



## FOOD GRAINS PRODUCTIVITY DYNAMICS IN INDIA SINCE 1990S: AN EMPIRICAL ANALYSIS

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### **Abstract**

*Over the decades, the Indian agriculture sector revamped in a new shape along with modernization. The green revolution provided enough food grains to feed the people. Mechanization of the sector enlarged which positively correlated with the total production and productivity of the sector. As the mechanization increases there requires more working as well as investment capital and other inputs demands also enlarged. The present study tries to analyze the causal relationship between the food grains yield/productivity and inputs (Fertilizer consumption, irrigation coverage and institutional credit) through Panel data regression model. There are 16 cross-sectional entities and 28 years of period (1990-2017) in the panel data series are taken into account. Hausman test have been conducted to select the model between fixed and random effects models for panel series regression. The regression results indicated a significant and positive relationship between the input factors and food grain yield/productivity. Both fixed (FEM) and random effects model (REM) results showing an expected signs and significant results.*

**Key words:** Food Grains Productivity, Panel Regression, Hausman Test, Mechanization.

### **Introduction**

Post green revolution era India conceived a lot more self-sufficiency in food grains<sup>1</sup> production. Now country is not a place of hand to mouth but becomes a food grains export destination. Over the decades post revolution, the mechanization enlarged and agriculture sector

<sup>1</sup> Food Grains consist of: Cereals (larger share rice & wheat) + Pulses + Course Cereals.

rejuvenated in a new shape. In total food grains crops rice comprised a larger share in total area and in total food grains production also. Continuously increment in food grains production not only important from food security concerns but also play a pivotal role in poverty alleviation (Parshuram, S., *et al.* 2018). The food grains production not only considered a most important activity in India but also an important source of employment. The input factors determine the productivity and overall production of the sector. And by analysis of state-wise panel data it reveals that there is high degree of relationship between input factors and food grains yield. Results indicates that institutional credit to agriculture and other input factors in real terms has registered a significant positive growth over the decades and also significantly and positively impacted on agricultural productivity. There need to give emphasis on institutional credit disbursement to the small and marginal farmers (Shivaswamay *et al.*, 2020).

Although, growth or the usage of input factors also increases over the period but till time there found lot of regional variations and disparities in the disbursement of inputs. Trends in the composition of cereals production during the two phases of agricultural development (i.e., the periods referring to before and after the introduction of the new agricultural technology) are significantly different from each other and the breaks in the trends could not be explained only in terms of the movement of prices of the crops (Chattopadhyay., and Maity, SK., 1991). Although, overall production of agriculture sector depends on area cropped under agriculture activities and vis-à-vis agricultural land shrinking over the decades. The sort of farm size is one of the hindrances and adversely affects on the production side. One of the reasons for this adversity is the unequal or the heterogeneity in the agricultural land. The negative relationship of land inequality and productivity implies heterogeneity in productivity by farm size. In an estimation of agricultural production function, the Gini Coefficient for land holdings is found to have a significant negative relation with productivity (Vollrath, D., 2007).

Therefore, size of the landholdings or farm size also affects the production of food grains and overall production of the sector. The present study tries to find out the causal relationship between the three input factors and aggregate food grains yield or productivity. Food grains comprised with Cereals, Pulses and Course cereals. Wheat and rice comprised the larger share in overall area wise and overall production in India. The reason for kind of distribution is demand

size factors. In between the usage of fertilizer increases by 322 times, however cereals production in India increases by five-fold only from the period of 1950-51 to 2007-08. The tremendously jump in fertilizer usage and lesser production comparatively reflects the very low efficiency of fertilizer (Rajendra, P., 2009). In between India is the 3<sup>rd</sup> largest fertilizer consumption country in the world. Meanwhile, the mean usage of fertilizer is about 85kg/hect only. The demand and consumption of fertilizer depends on various factors viz irrigation, HYV seeds and credit availability, all are interlinked (Mala, P., 2013). Irrigation is one of the major factors of overall production and productivity. But the fact that larger part of arable land depends on monsoon or Indian agriculture sector depends on monsoon's. Although, various reforms and projects in the field of irrigation coverage since 1980's brought out remarkable development in the irrigation coverage potential in India. The large area coverage interlinked with the mechanization, technical advancement and credit availability. All of that led to phenomenal growth in agriculture productivity, income and employment etc. The groundwater comprised the larger share in irrigation coverage resources. In between, the optimal and sustainable usage of these resources is the onus of all stakeholders (K.D.Sharma, 2009). But still there are lot more regional variations presence also which considered to the hindrances for the agriculture sector.

### **Research Question**

- What are the major input factors that impacts food grains productivity/ yield?

Hypothesis: -

- Whether input factors (fertilizer consumption, irrigation coverage and institutional credit) significantly impacted or does have any relationship with food grains yield/productivity?

### ***Data and Methodology***

The major 16<sup>2</sup> food grains producing states included in the panel data regression and 28 years of time period (1990-2017). The present study is based on the secondary data collected from various sources. After new economic reforms or globalization, the agriculture sector also changes its shape and patterns. Initially it presumes that globalization may be

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2 16 states are:-Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, J & K, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh & West Bengal.

helpful for agriculture sector and will push the export share. Although globalization helps in mechanization of agriculture sector. But despite that in many studies it reveals that globalization decelerated Indian agriculture sector. Study analyses the effect of economic reforms on agriculture sector. It reveals that economic reforms or trade liberalization neither positively impacted on agriculture sector nor agriculture sector got benefited as was expected. It was found that in post trade liberalization both agriculture output and of land yields showed downward trends as comparison of pre period (GS Bhalla, and Gurmail Singh., 2009/10).

The food grains yield or productivity is dependent variable, the term agriculture productivity and yield used interchangeably. And fertilizer consumption (kg/hect), irrigation coverage (% of gross irrigated area to total cropped area) and institutional credit (Rs/hect). For present study purposes scheduled commercial bank credit to agriculture sector considered under institutional credit. The incentive behind taking only SCB's credit disbursement is that SCB's comprised more than 70 percent share in agriculture credit as compare to other institutional credit. And there found lot of data inconsistency state- wise for other institution's credit. Data on the state-wise food grains yield/ productivity and institutional credit disbursement are extracted from Handbook of statistics on Indian states for various years published by RBI. Data on irrigation coverage state-wise were collected from the land use statistics reports of Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers welfare, Government of India (GoI).

**Specification<sup>3</sup> of Panel Data Regression Model**

**Random Effects Model**

Since Random Effects Model (REM) does incorporate with cross sectional effects ( $\alpha_i$ ) as a random component along with mean ( $\alpha_1$ ). Then the intercept of the cross-sectional units becomes  $\alpha_i = \alpha_1 + u_i$

$$Y_{it} = (\alpha_1 + u_i) + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \delta_{it} \tag{i}$$

$$i = 1, 2, 3, \dots\dots\dots 16$$

$$t = 1, 2, 3, \dots\dots\dots 28$$

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3 *The whole model construction and specification idealised from Basic Econometrics book of Gujarati and Principles of Econometrics book by Shankar Kumar Bhaumik. The references for these literature are mentioned.*

$$\left\{ \begin{array}{l} Y_{it} = \text{Agriculture foodgrains Yield / productivity} \\ X_{1it} = \text{Consumption of Fertilizer (Kg / hec)} \\ X_{2it} = \text{Irrigation Coverage (\%)} \\ X_{3it} = \text{Institutional Credit (Rs Crore / hec)} \end{array} \right\}$$

$$Y_{it} = \alpha_1 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + e_{it} \tag{ii}$$

Here,  $e_{it} = u_i + \dot{o}_{it}$  (composite error term)

$u_i$  = cross section error term

$\dot{o}_{it}$  = combined time series and cross section random error term

### Results and Discussion

#### Model 1: Random-Effects (GLS), using 446 observations

Included 16 cross-sectional units

Time-series length: minimum 26, maximum 28

Dependent variable: AFY <sup>4</sup>(Kg/Hec)

Variables	AFY (Kg/Hec)	Z-statistic
Constant	606.2342*** (5120.8504)	5.02
FC (kg/Hec)	4.794*** (0.4238426)	11.31
GIA to TCA (%)	16.83399*** (2.068417)	8.14
Institutional Credit (Rs/Hec)	0.0011168*** (0.0002248)	4.97
Within R- Squared	0.6066	
Between R- Squared	0.7759	
Overall R- Squared	0.7503	
Wald $Chi^2$ (3)	706.53	
Prob> $Chi^2$	0.0000	

Note: In parenthesis Standard errors are given, \*\*\*represents 1% level of significance

4 AFY(kg/hec); Agriculture Food Grains Yield or Productivity per hectare ; FC(kg/hec): Fertilizer consumption(NPK) per hectare; GIA to TCA(%): Irrigation Coverage (%); Credit(Rs/hec): Institutional Credit to Agriculture (rs/hec)

5 In parenthesis standard errors are given.

The random effects (GLS) regression results showing that there is positive and highly significant effect of fertilizer consumption, irrigation coverage and institutional based credit. Although the extraneous variables like monsoon (rain), variety of seeds etc have not considered in the present study. According to the estimates, climate change is negatively affecting food grain output in India and might pose a severe danger to the country’s ability to feed its population. The findings further emphasise the significance of irrigation and effective fertiliser use in reducing the negative effects of climate change. The  $R^2$  values lie within the expected range which shows the regression model is good fit and explaining the variations in the dependent variables.

Regression equation

$$Y_{it} = 606.23 + 4.79(\text{Fertilizer Consumption}) + 16.83(\text{Irrigation}) + 0.011(\text{institutional credit})$$

**Model 2: Fixed Effects Model**

*Specification of the Fixed Effects Model*

The FEM consider intercept term as a variable and incorporate N number of dummy variables<sup>6</sup> for N number of explanatory variables to accommodate the heterogeneous feature of cross-sectional entities in the model. And FEM can be written as

$$Y_{it} = \alpha_i + \beta_{1it} + \beta_{2it} + \beta_{3it} + \epsilon_{it} \tag{2.1}$$

One-way fixed effects model

$$Y_{it} = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \dots + \alpha_N D_{Nt} + \beta_{1it} + \beta_{2it} + \beta_{3it} + \epsilon_{it} \tag{2.2}$$

Model (2.1) and (2.2) known as FEM considering although the intercept term vary cross cross- sections, but intercept of all cross-sectional entities is assumed to be constant or time invariant.

**Model 2: Fixed-effects, using 446 observations**

Included 16 cross-sectional units

Time-series length: minimum 26, maximum 28

Dependent variable: AFY (Kg/hect)

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6 When one dummy variable is used for each cross-sectional units, in those stances there would not be any intercept for any of reference category in the model (2.2), otherwise our model may lead to the problem of Dummy Variable Trap.

<i>Variables</i>	<i>AFY (Kg/hect)</i>	<i>t-statistic</i>
Constant	632.3374*** (77.4163)	8.17
FC (kg/Hect)	4.875311*** (0.4332292)	11.25
GIA to TCA (%)	16.04837*** (2.251629)	7.13
Institutional Credit (Rs/Hect)	.0011151*** (.0002256)	4.94
Within R- Squared	0.6067	
Between R- Squared	0.7749	
Overall R- Squared	0.7491	
Prob> F	0.0000	

Note: In parenthesis Standard errors are given, \*\*\*represents 1% level of significance

The fixed effects model (FEM) also showing the similar results to random effects model (REM). The regression results showing significant and positive impact of agriculture inputs on food grains/productivity that taken into consideration for this study. It found that the relationship between foodgrains productivity and accounted variables are positive and is significant at one percent level of significance.

### Hausman <sup>7</sup>Specification Test

The Hausman specification test help us to incorporate the difference between FEM and REM. If there is significant difference then we could go for FEM otherwise REM.

<i>Variables</i>	<i>Fe (b)</i>	<i>Re (B)</i>	<i>Diff (b-B)</i>	<i>Sqrt(diag(V_b-V_B))</i>
FC (kg/Hect)	4.875311	4.794	.813117	.0896939
GIA to TCA (%)	16.04837	16.83399	-.7856141	.8896548
Institutional Credit (Rs/Hect)	.0011151	.0011168	-1.75e-06	.0000198

$$chi2(2) = (b-B)'[(V_b-V_B)^{-1}](b-B) = 0.85$$

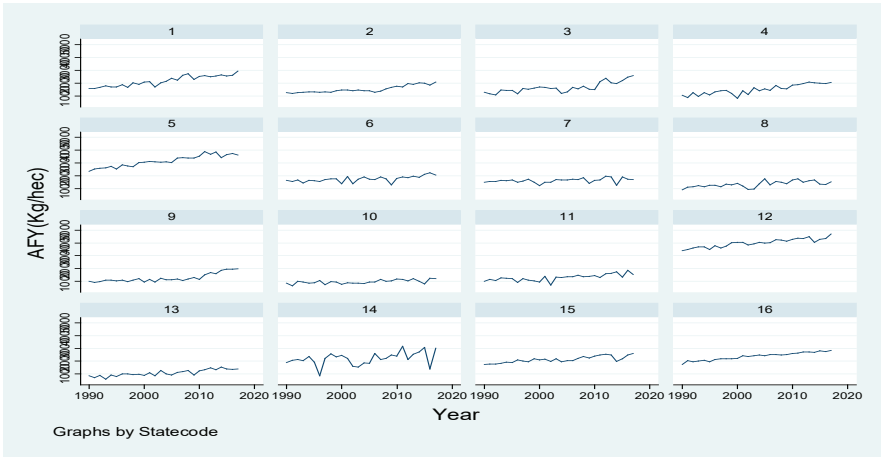
$$Prob>chi2 = 0.6531$$

The Hausman test was conducted to select the model between random effects or fixed effects models. The results showing that the chi<sup>2</sup> value (0.65) is quite high and couldn't reject the null hypothesis. On

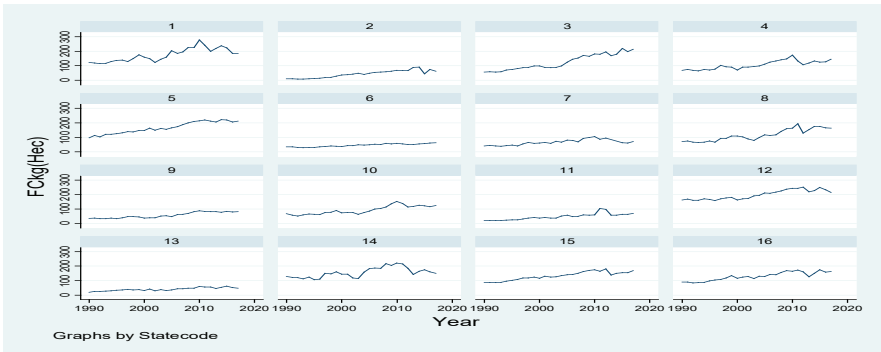
<sup>7</sup> Meanwhile, test results showing that REM can be selected for study purpose. But for time being both REM and FEM results mentioned here.

the basis of that we can conclude that there is a systematic difference between the FEM and REM. And Random effects model considered to more be appropriate for panel regression. As aforementioned the REM results shows positive and statistically significant relationship among the independent and dependent variables. Also, FEM leads to loss in degree of freedom but REM override that leakages of FEM. Hence, conclude that REM would be more significant and appropriate to consider the cross sectional and time series effects of all entities.

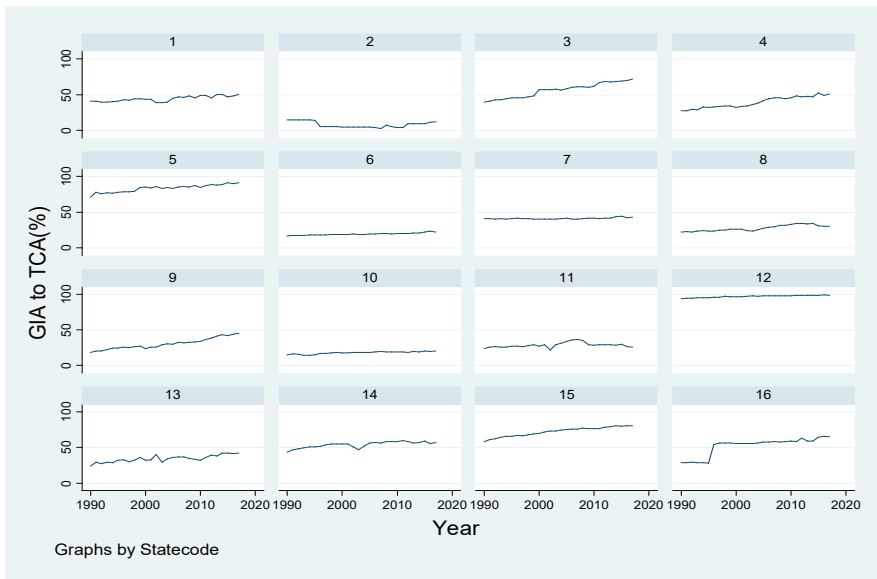
The aforementioned all variables (Dependent and explanatory) are showing positive spikes or positive trends over the period of time across the selected states. But the trends and patterns in both irrigation coverage and credit disbursement seems more or less same over the



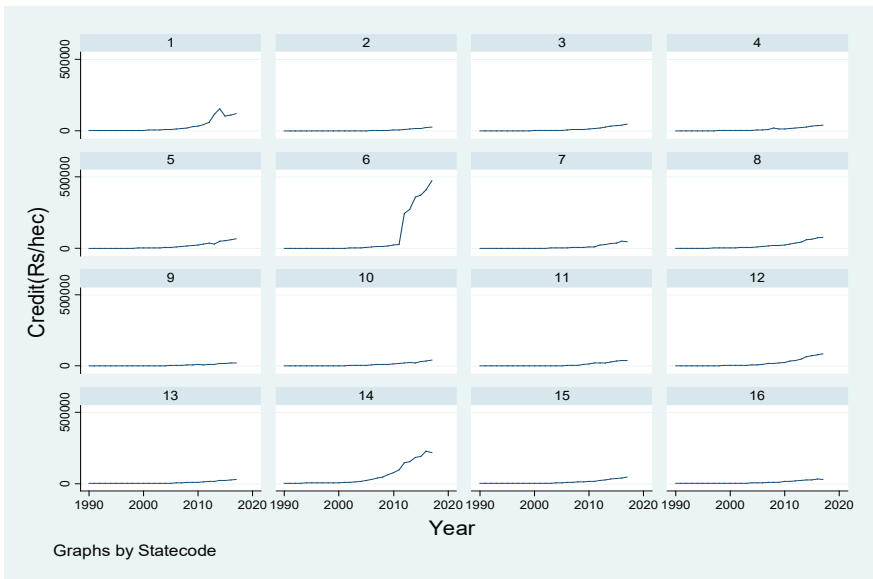
**Fig. 1.1 Agriculture Food grains Yield Line Graph for all Cross-Sections**



**Fig. 1.2 Fertilizer Consumption Graph**



**Fig. 1.3 Irrigation Coverage Line Graph**



**Fig. 1.4 Agriculture Credit by SCB's Graph**

period of time in few cross-sectional unit's cases. Although, there also found an exceptional increasement positive trends in the variables across the states.

## *Conclusions*

By concluding remarks on the basis of present study regression results and literature findings reflects a positive and highly significant impact of fertilizer consumption, irrigation coverage and credit disbursement on food grains yield or productivity. The regression results of both the models reflects that model is good fit and explaining the expected variations in the dependent variable. There is no serial correlation or autocorrelation problem found in the panel data regression model. And it is also observed that emphasis should be given on the fairly disbursement of institutional credit to the small and marginal farmers and regional variations should be taken into consideration. Although, total production of food grains but up till now there are regional variations found in the per hectare yield or productivity of food grains. Post green revolution agriculture sector modernized or the mechanisation of the agriculture revamped a lot. The sort of push contributes in the overall production and productivity of the food grains across states.

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