ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(5): 841-848
www.allresearchjournal.com
Received: 11-03-2016
Accepted: 12-04-2016

Satyvan Yashwant
Research Scholar, Department of Statistics, Dr. B.A.M.U Aurangabad, Maharashtra, India.

SL Sananse
Professor, Department of Statistics, Dr. B.A.M.U Aurangabad, Maharashtra, India.

Correspondence
Satyvan Yashwant
Research Scholar, Department of Statistics, Dr. B.A.M.U Aurangabad, Maharashtra, India.

Identification of climatic effect on crop yield of Marathwada region by using multiple linear regression & stochastics frontier approach

Satyvan Yashwant, SL Sananse

Abstract
The aim of this study is estimate climatic effect on soybean crop yield and measures its crop production efficiency by using multiple linear regression and stochastic frontier model. In this study we have use 30 years (1980 to2010) data of soybean and ten climactic factor in Marathwada region. This region is situated between 170 -35 N and 200- 40 N latitude and 740 - 40 E and 780 – 15 E longitudes in Maharashtra state In this region consist of eight districts such as, Aurangabad, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani. The economy of this region depends upon agriculture sector. The last ten year this region is less rainfall affected region in Maharashtra. The result show that rainfall, area, dry spell max temp are positively effect on soybean crop production and min humidity, minimum temp, total could are negative effect on crop production of soybean. The fitted multiple linear regression model of parameter estimate by using least square regression method. result show that value of multiple R-square of Later and Hingoli district are 0.921 and 0.90 respectively this indicate that fitted model can explain more variability of repressors variable. The Cobb-Douglas stochastic frontier model is applied to Latur and Hingoli of soybean crop production for measure production efficiency. The result show that efficiency of Latur and Hingoli district are 0.86 and 0.84 respectively This result indicates that 86%and 84% of total composed error variance of the production function is explained by the variance of the technical inefficiency term. This result is importance to incorporate technical inefficiency in the production function.maximum like hooded method is used for estimation of parameter of stochastic frontier model. The value of gamma is used to testing the hypothesis to check stochastic noise and technical inefficiency. This result is helpful to framer and regional and local planer in Marathwada region.

Keywords: Multiple Regression model, Stochastic Frontier model, Maximum likelihood Estimator, likelihood Ratio test

Introduction

Marathwada of Maharashtra comprising eight districts (Aurangabad, Jalna, Parbhani, Nanded, Latur, Beed, Omarabad and Hingoli) is traditionally a drought-prone region. The situation has worsened with rainfall deficiency for three consecutive years. Rainfall deficit for 2014 was 45 per cent; this was followed by a deficit of more than 50 per cent in many districts till the end of August 2015. The region has struggled with frequent droughts for the past 50 years. Even a moderate rainfall deficiency is impacting agricultural output significantly due to increased water demand. Soybean is gaining popularity on account of its unique characteristics and adaptability to varied agro-climatic conditions. It has unmatched composition of 40 per cent protein and 20 per cent oil and nutritional superiority on account of containing essential amino acids, unsaturated fatty acids, carbohydrates, vitamins and minerals. in study we use two method for study the soybean crop yield in Marathwada region such as multiple linear regression and stochastic frontier analysis. Regression analysis is a statistical technique that utilizes the relation between two or more quantitative variables on observational database so that outcome variable can be predicted from the others. One of the purposes of a regression model is to find out to what extent the outcome (dependent variable) can be predicted by the independent variables. Rainfall forecast methods are employed in weather forecasting at regional and national levels. Fundamentally, there are two approaches to predict rainfall. They are Empirical method and dynamical methods. The empirical approach is based on analysis of historical data of the rainfall and its relationship to variety of atmospheric and oceanic variables over different parts of the world in this study using regression analysis we have check the climatic effect on soybean crop production in Marathwada region. The stochastic frontier analysis is an analytical approach that utilizes econometric (parametric) techniques whose models of production recognize technical inefficiency and the fact that random shocks beyond producers' control may affect the product. Differently from non-parametric approaches that assume deterministic frontiers, SFA allows for deviations from the frontier, whose error can be decomposed for adequate distinction between technical efficiency and random stock (rainfall, dry spells, max temp, etc) Stochastic frontier models allow to analyse technical inefficiency in the framework of production functions. Production units (firms, regions, countries, etc.) are assumed to produce according to a common technology, and reach the frontier when they produce the maximum possible output for a given set of inputs. Inefficiencies can be due to structural problems or market imperfections and other factors which cause countries to produce below their maximum attainable output Over time, production units can become less inefficient and catch up to the frontier.1 It is also possible that the frontier shifts, indicating technical progress. In addition, production units can move along the frontier by changing input quantities. Finally, there can be some combinations of these three effects. The stochastic frontier method allows decomposing growth into changes in input use, changes in technology and changes in efficiency, thus extending the widely used growth accounting method. When dealing with productivity, two main problems arise: its definition and its measurement. Traditionally, empirical research on productivity has suffered from a number of shortcomings. Most empirical studies have employed the so called Solow residual (Solow 1956) [15]. The use of this measure is problematic: Abramovitz (1956) [2] refers to the difference between the growth rates of output and the weighted sum of input growth rates as a "measure of our ignorance about the causes of economic growth". In this study we have use soybean crop yield is output variable and other ten are input variable. Using this technique have check the main efficiency of model for cheeking utilization of maximum level of output of soybean by using input in Marathwada region.

Related Work

Many researchers have study of crop production by using multiple linear regression and stochastic frontier such as, Díaz and Sánchez (2004) [9] investigated the temporary employment and technical efficiency in Spain's productivity growth that occurred between mid-1995 to the end of 2000. Aigner and Chu (1968) [1], who proposed the use of specific econometric models consistent with the frontier--the 'best-practice' notions of Farrell (1957) [10]. Contemporary researchers familiar with econometric modelling would prefer the use of stochastic frontier analysis (SFA) in their efficiency studies (Aigner *et al*. 1977; Meeusen and Broeck 1977) [1, 9]. Dolado *et al*, (2001) [2]. The use of SFA software developed by Battese and Coelli (1995) [4] has been widely applied, not only in manufacturing and agriculture sectors, but also in fisheries studies that wish to compare the performance of firms (see Roy 2002, Basri *et al*. 2006) [4]. They should be highly accredited for making this robust computer program freely available to those who wish to use it for teaching and research. Koop *et al*. (1999, 2000a, b) [11], and Koop (2001) [16] adopt a Bayesian approach to estimate stochastic production frontiers. While there are certainly advantages of the Bayesian estimation method, the choice of Maximum Likelihood estimation in large sample is justified. Kim and Schmidt (2000) [12]. examine a large number of classical and Bayesian procedures to estimate the level of technical efficiency using different panel data sets. They find that Maximum Likelihood estimation based on the exponential distribution gives similar results to the Bayesian model in which the prior distribution for efficiency is exponential and there is an uninformative prior for the exponential parameter. Kumbhakar and L¨othgren (1998) [18] assume in their Monte Carlo study that the true values of the underlying parameters are unknown and must be replaced by their ML estimates. They found that the result is true for all value of inefficiency and for sample sizes less than 200. Afriat (1972) and Richmond (1974) [3] explicitly assume that the disturbances follow a one-sided distribution, such as exponential or half normal. See Temple (1999) and the introduction for a more detailed discussion. Addition, it allows to include explanatory variables in both the production unction and the efficiency term. These are related work.

Data and Methodology

Study area and data collection

Marathwada region consist of eight districts such as, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani. This In this study we have used 30 years (1980 to2010) of time series data in rainfall, minimum &maximum temperature, minimum &maximum humidity, wind speed, wind direction & total could cover(octa) of eight metrological station in Marathwada region. In this region consist of eight districts such as, Beed, Hingoli, Jalna, Latur, Nanded, Osmanabad and Parbhani. This region is situated between 170 -35 N and 200- 40 N latitude and 740 - 40 E and 780 – 15 E longitudes. The data of two districts of 30(1980 to2010) years were obtained by IMD & Maharashtra agriculture department.

In this study we have use the crop yield of soybean is dependent (out variable) and other ten are independent (input variable) such as, rainfall, dry spell, max. temp, min temp, wind speed, wind direction, total could cover, area of crop growing (hector), max. Humidity and min.humidity

1. Regression analysis

Regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modelling and analysing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. In this study use have used seven variables such as Rainfall, Max temp, Min temp, Total could cover, Max humidity, Min humidity, Wind speed, Wind direction yield and Area, Yield is dependent variable. In that study more than two variable present in data we have use multiple regression

A. Multiple Regression analysis

Multiple regressions fit a model to predict a dependent (Y) variable from two or more independent (X) variables. Multiple linear regression models are often used as approximating functions. That is, true functional relationship between y and x1,x 2, x3 …, is unknown, but over certain ranges of the repressor variables the linear regression model is an adequate approximation to the true unknown function. In the present study rainfall was treated as dependent variable and maximum & minimum temperature, minimum &maximum humidity, wind speed, wind direction & total could cover (octa) as independent variable. The form of the multiple linear regression equation fitted to the weekly average weather parameters is given below.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon_i$$

Y = Crop yield
X1=rainfall (mm)
X2= Area (hectare)
X3= Maximum temperature (°C)
X4= Total cloud cover (octa)
X5= Maximum Relative humidity (%)
X6= Wind speed (kmph)
X7= Wind direction (deg)
X8= Dry spell
X9 = Minimum temperature (°C)
X10= Minimum Relative humidity (%)
β_0 = intercept
β_i = regression coefficient of i^{th} independent variables (i=1, 2,…7
ϵ = error term.

2. The Production Frontier: Theoretical Framework
The standard definition of a production function is that it gives the maximum possible output for a given set of inputs; the production function therefore defines a boundary or a frontier. All the production units on the frontier will be fully efficient. Efficiency can be of two kinds: technical and allocate. Technical efficiency is defined either as producing the maximum level of output given inputs or as using the minimum level of inputs given output Allocate efficiency occurs when the marginal rate of substitution between any of the inputs equals the corresponding input price ratio. If this equality is not satisfied, it means that the country is not using its inputs in the optimal productions. An initial justification for computing efficiency can be found in that its measure facilitates comparisons across economic units. Secondly, and perhaps more importantly, when divergence in efficiency is found some further research needs to be undertaken to understand which factors led to it. Finally, differences in efficiency show that there is scope for implementing policies addressed to reduce them and to improve efficiency. A production frontier model can be written as

$$Y_i = f(x_i;\beta) TE_i \quad (2)$$

Where, Yi is the output of producer i (i = 1, 2… N); x is a vector of M inputs used by producer is $f(xi;\beta)$ the production frontier and β is a vector of technology parameters to be estimated. Let TEi be the technical efficiency of producer i,

$$TE_i = \frac{Y_i}{f(xi;\beta)} \quad (3)$$

In the case, $TE_i = 1$, Y_i achieves its maximum feasible output of $f(xi;\beta)$ .if $TE_i < 1$, it measures technical inefficiency in the sense that observed output is below the maximum feasible output. The production frontier $f(xi;\beta)$ is deterministic. That means that the entire shortfall of observed output Yi from maximum feasible output $f(x_i;\beta)$ is attributed to technical inefficiency. Such a specification ignores the producer specific random shocks that are not under the control of the produce. We have to specify the stochastic production frontier

$$Yi = f(xi;\beta)\exp(v_i) TE_i \quad (4)$$

where, $f(xi;\beta)\exp(v_i)TE_i$ is the stochastic frontier, which consists of a deterministic part $f(xi;\beta)$ common to all producers and a producer-specific part which $\exp(v_i)$ captures the effect of the random shocks to each producer TE_i can be computed for Stochastic Frontier production of i^{th} producer.

$$TE_i = \frac{Y_i}{f(xi;\beta)\exp(v_i)} \quad (5)$$

Technical efficiency can be estimated using either the deterministic production frontier model given by equations (2) and (3), or the stochastic frontier model given by equations (4) and (5) since the stochastic frontier model includes the effect of random shocks on the production process, this model is preferred to the deterministic frontier

3. Stochastic Frontier Productions Function
The econometric approach to estimate frontier models uses a parametric representation of technology along with a two-part composed error term. Under the assumption that is of $f(x_i;\beta)$ is of Cobb-Douglas type, the Stochastic frontier model in equation can be written as.

$$\ln Y_i = \alpha + \beta X_i + \varepsilon_i \quad (6)$$

Where, ε_i is an error term with? $\varepsilon_i = v_i - u_i$
In this study using crop yield of soybean is output variable and other ten are input variable. The Cobb-Douglas type of stochastic frontier model in equation can be written as follows.
ln (Yi)= β_0+ β_1 ln(Rainfall) + β_2 ln (Area) + β_3 l ln (Max temp) +β_4 ln (Total Could cover)+ β_5 ln (Max. Humidity)+ β_6 ln (Wind speed)+ β_7 ln (Wind direction)+ β_8 l ln g (dry spell)+ β_9 ln (Min.Temp)+ β_{10} ln (Min. Humidity))+ ϵ_i
The economic logic behind this specification is that the production process is subject to two economically distinguishable random disturbances. Statistical noise represented by v_i and technical inefficiency represented by

u_i There are some assumptions necessary on the characteristics of these components. The errors v_i assumed to have a symmetric distribution, in particular, they are independently and identically distributed as $N(0, \sigma_v^2)$. The component u_i is assumed to be distributed independently of v_i i and to satisfy $u_i \geq 0$ (e.g. it follows a one-sided normal distribution $N^+(0, \sigma_v^2)$. The non-negativity of the technical inefficiency term reflects the fact that if $u_i > 0$ the country will not produce at the maximum attainable level. Any deviation below the frontier is the result of factors partly under the production unit's control, but the frontier itself can randomly vary across firms or over time for the same production unit. This last consideration allows the assertion that the frontier is stochastic, with a random disturbance v_i being positive or negative depending on favourable or unfavourable external events. It is important to note that given the non-negativity assumption on the efficiency term, its distribution is non-normal and therefore the total error term is asymmetric and non-normal. This implies that the least squares estimator is inefficient. Assuming that v_i and u_i are distributed independently of X_i estimation of (6) by OLS provides consistent estimators of all parameters but the intercept, since $E(\varepsilon_i) = -E(u_i)$ Moreover, OLS does not provide an estimate of producer-specific technical efficiency. However, it can be used to perform a simple test based on the skewness of empirical distribution of the estimated residuals. Schmidt and Lin (1984) propose the test statistic.

$$b^{1/2} = \frac{m_3}{m_2^{3/2}} \tag{7}$$

Where, m_2 and m_3 are the second and the third moments of the empirical distribution of the residuals. Since v_i is symmetrically distributed, m_3 is simply the third moment of the distribution of u_i. The case $m_3 < 0$ implies that OLS residuals are negatively skewed, and that there is evidence of technical inefficiency. In fact, if $u_i > 0$ then $\varepsilon_i = v_i - u_i$ negatively skewed. The positive skewness in the OLS residuals, i.e. $m_3 > 0$, suggests that the model is mis-specified. Coelli (1995) [5] proposed an alternative test statistic.

$$b^{1/2} = \frac{m_3}{(6m_2^3 / N)^{1/2}} \tag{8}$$

Where, N is equal to the number of observations. Under the null hypothesis of zero skewness in the OLS residuals, $m_3 = 0$, the third moment of OLS residuals is asymptotically distributed as a normal random variable with mean zero and variance $(6m_2^3 / N)^{1/2}$. This implies that the test statistic (10) is asymptotically distributed as a standard normal random variable N (0,1). Coelli (1995) [5] presents Monte Carlo experiments where these tests have the correct size and good power. The asymmetry of the distribution of the error term is a central feature of the model. The degree of asymmetry can be represented by the following parameter.

$$\lambda = \frac{\sigma_u^2}{\sigma_v^2} \tag{9}$$

The larger λ is, the more pronounced the asymmetry will be. On the other hand, if λ is equal to zero, then the symmetric error component dominates the one-side error component in the determination of ε_i. Therefore, the complete error term is explained by the random disturbance v_i, which follows a normal distribution. ε_i Therefore has a normal distribution.

To test the hypothesis that $\lambda = 0$, we can compute a Wald statistic or likelihood ratio

Test both based on the maximum likelihood estimator of λ Coelli (1995) [5] tests as equivalent hypothesis $\gamma = 0$ against the alternative $\gamma > 0$, where

$$\lambda = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \tag{10}$$

A value of zero for the parameter γ indicates that the deviations from the frontier are entirely due to noise, while a value of one would indicate that all deviations are due to technical inefficiency. The Wald statistic is calculated as

$$W = \frac{\hat{Y}}{\hat{\sigma}_\gamma} \tag{11}$$

Where, $\hat{Y}$ is maximum likelihood estimate of γ and $\hat{\sigma}_\gamma$ is its estimated standard error. Under $H_0 = \gamma = 0$ is true, the test statistic is asymptotically distributed as a standard normal random variable. However, given that γ cannot be negative, the test is performed as a one-sided test. The likelihood test statistic is

$$LR = -2[log(L_0) - log(L_1)] \tag{12}$$

Where, $log(L_0)$ is the log-likelihood valued under the null hypothesis and $log(L_1)$ is the log-likelihood value under the alternative. This test statistic is asymptotically distributed as chi-square random variable with degrees of freedom equal to the number of restrictions. Coelli (1995) [5] notes that under the null hypothesis $\gamma = 0$, the statistic lies on the limit of the parameter space since γ cannot be less than zero. He therefore concludes that the likelihood ratio statistic will have an asymptotic distribution equal to a mixture of chi-square distribution.

4. Estimation of parameter of Cobb-Douglas stochastic frontier model

There are two main methods to estimate the parameter of stochastic frontier models is modified ordinary least Squares method and other consists of maximum likelihood method.

A. Modified Ordinary Least Squares

In this method all the assumptions of the classical regression model apply, with the exception of the zero mean of the disturbances. The OLS estimator will be a best linear unbiased and consistent estimate of the vector β. Problems arise for the intercept term α. its OLS estimate is not consistent.

B. Maximum Likelihood Estimator method

In this method consistent estimates of all the parameters of the frontier function can be obtained simply using a modification of the OLS estimator. However the distribution of the composed error term is asymmetric (because of the asymmetric distribution of the inefficiency term). A maximum likelihood estimator that takes into consideration this information should therefore give more efficient estimates, at least asymptotically. This has been investigated by Greene (1980a, b) [20] who argues that the Gamma distribution is one of the distributions which provides a maximum likelihood estimator with all of the usual desirable properties and which is characterised by a high degree of flexibility. This distribution should therefore be used to model the inefficiency error term. However, it has been noticed that the flexibility of the Gamma distribution can make the shapes of statistical noise and inefficiency hardly distinguishable

IV. Result and Discussions

In this study present methodology is applied to five selected metrological station of Marathwada region. In this region Latur district shows the highest soybean crop production district of Marathwada average production of soybean of Latur is 2013 tonnes.in that skews and kurtosis value is 1.08 and 0.66 respectively this indicate that increasing the crop production of soybean. Area per hector of soybean of Latur is higher than other district. Table (1) show the descriptive statistics of selected variable of district of Marathwada region.

Table 1: Descriptive statistics selected variable of metrological station (district)

Station	Variable	Mean	StDev	Minimum	Maximum	Skewnes	Kurtosis
Latur	Yield	2013	1847	84	6254	1.08	0.66
	Rainfall	113.4	55.0	55.8	244.9	1.61	2.23
	Area	1539	1020	70	3368	0.00	-0.79
	Max Temp	34.929	2.786	29.	39.	-0.64	0.05
	Total could cover	6.143	1.834	2.	8	-1.12	0.95
	Max. Humidity	68.571	3.631	64	75	0.26	-0.87
	Wind. Speed	23.643	3.500	19	30	0.37	-0.72
	Wind. Direction	271.79	7.79	256	285	-0.40	0.08
Parbhani	Yield	827	544	122	1869	0.70	-0.44
	Rainfall	125.86	37.02	56	189	0.02	-0.03
	Area	758	454	114	1546	0.24	-1.00
	Max Temp	33.071	2.702	29	38	0.35	-0.98
	Total could cover	7.000	0.961	5.000	8.	-0.61	-0.39
	Max. Humidity	83.143	1.875	79.000	86	-0.40	0.76
	Wind. Speed	14.86	4.44	10.00	27	1.81	3.83
	Wind. Direction	269.64	12.33	259.00	311	3.30	11.72
Nanded	Yield	1303	854	91	2834	0.56	-0.64
	Rainfall	122.6	39.7	78.0	200	1.06	-0.18
	Area	1251	712	101	2189	-0.47	-1.43
	Max Temp	32.643	2.706	29.000	36	0.12	-1.90
	Total could cover	7.500	0.855	5.000	8	-2.15	5.30
	Max. Humidity	71.071	3.583	63.000	78	-0.18	1.61
	Wind. Speed	16.143	1.956	13.000	19.	-0.30	-1.04
	Wind. Direction	1303	854	91	2834	0.56	-0.64
Osmanabad	Yield	442	438	7	1374	1.09	0.09
	Rainfall	481	405	21	1335	0.90	0.06
	Area	31.000	1.569	29.000	34.000	0.56	-0.77
	Max Temp	6.429	1.284	4.000	8.000	-0.20	-0.78
	Total could cover	84.93	4.87	71.00	91.00	-1.93	4.85
	Max. Humidity	10.50	3.78	3.00	17.00	-0.04	0.01
	Wind. Speed	277.21	34.65	174.00	314.00	-2.17	6.11
	Wind. Direction	442	438	7	1374	1.09	0.09
Hingoli	Yield	1368	823	245	2867	0.16	-0.97
	Rainfall	1064	491	204	1505	-1.01	-0.76
	Area	34.286	3.221	29.000	39.000	-0.01	-1.46
	Max Temp	7.286	0.914	5.000	8.000	-1.37	1.75
	Total could cover	74.143	2.627	70.000	79.000	0.68	-0.36
	Max. Humidity	16.071	2.369	13.000	19.000	-0.18	-1.48
	Wind. Speed	267.57	9.17	254.00	286.00	0.21	-0.17
	Wind. Direction	1368	823	245	2867	0.16	-0.97

Multiple Linear Regression model (MLR)

In multiple regressions a common goal is to determine which independent variables contribute significantly to explaining the variability in the dependent variable. A goal in determining the best model is to minimize the mean square error (MSE), which would intern maximize the multiple correlation value (R).In this study we have use crop yield of soybean is dependent variable and other ten are independent variable for fitting multiple linear regression model of two districts such as Latur and Hingoli. The Latur district is highest soybean crop production in Marathwada region

Table 2: show the parameter estimates of fitted Multiple Regression model for measuring the climatic effect on soybean crop of Latur district (station)

Coefficient	Estimate	Std. Error	t-value	Pr(>$\|t\|$)
Intercept	-13261	4610	-2.88	0.014
Rainfall	15.993	3.462	4.62	0.001
Area	0.4964	0.2348	2.11	0.056
Max.Temp	113.21	66.26	1.71	0.113
Toat.could	12.61	79.61	0.16	0.877
Max. Humidity	-28.30	26.25	-1.08	0.302
Wind Speed	153.54	51.49	2.98	0.011
Wind Direction	11.440	3.785	3.02	0.011
Dry Spell	52.04	33.05	1.57	0.141
Min.Temp	284.9	129.5	2.200	0.048
Min.Humidity	-110.57	53.67	-2.06	0.062

Table 3. Show that multiple regression equation of soybean crop of Latur district. in this method we have use crop yield of soybean is dependent variable and other ten are independent variable. The rainfall, Area, max. Temp, total could cover, wind speed, wind direction is positive effect on crop production of soybean and Max & min humidity are negative effect on crop production of soybean. In multiple regression model, multiple R-squared is 0.905, which implies that 90.05% of the total variations can be explained by the repressor variables and Adjusted R-squared is 0.8109, which implies that 81.09 % variation can be explained by the repressor after adjustment variables after adjustments and from the overall test. The level of significance (α=5%) used for this study. Multiple regression model is good fit to soybean crop production of Latur district on basis value of multiple R-square and adjusted R-square.

Table 3: show the parameter estimates of fitted Multiple Regression model for measuring the climatic effect on soybean crop of Hingoli district (station)

Coefficient	Estimate	Std. Error	t-value	Pr(>$\|t\|$)
Intercept	276	3121	0.09	0.931
Rainfall	6.843	1.881	3.64	0.003
Area	0.1736	0.1233	1.41	0.184
Max.Temp	-10.03	16.28	-0.62	0.549
Toat.could	-244.68	71.85	-3.41	0.005
Max. Humidity	17.78	19.19	0.93	0.372
Wind Speed	21.92	22.51	0.97	0.349
Wind Direction	-1.421	7.135	-0.20	0.845
Dry Spell	-11.09	14.93	-0.74	0.472
Min.Temp	-9.97	11.56	-0.86	0.405
Min.Humidity	19.31	10.46	1.85	0.09

Table3. Show that multiple regression equation of soybean crop of Latur district. in this method we have use crop yield of soybean is dependent variable and other ten are independent variable. The rainfall, Area, max.Temp, total could cover, wind speed, wind direction is positive effect on crop production of soybean and Max& min humidity are negative effect on crop production of soybean. In multiple regression model, multiple R-squared is 0.905, which implies that 90.05% of the total variations can be explained by the repressor variables and Adjusted R-squared is 0.8109, which implies that 81.09 % variation can be explained by the repressor variables after adjustments and from the overall test. The level of significance (α=5%) used for this study.

Stochastic Frontier model

The Cobb-Douglas stochastic frontier model is used for measure the production efficiency of soybean crop yield production. In this method we have use crop yield is output variable and other ten such as, rainfall, dry spell, max. Temp, min temp, wind speed, wind direction, total could cover, area of crop growing (hector), max. Humidity and min. humidity

Table 4: show the parameter estimates of fitted Cobb-Douglas Stochastic Frontier model. for measuring efficiency of climatic effect on soybean crop of Latur district (station)

Coefficient	Estimate	Std. Error	Z-value	Pr(>$\|z\|$)
Intercept	-10.2739	0.978435	-10.500	< 2.2e-16
Ln(Rainfall)	1.5490	0.239181	6.476	9.399e-11
Ln(Area)	0.3733	0.052085	7.167	7.649e-13
Ln(Max.Temp)	1.0080	0.640961	1.573	0.1158037
Ln(Toat.could)	0.4541	0.120384	3.772	0.0001620
Ln(Max. Humidity)	-0.2372	0.587920	-0.404	0.6866150
Ln(Wind Speed)	1.2382	0.332693	3.722	0.0001979
Ln(Wind Direction)	0.3816	0.045211	8.441	9.399e-11
Ln.(Dry Spell)	0.1513	0.198225	0.763	0.4454404
Ln(Min.Temp)	-1.3599	0.502149	-2.708	0.0067664
Ln (Min.Humidity)	0.4237	0.664963	0.637	0.5239849
SigmaSq	0.0576	0.014952	3.855	0.0001159
gamma	1.0000	0.002521	396.652	0.4454404

The Cobb-Douglas stochastic frontier model assuming a logarithmic transcendental (translog) technology, the parameters estimates of the production frontier and the technical inefficiency component are presented in Table 4. The statistically significant parameters at the level of 5% are essentially related to soybean crop production, as well as the measures of regional technical inefficiency expressed by dummy variables. The Likelihood Ratio statistic presents significant value at 1% level, indicating effects of technical inefficiency in the model. The results show that of technical inefficiency. Presents approximated value of 0,90. This result indicates that 90% of total composed error variance of the production function is explained by the variance of the technical inefficiency term. This reveals the importance to incorporate technical inefficiency in the production function. The estimated coefficients of all the parameters of production function of rainfall, area, max. temp, total could cover are positive there is positive effect on soybean crop production and other is negative effect on soybean crop production.

The value Coelli's test H0: γ= 0, which gives the value of gamma is1 and it's p-value for testing the hypothesis is 0.4454, indicates highly insignificant and all of the deviations arises due to stochastic noise and there is no technical inefficiency. The test statistics value of likelihood ratio test is Pr(>|χ2|) ≥ 0=0.458 which implies to accept the null hypothesis that there is no production inefficiency of soybean production due to climates change in Marathwada region.

Table 5: Show the parameter estimates of fitted Cobb-Douglas Stochastic Frontier model. For measuring efficiency of climatic effect on soybean crop of Hingoli district (station)

Coefficient	Estimate	Std. Error	Z-value	Pr(>|z|)
Intercept	-11.481	0.9952	-11.5366	< 2.2e-16
Ln(Rainfall)	0.8007	0.758	1 1.0555	0.2912
Ln(Area)	0.316033	0.349032	0.9055	0.3652
Ln(Max.Temp)	-0.196891	0.941148	-0.2092	0.834290
Ln(Toat.could)	-0.162508	0.973970	-0.1669	0.867488
Ln(Max. Humidity)	2.685481	0.902939	2.9742	0.002938
Ln(Wind Speed)	0.40894	0.930934	0.2210	0.8250829
Ln(Wind Direction)	0.276084	0.839183	0.3290	0.742162
Ln.(Dry Spell)	-0.235133	0.746968	-0.3148	0.752926
Ln(Min.Temp)	-0.154406	0.442745	-0.3487	0.727279
Ln(Min.Humidity)	0.343671	0.936492	0.3670	0.713636
SigmaSq	0.053055	0.046049	1.1521	0.249261
gamma	0.976376	0.565131	1.7277	0.084042

The Cobb-Douglas stochastic frontier model assuming a logarithmic transcendental (translog) technology, the parameters estimates of the production frontier and the technical inefficiency component are presented in Table 5. The statistically significant parameters at the level of 5% are essentially related to soybean crop production, as well as the measures of regional technical inefficiency expressed by dummy variables. The Likelihood Ratio statistic presents significant value at 1% level, indicating effects of technical inefficiency in the model.

The results show that of technical inefficiency. Presents approximated value of 0,925. This result indicates that 92.5% of total composed error variance of the production function is explained by the variance of the technical inefficiency term. This reveals the importance to incorporate technical inefficiency in the production function. The estimated coefficients of all the parameters of production function of rainfall, area, max. humidity, total could cover are positive there is positive effect on soybean crop production and other is negative effect on soybean crop production. The value Coelli's test H0: γ= 0, which gives the value of gamma is0.976 and it's p-value for testing the hypothesis is 0.084, indicates highly insignificant and all of the deviations arises due to stochastic noise and there is no technical inefficiency. The test statistics value of likelihood ratio test is Pr(>|χ2|) ≥ 0=0.0118which implies to accept the null hypothesis that there is no production inefficiency of soybean production due to climates change in Marathwada region.

Conclusion

The aim of this study is to estimate climatic effect on soybean crop yield and measures its crop production efficiency by using multiple linear regressions and stochastic frontier model.In multiple regression model we have use crop yield is dependent variable and other ten are independent variable in Latur and Hingoli district respective. The result show that rainfall, area, dry spell max temp are positively effect on soybean crop production and min humidity, minimum temp, total could are negative effect on crop production of soybean. The fitted multiple linear regression model of parameter estimate by using least square regression method. result show that value of multiple R-square of Later and Hingoli district are 0.921 and 0.90 respectively this indicate that fitted model can explain more variability of repressors variable. The Cobb-Douglas stochastic frontier model is applied to Latur and Hingoli of soybean crop production for measure production efficiency. The result show that efficiency of Latur and Hingoli district are 0.86 and 0.84 respectively This result indicates that 86%and 84% of total composed error variance of the production function is explained by the variance of the technical inefficiency term. The estimated coefficients of all the parameters of production function of rainfall, area, max. temp, total could cover are positive there is positive effect on soybean crop production and other is negative effect on soybean crop production.

The value Coelli's test H0: γ= 0, which gives the value of gamma testing the hypothesis to check stochastic noise and there is no technical inefficiency. The statistics value of likelihood ratio test is Pr(>|χ2|) ≥ 0=0.0118 which implies to accept the null hypothesis that there is no production inefficiency of soybean production due to climates change in Marathwada region. This study is help farmers in making decision concerning with their crop & regional and local plan they depend on rainfall of Marathwada region

References

1. Aigner DJ, Lovell CAK, Schmidt P. Formulation and Estimation of Stochastic Frontier Production Function Models, Journal of Econometrics. 1977.
2. Abramovitz M. Resource and output trends in the united states since 1870, American Economic Review. 1956; 46:5–23.
3. Afriat SN. Efficiency estimation of production functions, International Economic Review 13, Oct, 1972, 568-598
4. Battese GE, Coelli TJ. A Stochastic Frontier production Function Incorporating a Model for Technical Inefficiency Effects, Working Paper in Econometrics and Applied Statistics, No.69, Department of Econometrics, University of New England, Armindale. 1993.
5. Coelli T. Estimators and hypothesis tests for a stochastic frontier function: A Monte carol analysis, Journal of Productivity Analysis. 1995; 6:247-268.
6. Coelli TJ. Battese GE. Identification of Factors which Influence the technical inefficiency of Indian Farmers. Australian Journal of Agricultural Economics. 1996; 40(2):103-128.
7. Coelli VJ. Guide to Frontier Version 4.1: A Computer Programmed for Stochastic Frontier Production and Cost Function Estimation, Department of Economics, University of New England, Armanda, Australia. 1996
8. Constantin PD, Martin LM, Rivera EBBR. Cobb-Douglas, Translog Stochastic Production Function and Data Envelopment... Journal of Operations and Supply Chain.
9. Díaz-Mayans MA, Sánchez R. Temporary employment and technical efficiency in Spain, International Journal of Manpower. 2004; 25(2):181-194.

10. Farrell MJ. The measurement of productive efficiency, Journal of the Royal Statistical Society (A, general) 120, pt. 1957; 3:253-281.
11. Ngwenya, S, Battese GE, Fleming EM. The Relationship between Farm Size and Technical Inefficiency of Production of Wheat Farmers in Eastern Orange Free State, South Africa, Agrekon (South Africa), FAO, 1997.
12. Schmidt P, Lovell, CAK. Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers. Journal of Econometrics North-Holland 1979; 9:343-366.
13. Paulo Dutra Constantin, Diogenes Leiva Martin, Edward Bernard Bastiaan de Rivera Y Rivera, Cobb-Douglas. Translog Stochastic Production Function and Data Envelopment Analysis in Total Factor Productivity in Brazilian Agribusiness, the flagship research journal of international conference of the production and operations management society, 2009, 2(2).
14. Racsko P, Szeidl L, Semenov L. A serial approach to local stochastic weather models. Ecological Modelling. 1991; 57:27-41.
15. Robert M. Solow A Contribution to the Theory of Economic Growth The Quarterly Journal of Economics. 1956; 70(1):65-94.
16. Koop G, Osiewalski J, Steel M. The component of output growth: A stochastic frontier analysis, Oxford Bulletin of Economics and Statistics 1999; 61:455-487.
17. Kim Y. Schmidt P. A review and empirical comparison of Bayesian and classical approaches to inference on efficiency levels in stochastic frontier models with panel data, Journal of Productivity Analysis 2000; 14:91-118.
18. Kumbhakar S, Lovell C. Stochastic Frontier Analysis, Cambridge University Press, Cambridge, 2000.
19. Satyvan Yashwant, Sananse SL. Comparing Neural Network and Multiple Regressions Models to Estimate Monthly Rainfall Data, International Journal of Science and Research (IJSR). 2015, 4(12).
20. William H. GREENE maximum likelihood estimation of econometric frontier functions Journal of Econometrics. 1980; 1327-56.
21. www.mahaagri.gov.in
22. www.imd.gov.in