

Panel Data Approach to Estimate Factors Affecting Wheat Yield in Rajasthan

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Abstract

India is the topmost wheat producer in the world after China. Rajasthan state has fifth place in wheat production after U.P., M.P., Punjab, and Haryana. The second most important food crop in India is wheat, next to rice. This study focuses on some factors that may affect the crop's yield. The objective of the paper is to determine the impact of panel data factors for all districts (30) of the state. For this twenty years (1998-2018) data were used for the empirical study. The data have been set according to districts, and proper adjustments have been made because some districts craved out. This study concluded that gross cropped area, fertiliser consumption, energised wells and tube wells play a significant role in enhancing wheat yield across the districts. The investigation revealed that rainfall and cropping intensity role in wheat yield is insignificant. It can be commenced by this study that government policy for subsidised fertiliser and infrastructure development influenced wheat yield significantly.

Key Words: Factors, Panel Data, Rajasthan, Wheat and Yield

INTRODUCTION

Wheat is the second most popular cereal in the country, next to rice. Wheat is the staple food of millions of people, particularly in India's northern and north-western regions. Rajasthan (9,871 thousand tonnes) state has fifth place in wheat production after U.P (26,874), M.P (17,689). Punjab (16,081) and Haryana (1,352) in the year 2015-16 (DES, Ministry of Agriculture, GoI). On the other hand, Punjab (5188 kg/hectare) state has the highest wheat yield, followed by Jharkhand (4925), NCT Delhi (4312) and Rajasthan (3501) in the year 2018-19 (RBI). The state is one of the significant states in wheat production because there is 61 per cent of desert area. Hence, it is the most potential state for agriculture and allied activities. Although the country has had sufficient stock of wheat production in recent years' erratic rainfall, change in climate, and population enhancement over the year can make its production more significant shortly. In India, there are few states where the potentiality of enhancement of wheat has remained consistent while most productive

states such as Punjab and Haryana are suffering the problem of the low yield of crops due to the non-rationalised use of fertiliser. Rajasthan state can be a better state in terms of cereals production because it is the state where most of the area is not utilised effectively.

The growth of agriculture products in the country is 28.36%, with exports of USD 29.81 billion in 2020-21, which was USD 23.23 billion in 2019-20. The food security bill was launched in 2007 in India to increase food grain production by 20 million tonnes, rice by 10 million tonnes, wheat by 8 million tonnes and pulses by 2 million tonnes over the following five years. So, India achieved food grain production in 2019-20. The country's foodgrains output stood at a record 297.5 million tonnes. The GDP growth rate of Rajasthan in 2017-18 is about 5 per cent which is much better than others in which the agriculture sector is playing an important role.

Literature Review

There are some studies on wheat crops focused on specific regions of the country like

Sindhu and Byerlee (1991, 1992), Sims (1988), Gandhi (1997), Gandhietal. (2004), Nair and Eapen(2011). There are also some studies focused on the food grain of the country for example, the green revolution gives a better growth rate in food grain production (Sharma and Gandhi, 1990).

Concerning factors that can affect wheat yield, few studies have been done in this respect. A yield function for corn is used in the United States with relative fertiliser price, an index of moisture conditions, land acreage dummies estimated by Houck and Gallagher (1976). Sagar (1978) has been attempted to measure the contribution of the three technological factors, viz, high yielding varieties of seed, fertilisers, and irrigation, in the growth of agricultural yield in Rajasthan from 1961-to 74. Byerlee and Traxler(1995) related wheat yield in different regions of the world to the release of varieties of CIMMYT germplasm. Sharma and Gandhi(1990) estimated yield functions for food grains in India using fertilisers, high yielding varieties, irrigation and rainfall as explanatory variables. Gandhi *et al.*(2004) estimated Cobb Douglas functional form of yield in India using fertiliser consumption, high yield varieties area, irrigated area, and rainfall as explanatory variables. Mathur *et al.* (2007) clarified that the agricultural output is significantly and positively dependent on the government's expenditure on agriculture, fertiliser usage, rainfall and population.

Kulshrestha (2017) explained based on data from 1956-57 to 2009-10 using a semi-log model of econometrics that the yield of the wheat became more than triple per hectare in Rajasthan as it was below 1000 kg per hectare before 1968-69. The wheat crop in the state also replaces most of the rabi crops. This study also estimated the growth rate during the period of study in the crop area was 4 percent per year, and the production growth rate was 1.5 per cent. So the growth rate of wheat yield plays a significant role in the state, and irrigated areas contribute a substantial part because the growth rate of the irrigated area was 3 per cent per year.

Gulati (2014) suggests that the enhancement of export cereals free market does help it, but there is a need to impose a tax on input-intensive commodities. Dev (1985) describes the analysis of the performance of all crops in Indian agriculture in the late 1970s compared to the early 1970s and early 1960s. He has revealed some of the high growth, and most of the hostile growth districts in 1962-65 to 1970-73 have shifted to medium growth in agriculture. Thus the evidence of the decline in output in one-fourth of the Indian districts is not valid in the late 1970s. The analysis across agro-climatic regions also indicates similar results.

Further, rich regions are becoming relatively more prosperous in output per capita and per area. On the other hand, though poor areas have not become poorer, they have remained relatively poor in production per area. As a result, the poor regions have become poorer in output per capita.

Methodology

This study is based on secondary data from 1997-98 to 2017-18. The data were collected from Agricultural Statistics of Rajasthan published by the Directorate of Economics & Statistics, Rajasthan. The given formula calculates yield as below;

Yield or Productivity=(production/area) *100
Panel or longitudinal data are repeated measurements at different time points on the same unit. Regressions are helpful for both variations over units, similar to regression on cross-section data and variation overtime.

The model is $y_{it} = \alpha + X_{it}^1 \beta + \epsilon_{it}$
There y_{it} =Wheat yeild
 X_{it} =Six factors

- i. Cropping intensity
- ii. Rainfall
- iii. Gross irrigated area
- iv. Fertiliser consumption
- v. Road length
- vi. Wells and tube wells energised

Where X_{it} are regressors, μ_i are random individuals' specific effects, and ε_{it} is an idiosyncratic error. (Cameron and Trivedi, 2009)

This study is based on panel analysis's fixed and random effect model.

In the fixed effect (F.E.) model, the μ_i are permitted to correlate with the regressors X_{it} and in the random effects (RE) model, it is assumed that μ_i is purely random, a stronger assumption implies that μ_i is uncorrelated with regressors.

Analysis

Panel Data Analysis

Panel data is used to know the impact of various

factors on wheat yield. First, we standardise the data due to doing units free to those factors. There are six factors such as cropping intensity (CI), rainfall (R.F.), gross irrigated area (GIA), fertiliser consumption (F.C.), road length (R.L.) and wells and tube wells energised (WE), which influenced wheat yield. Table 1.1 shows the standardised mean of all variables. The standard deviation of the standardised variable is the overall one. The standard deviation between the 30 districts is more diminutive than within the 20 districts, except for wheat yield and cropping intensity.

Table 1.1 Descriptive Statistics of Panel Data

Variable		Mean	Std. Dev.	Min	Max.
Whepty	Overall	3.82e-10	1	-2.656747	3.140254
	Between		.7005538	-1.281551	1.323367
	Within		.7247273	-2.549459	3.309487
CI	Overall	-.0372936	1.12793	-7.45873	2.619991
	Between		.7968937	-1.420281	1.246279
	Within		.8110108	-8.075276	2.046173
RF	Overall	-.00127	.9996491	-.7619951	8.913571
	Between		.9260032	-.5101203	4.784726
	Within		.4111204	-3.548786	4.127576
GIA	Overall	-.0019107	.9978574	-.3821353	7.010269
	Between		.9833213	-.3643791	5.107982
	Within		.2438292	-2.597948	1.900376
FC	Overall	-.0020972	1.000485	-1258302	10.20252
	Between		.8406448	-1.219676	2.097844
	Within		.5638072	-2.416636	9.097829
RL	Overall	-.0292279	1.020375	-1.94853	4.521019
	Between		-.911282	-1.144137	2.097844
	Within		-.48597017	-1.37948	9.097829
WE	Overall	-.0018253	1.000165	-1.095198	4.915514
	Between		.9569561	-1.030061	3.494965
	Within		.3432176	-1.20289	1.609871

Results and Discussion

Many factors influence wheat yield, but this model takes only six factors that our data can estimate. In this model, we have used standardised variables. We have used the Hausman test to identify whether a fixed effect or random effect is applicable for this purpose, as shown in table 1.2. The Hausman test does not discriminate whether it uses the random or fixed effect. In table 1.3 fixed effect model drawn the result based on 600 observations across 30 districts over the twenty years that gross

irrigated area, fertiliser consumption, road length and energised well as tube wells are statistically significant, and the F test is also significant. As the result of table 1.4, there is the same result as the random effect model. Only two variables such as cropping intensity and rainfall, are insignificant. In this model wild chi-square test is also statistically significant. It is tested in table 1.5, and we reject the null hypothesis of the presence of homoskedasticity through the modified wald test. To avoid the problems such as heteroskedasticity and autocorrelation,

a robust standard error method need to be used in the panel analysis. Table 1.6 shows a positive impact of gross cropped area, fertiliser consumption, energised wells and tube wells on wheat yield. Although road length impact on wheat yield is negative, we can describe that standardised road length increases by one standard deviation by holding other variables constant. On average, the standardised wheat yield decreases by about 0.32 standardised deviation. The errors are correlated with the

regressors in the fixed effect model is -0.70, and the variance not explained by differences across districts is 0.68, also known as intraclass correlation. In the Random effect model, as in table 1.7, there are the same results in terms of impact, but standardised coefficients are different due to random error is not included in regressors. This model can be said better than the fixed effect due to overall R- the square is better.

Table 1.2 Hausman Test Result

	Coefficients		Difference	S.E
	Fixed	Random		
CI	.0385023	.0385023	0	0
RF	.0761827	.0761827	0	0
GIA	.590114	.590114	0	0
FC	.1894911	.1894911	0	0
RL	-.3240968	-.3240968	0	0
WE	.7196954	.7196954	0	0

Table 1.3 Result of Fixed Effect Model

	CI	RF	GIA	FC	RL	WE	cons
Coef.	0.04	0.08	0.59	0.19	-0.32	0.72	-0.01
Std. err	0.04	0.07	0.12	0.05	0.07	0.10	0.03
P>[t]	0.29	0.27	0.00	0.00	0.00	0.00	0.85
sigma_u	0.99	sigma_e	0.67	rho	0.68	corr(u_i, xb)	-0.69
F(,564)	21.34	Prob > F	0.00				

Table 1.4 Result of Random Effect Model

	CI	RF	GIA	FC	RL	WE	cons
Coef.	0.05	0.01	0.25	0.26	-0.24	0.46	0.00
Robust Std. Err.	0.04	0.06	0.08	0.05	0.06	0.08	0.11
P> z	0.13	0.82	0.00	0.00	0.00	0.00	0.97
sigma_u	0.54	sigma_e	0.67	rho	0.39	corr(u_i, x	0.00
Wald chi2(6)	108.77	Prob > chi2	0.00				

Table 1.5 Test of Heteroskedasticity in Fixed Effect Model

Chi ² (30)	39616.25
Prob>chi ²	0.00

Table 1.6 Result Fixed Effect Model (Robust)

	CI	RF	GIA	FC	RL	WE	cons
Coef.	0.04	0.08	0.59	0.19	-0.32	0.72	-0.01
Robust Std. Err.	0.03	0.13	0.08	0.08	0.13	0.09	0.00
P> z 	0.22	0.56	0.00	0.03	0.02	0.00	0.17
sigma_u	0.99	sigma_e	0.67	rho	0.68	corr(u_i,xb)	-0.69
F(6, 29)	33.1	Prob > F	0.00				

Conclusion

This study focuses on wheat yield in terms of factors that can be affecting it. No doubt there may lot of factors that affect it, but as far a concern we included six factors in which irrigation facilities and energised wells and tube wells done well in this context and both model whether fixed effect or random effect the role of energised contribute much there variable due to this crop demand timely water facilities. Since the state is water-deficient, traditionally, farmers depend on the bajra crop for food purposes. Still, electricity facilities make towards wheat crop although we cannot ignore the role high yield variety seeds besides that the yield also influenced by electricity and irrigation facilities. Fertiliser consumption also plays a very crucial role in this. The policy of subsidised fertiliser makes farmers use it extensively. Road length is even an indicator of development, and it made accessible transportation facilities. Still, it also has an adverse impact that area of cultivation is going to decrease due to this. As far as a result is concerned across the districts, road length is negative. Cropping intensity shows how much time per year crops are shown. Still, it is not statistically significant because all the crops have influenced cropping intensity, and some crops have been negatively affected because of the wheat crop. The state's farmers grow more wheat in rabi season than other crops due to the government's minimum support price. The role rainfall is crucial in the state however over and under rainfall adversely impact the productivity of the crop. So dependency on the unexpecting behaviour of rain makes significant impacts on

wheat yield.

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