productivity. Subsidizing fertilisers, equipment, and crops

for poor farmers may prevent feudalism in India. Agriculture investment would improve the economy. Irrigation dams should be built. Agriculture and industrial education can boost employment in India. Modernize India's agriculture. Expand irrigation systems.

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