IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
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Stepwise Regression Analysis on Paddy Production in Manipur

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Abstract

Manipur is in north eastern part of India and internationally boundering state with Myanmar. Rice is staple food. The economy coming from rice crop production generates income of the people for their livelihood mainly and has a major contribution to NSDP. Hence, the contributing factors, for enhancing in the rice production, have to be identified so as to gear up the sustainable development in the state. The aim is to identify the factors of rice crop with reference to various agro-climatic, socio-economic, and topographical conditions of Manipur. Under a stratified two- stage sampling design, cross-sectional primary data is collected and stepwise regression analysis was followed by proposing a statistical model. The model fits the data well and diagnostic checks confirmed that the data do not contradict the general underlying assumptions about the model. By the value of R=0.907(before) and R=0.925(after) application of stepwise regression process respectively indicates that 90.7 percent (before) and 92.5 percent (after) of variation in the yield is explained by the independent variable under consideration.

Key words: step-wise regression, Manipur, cross sectional data, statistical model

1. Introduction

The yield figure of crops may be considered as the combined and collective contribution of the factors that influenced the crop production. The collective influence of these production factors cannot be systematically arranged and properly managed. As such when one factor decrease while some other factors remain constant. Therefore, the behavioural nature of these factors influencing the crop yields is not predictable in general. Few workers who have carried out the work taking some general factors influencing the crop productivity are worth mention (Parikh and Mosley, 1986; Mohapatra et al,1996; Rajinder Kaur and Sekarwar 1997; and Loidang et al, 2004).

Manipur, having different topographic, socio-economic and agro-climatic conditions which is in snail's faceas far as the agricultural development is concerned.The problem to be considered,particularly the agriculture,is supposed to be handled and dealt with in the light of the prevailing conditions and factors of the state. Due to lack of manpower and scientific and technological facilities, systematic and periodical reliable data cannot be found. Consequently, many relevant data cannot be properly utilized and identified in this region. For instance, scientific irrigation facility is almost nil in Manipur.

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And hence, these existing models cannot appropriately be applied and used in the above context. Accordingly, the existing models had to be modified, to suit the prevailing conditions of this region as well as to enable us to carry out formal mathematical analysis using relevant and sophisticated data. In view of these consideration, a reasonably justifiable and workable mathematical model that fulfills the essentialities, have been developed.

2. Model

The statistical model proposed for the production of rice in the Union State of Manipur is

$$Y_i = C\prod_{j=1}^{p} X_{ij}^{b_{ij}} e^{e_i}; \quad i = 1,2, \ldots\ldots, n; \qquad \text{(A)}$$

$j = 1,2, \ldots\ldots., p$

which, by taking logarithm, may equivalently be given as

$$\log_e Y_i = b_{io} + \sum_{j=i}^{p} b_{ij} \log_e X_{ij} + e^{ei}, \qquad \text{(B)}$$

$i = 1,2, \ldots.., n$

$j = 1,2, \ldots\ldots, p.$

where, Y_i = Yield of the i^{th} farm,

X_{i1} = Age of the i^{th} farmers,

X_{i2} = Year of schooling of the i^{th} farmer,

X_{i3} = Size of the family for the i^{th} farmer,

X_{i4} = Area under tenant operated by the i^{th} farmer in hectare,

X_{i5} = Area under owner operated by the i^{th} farmer in hectare,

X_{i6} = Area under double cropping of the i^{th} farmer.

X_{i7} = Irrigated area of the i^{th} farmer (if any), in hectare,

X_{i8} = Quantity of fertilizers consumed by the i^{th} farmer, in kilograms,

X_{i9} = Area under modern High-Yielding Variety in the i^{th} farm, in hectare,

X_{i10} = 1, if the soil of the i^{th} farmer has been tested.

= 0, otherwise

X_{i11} = Quantity of farmyard manure applied to the i^{th} farm (per load of bullockcart).

X_{i12} = Distance of market centre from the i^{th} farmer's residence (house),

X_{i13} = Amount of credit, if any,

X_{i14} = Cost of cultivation without fertilizer cost for the i^{th} farmer,

X_{i15} = Monthly family income of the i^{th} farmer,

X_{i16} = Price of fertilizers used by the i^{th} farmer.

b_{i0} = constants, b_{ij} = regression co-efficients,

ε_i = error components which are assumed to be independently and identically distributed N(0,1).

3. Method of Analysis

(a). The Sampling Frame:

To fit the model, we collect the cross-sectional data by preparing a pre-designated questionnaire method is used. The sampling design of this crop survey is a stratified two stage sampling scheme of equal size suggested by Cochran (1977). With the blocks of the

ISSN PRINT 2319 1775 Online 2320 7876
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Imphal-west district as strata, villages in the blocks as the primary sampling unit and farmers of experimental site of the selected villages as the ultimate second stage sampling unit. The data used in this study were from the survey of 795 farms in 43 villages.

(b). Techniques applied:

The model is fitted by the ordinary least squares method. And for testing the hypotheses, student's t and Snedecor's F statistics were found useful in the regression analysis and analysis of variance that followed. For detecting and removing the superfluous observations in the data, we apply the filtration procedure which runs as follows. If -3≤ studentized residual ≤+3, the observation is counted in the analysis, if not, remove it.

For diagnostic checking, histograms, normal probability plot curves, scatter plots, etc., techniques and many other criteria, viz., tolerance limits, and VIF (Variance Inflation Factor), are also computed and examined for the models so that as formal claim as a good fit may be made for the model.

4. Analysis and Results

The production model performed has been

$$\log_e Y_i = b_{i0} + \sum_{j=1}^{16} b_{ij} \log X_{ij}; \quad i = 1, 2, \ldots\ldots.., 795; \qquad (C)$$

$$j = 1, 2, \ldots\ldots\ldots, 16.$$

where symbols have their usual meaning defined in the model equation (B)

TABLE – 1
Multiple Correlation co-efficient (R), F-statistic and Durbin-Watson (d) statistic

R	R Square	Adjusted R Square	F Change	df1	df2	Durbin-Watson
.907	.823	.819	225.564*	16	776	1.686

* indicates significances.

TABLE – 2
ANOVA

	Sum of Squares	df	Mean Square	F
Regression	137.650	16	8.603	225.564*
Residual	29.597	776	3.814E-02	
Total	167.247	792		

* indicates significance

Since the calculated F-value namely 225.564 is highly significant, we reject the null hypothesis that the b_{ij}'s are zero at the 0.01 probability level of significance even. Hence, each Y_i can be predicted by the X_{ij}'s accurately.

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ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 10, Iss 06, 2021

TABLE – 3
Coefficients, t-statistic, Collinearity Statistics

	Unstandardized Coefficients	**t**	**Collinearity Statistics**	
	B		Tolerance	VIF
(Constant)	-1.796	-11.368		
X_{i1}	2.657E-02	.875	.810	1.235
X_{i2}	8.958E-04	.118	.775	1.291
X_{i3}	4.043E-02	1.681	.886	1.129
X_{i4}	.280	13.081*	.310	3.221
X_{i5}	.290	13.893*	.282	3.551
X_{i6}	.106	2.736*	.848	1.179
X_{i7}	3.674E-03	.325	.853	1.172
X_{i8}	9.033E-02	3.139*	.091	10.987
X_{i9}	.152	7.798*	.471	2.122
X_{i10}	.155	2.158*	.979	1.021
X_{i11}	3.631E-02	4.414*	.905	1.105
X_{i12}	1.241E-02	1.208	.881	1.135
X_{i13}	4.333E-03	.621	.989	1.011
X_{i14}	8.849E-02	7.395*	.517	1.935
X_{i15}	6.862E-02	8.396*	.762	1.312
X_{i16}	6.224E-02	2.415*	01.3	9.699

* indicates significances.

It is thus found that majority of the regression co-efficients, namely those of X_{i4}, X_{i5}, X_{i6}, X_{i8}, X_{i9}, X_{i10}, X_{i11}, X_{i14}, X_{i15}, X_{i16} are significant while the remaining are found insignificant. So, it confirms that the linearity condition between Y_i and X_{ij}'s and $\forall$ j, as embodied by the model may reasonably be assumed.

Next, applying the techniques of variable selection and filtration, we get the following results and discussions.

TABLE -4

Multiple Correlation co-efficient (R), F-statistic and Durbin-Watson (d) statistic

	R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
Model				
1	.790	.625	.624	.2769
2	.847	.717	.716	.2407
3	.865	.749	.748	.2269
4	.881	.777	.776	.2139
5	.887	.787	.786	.2089

IJFANS International Journal of Food And Nutritional Sciences
Official Publication of International Association of Food and Nutrition Scientists

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 10, Iss 06, 2021

6	.920	.847	.846	.1773
7	.922	.850	.849	.1758
8	.924	.853	.852	.1740
9	.925	.855	.853	.1731
10	.925	.856	.854	.1724

Contd./-…

Change Statistics					**Durbin-Watson**
R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**	
.625	1304.620	1	784	.000	
.092	254.253	1	783	.000	
.032	99.402	1	782	.000	
.028	98.955	1	781	.000	
.011	38.819	1	780	.000	
.060	303.949	1	779	.000	
.003	14.291	1	778	.000	
.003	17.308	1	777	.000	
.002	8.643	1	776	.003	
.001	7.473	1	775	.006	1.713

a Predictors: (Constant), X_{i8}

b Predictors: (Constant), X_{i8}, X_{i9}

c Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}

d Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}

e Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}

f Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}

g Predictors: (Constant) X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}

h Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}

i Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}, X_{i16}

j Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}, X_{i16}, X_{i10}

k Dependent Variable: Y_I

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ISSN PRINT 2319 1775 Online 2320 7876
Research Paper Journal Volume 10, Iss 06, 2021

TABLE – 5

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	100.010	1	100.010	1304.620	.000
	Residual	60.100	784	7.666E-02		
	Total	160.110	785			
2	Regression	114.742	2	57.371	990.150	.000
	Residual	45.368	783	5.794E-02		
	Total	160.110	783			
3	Regression	119.858	3	39.953	776.191	.000
	Residual	40.252	782	5.147E-02		
	Total	160.110	785			
4	Regression	124.385	4	31.096	679.803	.000
	Residual	35.725	781	4.574E-02		
	Total	160.110	785			
5	Regression	126.078	5	25.216	577.941	.000
	Residual	34.032	780	4.363E-02		
	Total	160.110	785			
6	Regression	135.630	6	22.605	719.334	.000
	Residual	24.480	779	3.142E-02		
	Total	160.110	785			
7	Regression	136.072	7	19.439	629.133	.000
	Residual	24.038	778	3.090E-02		
	Total	160.110	785			
8	Regression	136.595	8	17.074	564.194	.000
	Residual	23.515	777	3.026E-02		
	Total	160.110	785			
9	Regression	136.854	9	15.206	507.399	.000
	Residual	23.256	776	2.997E-02		
	Total	160.110	785			
10	Regression	137.077	10	13.708	461.215	.000
	Residual	23.034	775	2.972E-02		

	Total	160.110	785			

a Predictors: (Constant), X_{i8}

b Predictors: (Constant), X_{i8}, X_{i9}

c Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}

d Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}

e Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}

f Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}

g Predictors: (Constant) X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}

h Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}

i Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}, X_{i16}

j Predictors: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}, X_{i16}, X_{i10}

k Dependent Variable: Y_I

Since the value of the multiple correlation coefficient (R) between dependent variable (on one side) and the set of independent variables (X_{ij}'s) (on the other side) is converged and residual sum of squares decrease, the model obtained at the 9th step will be recommended for selection accordingly.

Since the calculated F value, namely 507.399 when compared with the corresponding table value of F for 9 and 776 degree of freedom at 5 per cent level, is significant, we reject the null hypothesis. Hence, Y_i can be predicted accurately by using the X_{ij}'s.

TABLE – 6

Coefficients

		Unstandardized Coefficients		**t**	**Sig.**	**Collinearity Statistics**	
Model		**B**	**Std. Error**			**Tolerance**	**VIF**
1	(Constant)	-1.075	.062	-17.250	.000		
	X_{i8}	.448	.012	36.120	.000	1.000	1.000
2	(Constant)	-.730	.058	-12.512	.000		
	X_{i8}	.313	.014	22.850	.000	.619	1.615
	X_{i9}	.338	.021	15.945	.000	.619	1.615
3	(Constant)	-1.317	.081	-16.346	.000		
	X_{i8}	.282	.013	21.271	.000	.586	1.707

	X_{i9}	.317	.020	15.797	.000	.613	1.633
	X_{i15}	8.957E-02	.009	9.970	.000	.863	1.159
4	(Constant)	-2.075	.108	-19.287	.000		
	X_{i8}	.225	.014	16.309	.000	.483	2.071
	X_{i9}	.264	.020	13.459	.000	.568	1.760
	X_{i15}	8.700E-02	.008	10.269	.000	.862	1.160
	X_{i14}	.126	.013	9.948	.000	.562	1.781

5	(Constant)	-1.929	.108	-17.914	.000		
	X_{i8}	.221	.013	16.380	.000	.482	2.076
	X_{i9}	.240	.020	12.283	.000	.546	1.831
	X_{i15}	7.856E-02	.008	9.370	.000	.840	1.191
	X_{i14}	.116	.012	9.278	.000	.552	1.812
	X_{i5}	8.735E-02	.014	6.230	.000	.780	1.282
6	(Constant)	-1.273	.099	-12.880	.000		
	X_{i8}	.129	.013	10.235	.000	.397	2.517
	X_{i9}	.130	.018	7.348	.000	.477	2.095
	X_{i15}	5.704E-02	.007	7.898	.000	.815	1.227
	X_{i14}	8.263E-02	.011	7.693	.000	.535	1.870
	X_{i5}	.403	.022	18.603	.000	.235	4.258
	X_{i4}	.373	.021	17.434	.000	.273	3.666
7	(Constant)	-1.286	.098	-13.118	.000		
	X_{i8}	.128	.012	10.262	.000	.397	2.518
	X_{i9}	.122	.018	6.893	.000	.470	2.127
	X_{i15}	5.799E-02	.007	8.093	.000	.814	1.228
	X_{i14}	8.346E-02	.011	7.834	.000	.535	1.871
	X_{i5}	.399	.022	18.545	.000	.234	4.269
	X_{i4}	.373	.021	17.592	.000	.273	3.666
	Xi11	2.742E-02	.007	3.780	.000	.949	1.053
8	(Constant)	-1.240	.098	-12.690	.000		
	X_{i8}	.125	.012	10.133	.000	.396	2.525
	X_{i9}	.113	.018	6.382	.000	.463	2.161
	X_{i15}	5.920E-02	.007	8.340	.000	.813	1.230

	X_{i14}	7.673E-02	.011	7.193	.000	.522	1.915
	X_{i5}	.413	.022	19.153	.000	.229	4.370
	X_{i4}	.392	.021	18.251	.000	.261	3.828
	X_{i11}	3.125E-02	.007	4.318	.000	.934	1.071
	X_{i6}	.139	.033	4.160	.000	.916	1.091
9	(Constant)	-1.374	.107	-12.790	.000		
	X_{i8}	5.942E-02	.026	2.320	.021	.092	10.913
	X_{i9}	.110	.018	6.251	.000	.461	2.167
	X_{i15}	5.845E-02	.007	8.270	.000	.812	1.232
	X_{i14}	7.669E-02	.011	7.225	.000	.522	1.915
	X_{i5}	.415	.021	19.349	.000	.228	4.377
	X_{i4}	.393	.021	18.399	.000	.261	3.830
	X_{i11}	3.071E-02	.007	4.262	.000	.933	1.071
	X_{i6}	.146	.033	4.371	.000	.912	1.096
	X_{i16}	6.704E-02	.023	2.940	.003	.105	9.513

a Dependent Variable: Y_I

The coefficients obtained from model 9 are all found significant and this supports the assumption of linearity between the Yi's and the Xij's and $\forall\ j's$.

The scatter diagram, Figure- III also confirms the absence of heteroscedasticity of variances of all the residuals.

In Table 4 we see that the value of the Durbin-Watson statistic is 1.713 which is very close to 2. It thus speaks of the fast that the residuals are independent.

The Normal Probability Plot of Standardized Residuals, given in Figure-II, indicates that the residuals follow a joint normal distribution which means that the data are drawn from a normal population. It can be noticed from Table 6 (Co-efficients) that all the tolerance limits for the regression coefficients are less than 0.01 and the variance inflation factor (VIF) is not greater than 100. Therefore, it may be inferred that multicollinearity is absent.

The histogram shown in Figure -I, clearly depicts strong evidence of supporting the normal density function. It indicates that the data are drawn from a normal distribution.

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
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TABLE – 7

Excluded Variables

		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
Model						**Tolerance**	**VIF**	**Minimum Tolerance**
1	X_{i6}	.034	1.530	.126	.055	.997	1.003	.997
	X_{i16}	.145	2.169	.030	.077	.106	9.414	.106
	X_{i9}	.385	15.945	.000	.495	.619	1.615	.619
	X_{i10}	.056	2.591	.010	.092	1.000	1.000	1.000
	X_{i11}	.103	4.717	.000	.166	.982	1.019	.982
	X_{i14}	.320	12.495	.000	.408	.608	1.646	.608
	X_{i15}	.224	10.163	.000	.341	.872	1.146	.872
	X_{i4}	.053	2.310	.021	.082	.909	1.100	.909
	X_{i5}	.239	10.927	.000	.364	.870	1.149	.870
2	X_{i6}	.011	.570	.569	.020	.991	1.009	.616
	X_{i16}	.106	1.822	.069	.065	.106	9.430	.101
	X_{i10}	.047	2.488	.013	.089	.999	1.001	.619
	X_{i11}	.058	2.976	.003	.106	.959	1.043	.605
	X_{i14}	.231	9.641	.000	.326	.562	1.779	.502
	X_{i15}	.192	9.970	.000	.336	.863	1.159	.586
	X_{i4}	.041	2.040	.042	.073	.908	1.102	.589
	X_{i5}	.168	8.315	.000	.285	.816	1.226	.580
3	X_{i6}	.022	1.241	.215	.044	.987	1.013	.586
	X_{i16}	.090	1.634	.103	.058	.106	9.439	.101
	X_{i10}	.044	2.475	.014	.088	.999	1.001	.586
	X_{i11}	.061	3.374	.001	.120	.958	1.043	.586
	X_{i14}	.224	9.948	.000	.335	.562	1.781	.483
	X_{i4}	.048	2.577	.010	.092	.906	1.104	.557
	X_{i5}	.139	7.137	.000	.247	.794	1.260	.578
4	X_{i6}	.002	.111	.912	.004	.973	1.028	.482
	X_{i16}	.099	1.901	.058	.068	.106	9.442	9.685E-02
	X_{i10}	.035	2.043	.041	.073	.995	1.005	.482
	X_{i11}	.063	3.671	.000	.130	.958	1.043	.483
	X_{i4}	.050	2.856	.004	.102	.906	1.104	.462
	X_{i5}	.116	6.230	.000	.218	.780	1.282	.482
5	X_{i6}	-.001	-.054	.957	-.002	.972	1.029	.481

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	X_{i16}	.112	2.202	.028	.079	.106	9.457	9.653E-02
	X_{i10}	.030	1.810	.071	.065	.993	1.007	.481
	X_{i11}	.053	3.161	.002	.113	.949	1.053	.482
	X_{i1}	.468	17.434	.000	.530	.273	3.666	.235
6	X_{i6}	.052	3.600	.000	.128	.931	1.074	.229
	X_{i16}	.117	2.726	.007	.097	.106	9.457	9.235E-02
	X_{i10}	.039	2.756	.006	.098	.992	1.008	.235
	X_{i11}	.054	3.780	.000	.134	.949	1.053	.234
7	X_{i6}	.060	4.160	.000	.148	.916	1.091	.229
	X_{i16}	.112	2.619	.009	.094	.106	9.469	9.230E-02
	X_{i10}	.037	2.690	.007	.096	.991	1.009	.234
8	X_{i16}	.124	2.940	.003	.105	.105	9.513	9.163E-02
	X_{i10}	.038	2.732	.006	.098	.991	1.009	.229
9	X_{i10}	.037	2.734	.006	.098	.991	1.009	9.162E-02

a Predictors in the Model: (Constant), X_{i8}

b Predictors in the Model: (Constant), X_{i8}, X_{i9}

c Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}

d Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}

e Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}

f Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}

g Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}

h Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}

i Predictors in the Model: (Constant), X_{i8}, X_{i9}, X_{i15}, X_{i14}, X_{i5}, X_{i4}, X_{i11}, X_{i6}, X_{i16}

j Dependent Variable: Y_I

Let us recall that some variables are loaded with insignificant coefficients, and that each variables with almost zero-coefficients may well be removed. The table above shows such variables being removed step by step.

TABLE – 8

Casewise Diagnostics

Case Number	Std. Residual	Y_I	Predicted Value	Residual
56	-3.318	1.14	1.7098	-.5720
121	3.100	1.86	1.3218	.5345
164	-3.218	1.36	1.9106	-.5548
656	-3.430	.59	1.1790	-.5913
697	-3.352	.54	1.1203	-.5779
741	-3.428	.75	1.3423	-.5909

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a Dependent Variable: Y_I

As evident from Table-8 above, the case 56,121,164, 656,697,741 are the outliers which are the observations that appear inconsistent with the remainder of the data set.

TABLE – 9

Residuals Statistics

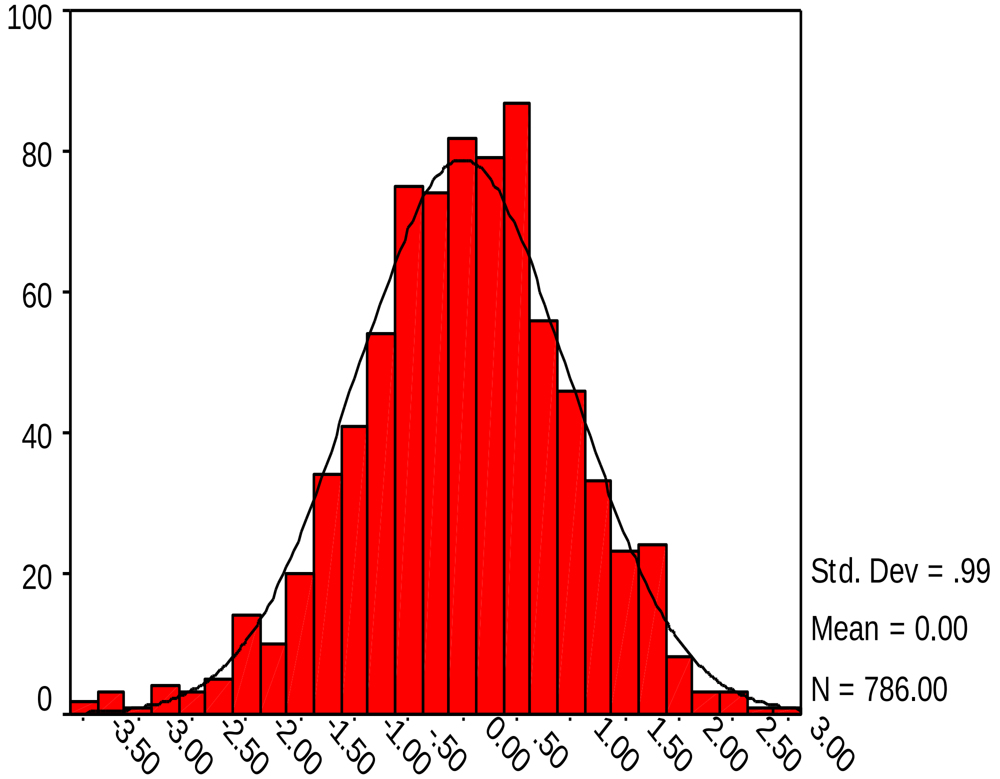
	Minimum	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2.783E-02	2.4138	1.1473	.4179	786
Std. Predicted Value	-2.679	3.031	.000	1.000	786
Standard Error of Predicted Value	7.603E-03	8.226E-02	1.867E-02	8.224E-03	786
Adjusted Predicted Value	2.292E-02	2.4094	1.1471	.4180	786
Residual	-.5913	.5345	-1.7993E-15	.1713	786
Std. Residual	-3.430	3.100	.000	.994	786
Stud. Residual	-3.440	3.114	.000	1.002	786
Deleted Residual	-.6068	.5391	1.090E-04	.1743	786
Stud. Deleted Residual	-3.464	3.131	.000	1.004	786
Mahal. Distance	.528	177.724	9.987	13.326	786
Cook's Distance	.000	.096	.002	.005	786
Centered Leverage Value	.001	.226	.013	.017	786

a Dependent Variable: Y_I

From Table-9, one may easily see the minimum and maximum values of the namely predicted value (of the observation) contained in the considered data, residual, Cook’s distance, centered leverage values, etc., which explain some information of the observations contained in the considered data and used in the analysis.

Histogram

Dependent Variable: YI



Regression Standardized Residual

FIG. - I

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NORMAL PROB. PLOT OF REGRESSION STANDARDIZED

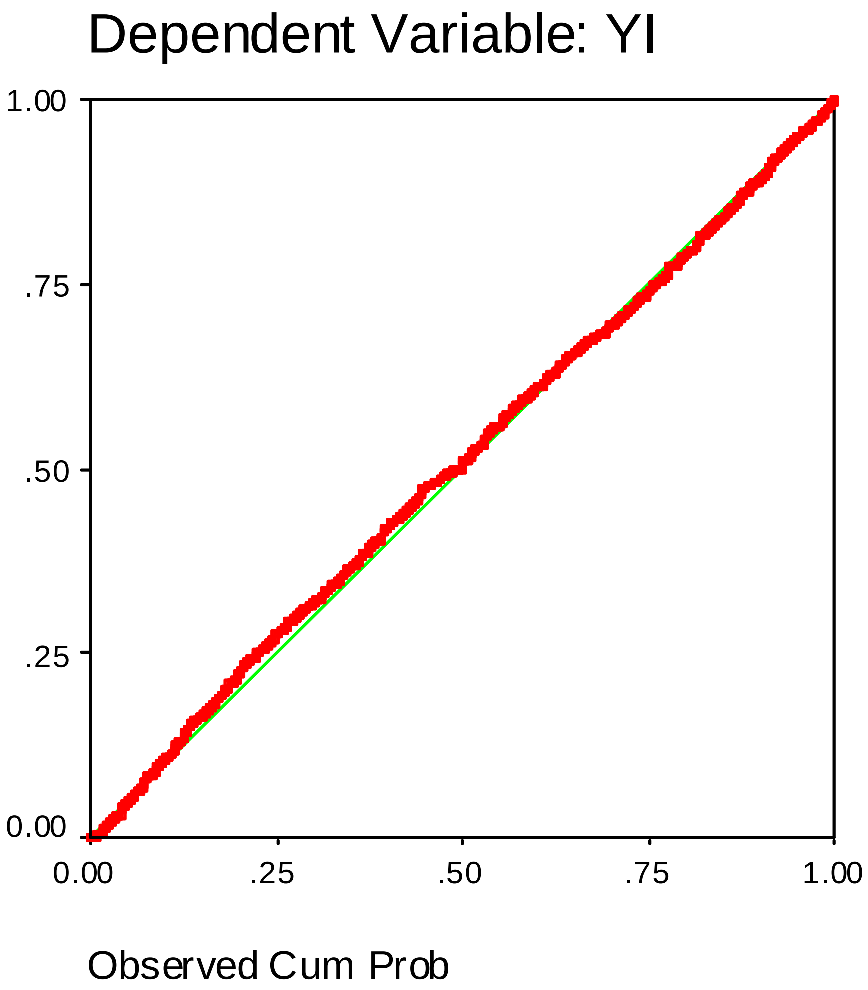

FIG. - II

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ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 10, Iss 06, 2021

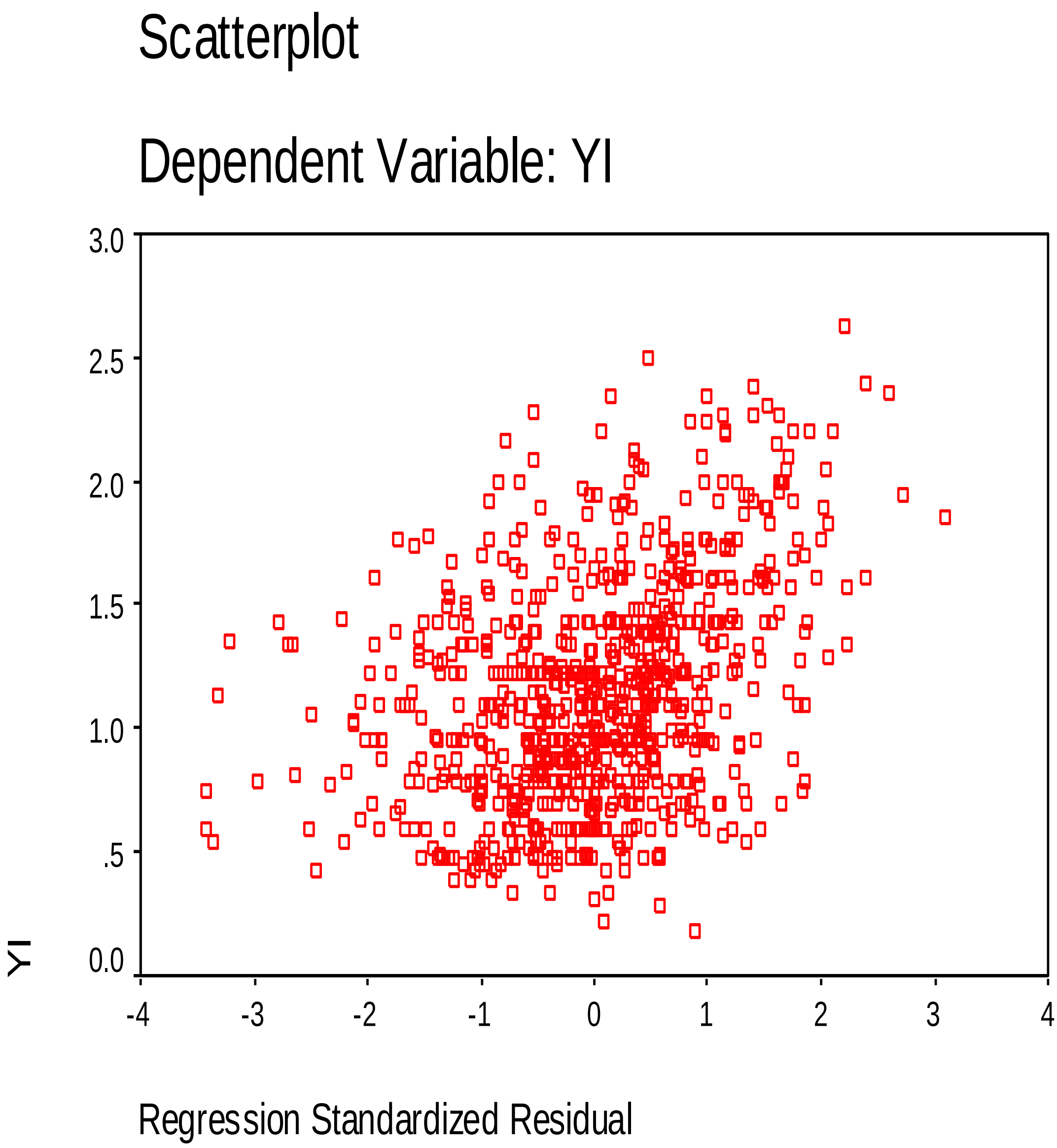

FIG. - III

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5. Conclusions

All the assumptions and criteria laid down are found fulfilled and satisfied by the proposed models. Thus, the testing of the above hypothesis and diagnostic checks confirm that the models fit the data well.

The considered independent variables could predicts the values of the dependent variables. For the model, it was R = 0.907(before) and R=0.925(after) the application of stepwise regression respectively, meaning that out of the total variation, 90.7 and 92.5 percent could be explained by the independent variables.

An interesting observation is that the elasticity of price was found inelastic (it was pointed out by the (+) ve sign of the regression co-efficient of price).

To be precise, the following had been either experienced or observed:

(1) Fertilizers, as it is generally expected, have as significant effect on the yield. This finding along with the farmer's wailings for inadequate amount of fertilizers serves a pointer to the fact that, even though we did achieve substantial progress through special programmes for developing small form agriculture, there exists further scope to increase utilization of fertilizers. So, it demands for opening more fertilizer cells and sale branches in the state.

(2) Cropping pattern also substantially influences the increase of production. This suggests that more and more portion of cultivable area must be allowed to enter under this pattern, if possible so that the production rapidly increases.

(3) Price of fertilizers is found inelastic (as indicated by the (+) ve sign). This means that consumption of fertilizers in Manipur cannot be influenced by their prices and hence it may be asserted that the policies affecting fertilizer prices are not likely to have serious impact on the growth of the agricultural sector and on the economy if the prices are not allowed to change drastically.

(4) This study also suggests that HYV's be sown on a larger scale and more and more area be brought under this to boost crop yield. For this, infrastructural facilities are indispensable in Manipur.

This is concerned with crop estimation practices (for plannings and policy makings). The findings point out that the models may be used as crop production model in the region.

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