



## Monsoon Role on Farmer Suicides In India

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**Abstract:** Farmer suicides in India is the single most manifestation of the distressed and pathetic situation of the agricultural sector and indicates the vulnerability of the rural economy to the vagaries of nature. Frequent failure of monsoon, inadequate rainfall, crop failure, overburden of loan, harassment of moneylenders and lack of accessibility to government support are the prime causes for a farmer ending his life on his own. This paper attempts to estimate the effects of annual rainfall and its shortage, along with gross irrigated area and GSDP, on farmer suicides in India using state-wise panel data for 10 states and for 10 years, 2001-2010. Panel data regression methods of fixed and random effects models are used for analysis. The estimated empirical results show that with increase in annual rainfall farmer suicides decline. This result is strengthened with the findings that monsoon rainfall is associated with reduced farmer suicides, whereas the shortage in monsoon rainfall increases farmer suicides. Also, female farmer suicides are more responsive to rainfall related factors than the male farmer suicides. Though the Indian growth performance is described as spectacular and even frequently celebrated as a shining example, the life of the Indian farmer still reels under the mercy of nature, and the mere fact that a farmer commits suicide is a dent on face of the surging Indian economy.

**Keywords:** Farmer suicides, Rainfall, Monsoon shortage, Panel data, Fixed and random effects estimates, Hausman specification test.

### INTRODUCTION

Farmers around the world have high suicide rates, relative to other professions (Judd et al. 2006). Though farmer suicides may be treated as relatively few and even isolated events compared to all causes of deaths in a large and densely populated India, the sheer phenomenon of suicide by a farmer, who is the backbone for feeding the millions, cannot be equated with other forms of suicides and taken so lightly. In fact, it is an indicator of the distressed and ill-fated scenario of development and income distribution. It is an essential facet in a comprehensive assessment of economic development and rural welfare for two reasons. First, the relative frequency of suicides is an objective quantitative measure of the prevalence of extreme individual distress. Second, unlike a transitory shock to household income, a suicide is irreversible. The farmer suicide, that too at a young and prime age, repercussions has not only to the income and debt problems, but also has devastating, pervasive and cascading effects for the entire family, including education and health of children, dependency on others, social neglect, and stigma. Hence, is important to understand the vulnerability of India's rural populations different from the much popular poverty angle and identify whether there is a need for reorienting rural development policies that are necessary to provide protection and mitigation against various sources of risk rather than just aggregate economic or income growth.

In order to understand the magnitude of the issue of farmer suicides, just look at the data on the causes of reported deaths in India available in the national crime records. For example, the actual demographic breakdown by NCRB report shows that out of 134,599 suicides reported in India in 2005, 15,964 belonged to the farming community. Figure 1 shows the trends in farmer suicides by gender in Indian states between 2001 and 2010. It can be observed that in Andhra Pradesh and Karnataka farmer suicides are much higher, despite better irrigation facilities and favorable political and government scenario, relative to poor states like Jharkhand and Rajasthan. It can also be noted that almost in every state the male farmer suicide rate is higher than female farmer suicide rate. In Karnataka, male suicide rate is much higher compared to the female farmer suicide rates, showing the glaring dependency on male in rural areas.

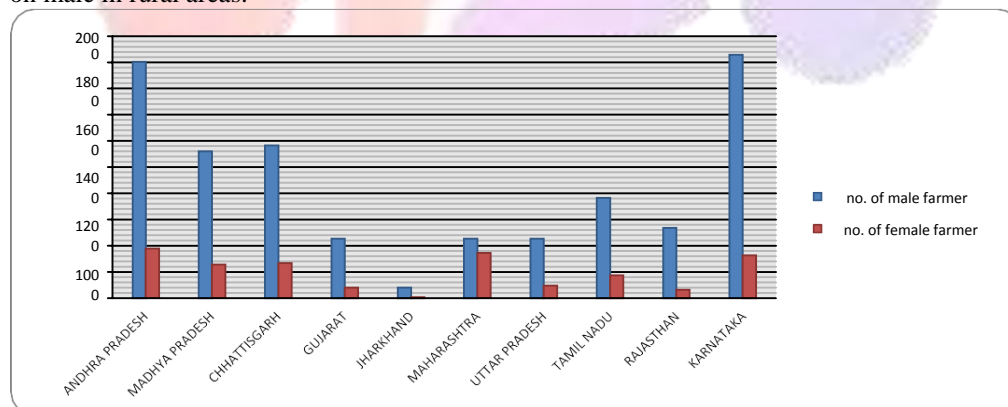


Fig. 1. Farmer Suicides in India / Source: NCRB data (2001-2010)



Traditionally, lack of sufficient and timely rainfall and irrigation facilities, frequent crop failure, poor capital investments and credit facilities, high costs of fertilizers and pesticides, inadequate and inappropriate technology, near non-existence of storage and marketing facilities, and total neglect of agricultural sector in the wake of economic reforms have been cited as the main causes for the phenomenon of farmer suicides. The absence of coping any mechanism, land fragmentation, poor organizational structure, high indebtedness, exploitation by local moneylenders, lack of education, large family size, land being the only asset, poor crop diversification, etc. further aggravate the woes of the farmers. The high levels of economic stress due to severe risks in agriculture and the rapid pace of structural change rub the salt to the wound, thus aggravate the pathetic situation faced by the farmers (World Bank, 2007). The rising farmer suicides have often been cited as the manifestation of the destitute situation of poor farmers in the wake of globalization and crony capitalism. The post reform drive for economic growth emphasizing manufacturing and service sector growth and urban development, relative to agricultural sector growth and rural development have been the cause of concern in many developing countries. The plight of farmers and the increasing farmer suicides have been the bone of contention for political controversy and broad media focus around the globe, especially in India. In fact, increasing farmer suicides reflects the distress, destitute and desperate situation of poor farmers in the midst of growing affluence elsewhere. Despite much acclaimed success in rural poverty reduction, increasing education and improving awareness, suicides by farmers in India in rural areas continues to be a sad reflection of poor state of agrarian structure and its performance.

In fact, it is paradox that much of the farmer suicides have happened in an era of increasing income and impressive growth performance in India. Again, most of farmer suicides are in the relatively developed states like Maharashtra and Andhra Pradesh is perturbing. Further, these states are better placed in terms of irrigation, credit, and rural development, compared to other dry land states like Chhattisgarh, Jharkhand or Rajasthan. This poses a paradoxical situation as if the development activities have no impact on farming and on improving farmer income. Thus, the rural scenario still points to the near no hope for farmers and the poor farmers continue to reel under the vagaries of nature expecting good monsoon every season and hoping that rain will tilt their fortunes. Out of the total geographical area of 328.7 million hectares in India, the net sown area is 141 million hectares, out of which the irrigated area is only 48 million hectares and the majority 92.6 million hectares are dependent on natural rainfall (Tyagi, 1984). This shows that the dry land farming by the Indian farmer is inevitable. The crops that are grown in the dry land farming, jowar, pulses, oilseeds, cotton, etc. often yield poor returns. These crops often depend on timely monsoon rainfall, and the monsoon often fails in India and the feeders of the nation have to stare at crop failure. As the rainfall in India is highly unpredictable, Indian agriculture is termed as the gamble of monsoon. Thus, the farmer is forced to turn to their conventional and the only reliable saviours, the moneylenders and other informal sources, in order to cope with nature's onslaught and to survive in the Indian economy.

As so many Indian farmers take out their life so sadly, without even taking the everlasting consequences his suicide will impose on the rest of the family, the causes that lead him to such a desperate situation need to be probed seriously. Of all the causes for farmer suicides, insufficient rainfall, that too erratic monsoon and crop failure are the frequently cited primary causes that push the farmers to commit suicide. Hence, this paper investigates the farmer suicides in India by examining the effects of income, irrigated area, and rainfall on farmer suicides using a panel data from 10 major states for 10 years covering the period 2001-2010. To capture the effects of unobservable heterogeneity and individual effects, panel data regression methods of fixed effects and random effects models are used in the empirical analysis.

In the literature on suicides, econometric studies on farmer suicide are scanty. In most studies, suicides generally view suicide as an expression of extreme self-perceived misery. Often farmer suicide is considered to the sign of distress and failure of coping mechanism. The literature that examines farmer suicides in India has focused mostly on listing socioeconomic causes and state-level policy recommendations (Parthasarathy and Shameem, 1998; Revathi, 1998). Among the causes mentioned are inadequate rainfalls, low yield, falling commodity price, lack of institutional credit, poor quality of inputs, and increased reliance on informal moneylenders. All of which, incidentally, are also sources of problems in Indian agriculture at large. Of these, moneylenders are widely vilified as being the primary stressor pushing already over-burdened farmers to take their own lives. Contributing to farmer suicides, Bose (2000) highlights that seed quality and lack of pesticides as primary causes.

In a time-series study for the period from 1995-2011, Basu, Das and Misra (2016) examines the Suicide Mortality Rate (SMR) of farmers and non-farmers in India for 19 major states, that account for more than 97 percent of farmer suicides in India. The study observes that the SMR for male farmers has been consistently and significantly higher than for female farmers. The SMR ratio, i.e. the ratio of farmer SMR and non-farmer SMR, has been less than one, implying that the suicide rate of farmers has been lower than the suicide rate of non-farmers. Further, the SMR ratio for India has increased between 1995 and 2004 and has declined since then.

Hebous and Klonner (2014) analyses the vulnerability of India's rural populations from the usual consumption or income-based poverty angle. The study, examining district-wise data on suicides in farm households in two major Indian states Karnataka and Maharashtra during 1998-2004, observes marked differences across the two states. In Karnataka, where rainfall and rural poverty varies significantly, suicides among male farmers rise sharply with transitory poverty shocks caused by lack of rainfall. For females, an intriguing opposite effect, though quantitatively smaller, has been observed. In Maharashtra, no such effect has been observed because of the effective rural social protection policies. The results underscore the need for rural development policies that are geared towards protection against various sources of risk rather than just aggregate growth.

Rashmi Bhat (2016) examines the predictive power of monsoon and annual rainfall, which is assessed by a comparison of how agricultural suicide rates differ from non-agricultural suicide rates in the way that they respond to fluctuations in rainfall. Using a panel of suicide data for 25 Indian states, the pathways by which rainfall could affect an individual's decision to commit suicide is analyzed. The results show that while both monsoon and annual rainfall are significantly associated with suicides rates,

the other factors like real GSDP per capita, real agriculture output per worker and percent of the population employed in agriculture have no impact on farmer suicide.

**DATABASE AND METHODOLOGY**

The data used in this paper is a 10 years’ state-wise panel data covering the period 2001-2010. The states are Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Gujarat, Jharkhand, Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka and Rajasthan. The panel unit is state and time variable is year. The period or number of years is 10 years starting from 2001 to 2010. The dependent variable of the study is the number of farmer suicides. Independent variables are annual rainfall, GSDP (gross state domestic product), GIA (gross irrigated area). The data on farmer suicides are collected from the Accidental Deaths and Suicides in India (ADSI) database of the National Crime Record Bureau NCRB, annual rainfall data from India Meteorological Department (IMD), gross state domestic product (GSDP) data from Planning Commission, Government of India, and gross irrigated area data from CSO (Central Statistical Organisation), and the irrigated area data from Ministry of Statistics and Programme Implementation.

The Figure 2 presents the pattern of average annual rainfall in India, showing the low level of rainfall in most Indian states. The Figure 3 presents the average GSDP of the states in India. The Figure 4 presents the average gross cropped area in the 10 Indian states together.

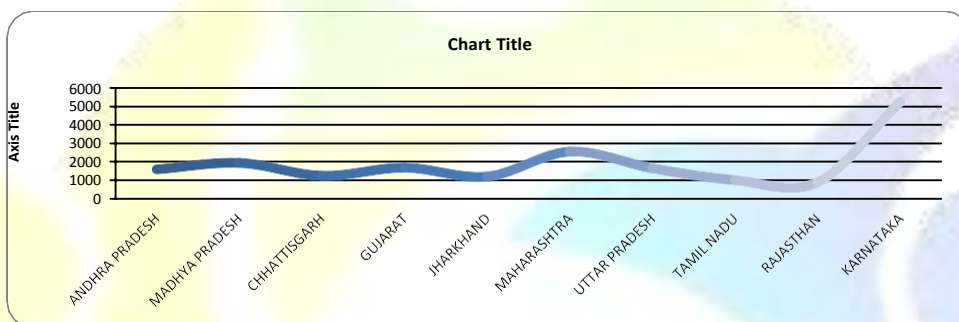


Fig. 2. Annual Rainfall in India  
Source: Indian Institute for Tropical Meteorology (2001-2010)

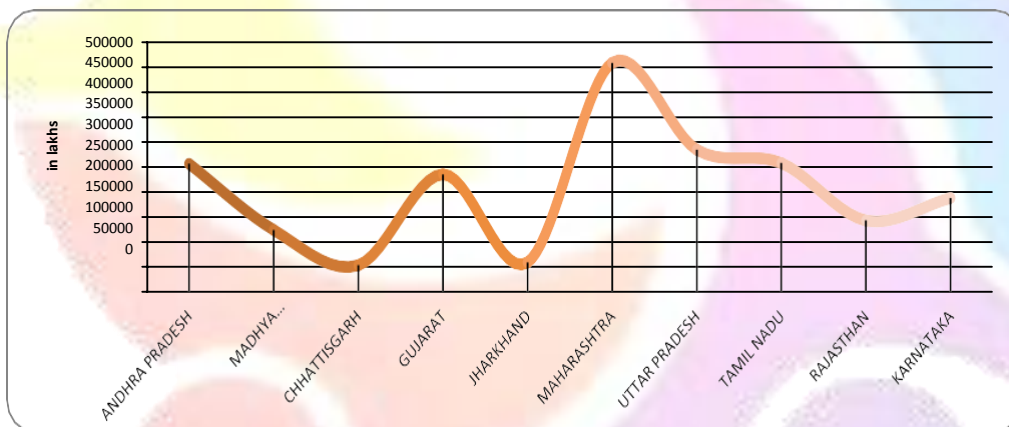


Fig. 3. Gross State Domestic Product(GSDP)  
Source: Central Statistical Organization (CSO)(2001-2010)

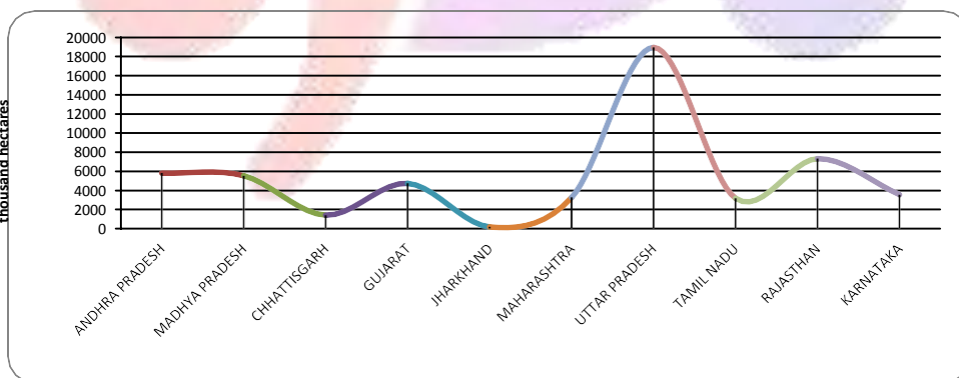


Fig. 4. Gross Irrigated Area (GIA)  
Source: Ministry of Statistics and Programme (2001-2010)

### Panel Data Methods

The fundamental advantage of panel data compared to cross section data is that it allows greater flexibility in modeling differences in behaviors across states. The panel methods control for both time invariants observed and unobserved individual heterogeneity between the states. The panel model is given by,

$$Y_{it} = X_{it}\beta + Z_i\alpha + \lambda_i + u_{it} \quad (1)$$

$$Y_{it} = X_{it}\beta + c_i + u_{it} \quad (2)$$

where,  $Y_{it}$  is the number of farmer suicides in state  $i$  during time  $t$ ,  $X_{it}$  is a set of explanatory variables,  $Z_i$  is the observed and  $\lambda_i$  is the unobserved individual effects, i.e. heterogeneity. As it stands, this model is a classical regression model. If  $Z_i$  is observed for all individuals, then the entire model can be treated as an ordinary linear model and can be estimated by least squares method. The complications arise when  $Z_i$  is unobserved, which will be the case in most applications. When  $Z_i$  is unobserved but correlated with  $X_{it}$ , then the least squares estimator of  $\beta$  is biased and inconsistent as a consequence of the omitted variable bias.

However, if the observed heterogeneity is time invariant, i.e.  $Z_i$  is constant over time, then  $Z_i$  can be conveniently added with the constant term of the model as,

$$Y_{it} = \alpha_i + X_{it}\beta + u_{it} \quad (3)$$

where,  $\alpha_i$  specifies an estimable conditional mean. This form of fixed effects estimation approach takes  $\alpha_i$  to be a group-specific constant term in the regression model. The fixed effects model allows the unobserved individual effects to be correlated with the included variables. We then modeled the differences between units strictly as parametric shifts of the regression function. If the individual effects are strictly uncorrelated with the regressors, then it might be appropriate to model the individual specific constant terms as randomly distributed across cross-sectional units. The payoff to this form is that it greatly reduces the number of parameters to be estimated. It should be noted that the term ‘fixed’ as used here signifies the correlation of  $c_i$  and  $X_{it}$ , not that  $c_i$  is not-stochastic. If the unobserved individual heterogeneity  $\lambda_i$ , however formulated, assumed to be uncorrelated with  $X_{it}$ , then the model may be formulated as,

$$Y_{it} = X_{it}\beta + \varepsilon_{it} \quad \varepsilon_{it} = \lambda_i + u_{it} \quad (4)$$

That is, a linear regression model with a compound disturbance that may be consistently, albeit inefficiently, estimated by least squares. The random effects estimation approach specifies that  $\lambda_i$  is a group specific random element, similar to  $u_{it}$ . Again, the crucial distinction between fixed and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not.

From the standpoint of causal analysis, a question is which model, fixed effects or random effects, is appropriate for empirical analysis. From a purely practical standpoint, the fixed effects model which uses dummy variables for individual effects has the disadvantage of losing as many degrees of freedom as the number of cross-section units. However, it has an advantage over the random effects; in that there is little justification for treating the individual effects as uncorrelated with the other regressors as is assumed in the random effects model. The random effects modeling suffers from the inconsistency due to this correlation between the explanatory variables and the individual effects. To overcome this specification issue, Hausman’s (1978) devised a specification test, using the orthogonality property of the common effects and the regressors, based on the idea that under the hypothesis of no correlation, OLS, fixed effects and random effects estimators are consistent, but OLS is inefficient, whereas under the alternative, fixed effect is consistent but the random effect is not. Therefore, under the null hypothesis, the two estimates should not differ systematically. Thus, the Hausman specification test is based on the difference in the variances of the two estimators, i.e. test the covariance matrix of the difference vector  $[\hat{\beta}_{FE} - \hat{\beta}_{RE}]$

$$\text{var}[\hat{\beta}_{FE} - \hat{\beta}_{RE}] = \text{var}[\hat{\beta}_{FE}] + \text{var}[\hat{\beta}_{RE}] - \text{cov}[\hat{\beta}_{FE} - \hat{\beta}_{RE}] - \text{cov}[\hat{\beta}_{RE} - \hat{\beta}_{FE}] \quad (5)$$

Note that, the covariance of an efficient estimator with its difference from an inefficient estimator is zero, implying that,

$$\text{cov}[(\hat{\beta}_{FE} - \hat{\beta}_{RE}) - \hat{\beta}_{RE}] = \text{cov}[\hat{\beta}_{FE} - \hat{\beta}_{RE}] - \text{var}[\hat{\beta}_{RE}] = 0 \quad (6)$$

$$\text{or } \text{cov}[\hat{\beta}_{FE} - \hat{\beta}_{RE}] = \text{var}[\hat{\beta}_{RE}] \quad (7)$$

Then, the covariance matrix is,

$$\text{var}[\hat{\beta}_{FE} - \hat{\beta}_{RE}] = \text{var}[\hat{\beta}_{FE}] + \text{var}[\hat{\beta}_{RE}] = \Omega \quad (8)$$

on which the Wald chi-squared test can be performed,

$$W = \chi^2_{k-1} = [\hat{\beta}_{FE} - \hat{\beta}_{RE}]' \Omega^{-1} [\hat{\beta}_{FE} - \hat{\beta}_{RE}] \tag{9}$$

If the computed value of the test statistics is greater than the critical value, the null hypothesis of the random effects is rejected, and the fixed effects model is specified.

**EMPIRICAL ANALYSIS**

The definition and descriptive statistics of the variables used in the empirical analysis are presented in Table 1. In 2010 alone, 1,34,599 suicides have been reported, which amounts to a suicide rate of 11.4. According to the NCRB, between 2000-2010, the number of suicides has increased by 23.9 percent, compared to the population increase of

18.3 percent during that decade. Out of all the suicides, on average, 1391 farmers per 1 lakh population committed suicide in India during the decade 2000-2010. During this time period, the mean annual rainfall is 1898 millimeters, and the shortfall in monsoon rainfall is 3,512 millimeters. The average gross irrigational area is 5,369 thousand hectares. The average GSDP at constant prices is Rs. 38,91,551 and the mean NSDP per capita is Rs.26,652.

Table 1. Descriptive Statistics of Variables in the Analysis of Farmer Suicides in India

Variable	Description	Mean	Standard Deviation
FS	No. of farmer suicides (per 1,00,000 population)	1391.18	1060.643
AR	Annual rainfall (millimeter per annum)	1898.012	1276.057
GSDP	Gross state domestic product (Rs. lakhs in constant price)	3891551	6432563
GIA	Gross irrigated area (thousand hectares)	5368.6	5018.541
MRS	Monsoon rainfall shortage (millimeter)	-512.593	4148.579

The empirical specification for panel estimation is,  
 $FS_{it} = \beta_0 + \beta_1 AR_{it} + \beta_2 GIA_{it} + \beta_3 GSDP_{it} + \alpha_i + u_{it}$

$$\tag{10}$$

$i = 1, 2, \dots, 10$   
 $t = 2001, 2002, 2010$

The heterogeneity or individual effect term  $\alpha_i$  is treated as a random variable with a specified probability distribution in the random effects model, whereas as a set of fixed parameters in fixed effects model. The term  $u_{it}$  is the usual stochastic disturbance term that follows normal distribution With mean 0 and variance  $\sigma^2$ .

The Table 2 presents the panel regression results for fixed and random effects models. The variables are taken in the linear form. The coefficient of the main variable annual rainfall is negative and significant at 1 percent level in both models. This result shows that for an increase in rainfall, the farmer suicide rate declines.

An increase of one unit in rainfall will reduce the number of suicides by 5.6 percent in India. Irrigation is a major factor in farmer suicide. An increase one unit in irrigated area will significantly reduce farmer suicides by 2.0 percent. Better irrigation facilities will improve the agricultural production and hence prevent farmer suicides. Aggregate income GSDP has significant positive effect on farmer suicides, though the effect is only modest. As the fixed effects model also produces close estimates similar to the random effects model, the fit of the appropriate model need to be tested further. For the null hypothesis that there is a random effect, the Hausman specification test accepts the null, as the chi-square value for Hausman test is insignificant. Hence, the fixed effects model is rejected and the random effects model is the better one.

Table 2. Fixed and Random Effects Estimates of Farmer Suicides in India  
 Dependent Variable: Number of Farmer Suicides

Variable	Fixed Effects	Random Effects
Annual Rainfall	-.0881* (-3.09)	-.0565* (-2.72)
Gross Irrigated Area	-.0102* (-3.27)	-.0205* (-3.62)
GSDP	.00002*** (1.70)	.00002*** (1.82)
Constant	155.58* (6.87)	154.07* (3.85)
R-squared (within)	0.209	0.185
R-squared (between)	0.461	0.541
R-squared (overall)	0.337	0.406
Rho	0.9437	0.9418
Hausman's Specification Test Chi-square Value	3.00 Prob > chi2 = 0.3920	

Note: Figures in parentheses are z-values for random effects and t-values for fixed effects models (\*significant at 1% level, \*\*\*significant at 10 % level).

Table 3. Random Effects Estimates of Monsoon Rainfall Shortage on Farmer Suicides  
Dependent Variable: Number of Farmer Suicides

Variable	Specification 1	Specification 2	Specification 3
Annual Rainfall	-.0030* (-3.08)	-	-
Monsoon Rainfall	-	-.0502* (3.37)	-
Shortage In Monsoon Rainfall	-	-	.0357* (3.08)
Gross Irrigated Area	-.0253*** (-1.83)	-.0236*** (-1.73)	-.0243*** (-1.73)
Gsdp	-.0026* (2.81)	-.00009 (-0.27)	-.00009 (-0.26)
Constant	147.707* (4.96)	146.973* (4.63)	166.955* (4.68)
R-squared (between)	0.491	0.452	0.383
R-squared (within)	0.103	0.214	0.197
R-squared (overall)	0.520	0.426	0.432
Rho	0.8954	0.9019	0.9031

Note: Figures in parentheses are z-values for random effects model (\*significant at 1% level  
\*\*\*significant at 10% level).

The Table 3 estimates the effects of monsoon rainfall and the shortage of monsoon rainfall on farmer suicides in India. In specification 1, annual rainfall has a negative impact in farmer suicide and significant at the 1 percent level, showing adequate rainfall improves crop prospects and the tendency for suicide by farmers declines.

In specification 2, timely monsoon rainfall also significantly reduces farmer suicides. But, inadequate or a shortage of monsoon rainfall has a statistically significant positive impact on farmer suicides. In all specifications, the effect of gross irrigated area is negative and significant at 10 percent level, showing irrigation facilities reduce farmer suicides. In specification 1, GSDP has a significant positive coefficient, but in other specifications GSDP effect on suicide by farmers is insignificantly negative.

Table 4. Fixed and Random Effect Estimates of Farmer Suicides by Gender  
Dependent Variable: Number of farmer suicides

Variable	Males		Females	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Annual Rainfall	-.0301* (3.42)	-.0622* (2.91)	-.0561* (2.93)	-.0819*** (-1.70)
Gross Irrigated Area	-.0053*** (2.14)	-.0109*** (-2.35)	-.0071* (2.71)	-.0119*** (-2.28)
GSDP Constant	.0012*** (-1.86)	.0007*** (1.83)	.0012*** (-1.68)	.0015*** (-1.70)
Constant	111.115* (5.38)	112.903* (3.35)	297.089* (5.28)	290.923* (4.66)
R-squared (within)	0.391	0.285	0.337	0.312
R-squared (between)	0.201	0.236	0.302	0.267
R-squared (overall)	0.384	0.246	0.637	0.414
Rho	0.936	0.920	0.887	0.776
Hausman's specification test Chi-square value (with p-value)	2.07 (0.558)		10.15 (0.017)	

Note: Figures in parentheses are z-values for random effects and t-value for fixed effects models (\* significant at 1% level, \*\*\* significant at 10% level).

In Table 4, the estimated results for male and female farmer suicides are presented separately. An increase in annual rainfall reduces both male suicides, as its sign is significantly positive. Female suicide rates are more responsive to rainfall than male farmer suicides. Further, irrigated area also reduces farmer suicides. The GSDP has got less positive effect on farmer suicides. The Hausman specification test shows insignificance for fixed effects and high significance for random effects leading to the acceptance of the null hypothesis that there is random effect.

## CONCLUSIONS

It is no wonder that the Indian farmer's life and death revolves around the nature. Among all the ill factors that are responsible to a farmer's suicide, rainfall failure that too shortage of monsoon rainfall is the single most effective factor. A crop failure due to monsoon failure causes a farmer to default the crop loan, and his own life. This paper has attempted to estimate the effects of annual rainfall and its shortage, along with gross irrigated area and GSDP, on farmer suicides in India using state-wise panel data for 10 states and for 10 years. Panel data regression methods of fixed and random effects models are used for analysis.



The estimated empirical results show that there is a direct relationship between annual rainfall and farmer suicide. With increase in annual rainfall, farmer suicide declines in India. This result is strengthened with the findings that monsoon rainfall is associated with reduced farmer suicides, whereas the insufficient monsoon rainfall increases farmer suicides. It seems that female farmer suicides are more responsive to rainfall related factors than the male farmer suicides. Thus, despite India's enviable growth rates, booming economy, and shining urban sector, Indian farmers are still at the mercy of the 'rain God' and are 'born in debt, live in debt and die in debt', not because of ageing or natural causes, but by cutting short in his own hands his hopeless life, the sin being carrying out his family's professed occupation of agriculture.

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