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INFERENTIAL STUDY OF FERTILIZERS PERTAINING TO PRODUCTION, IMPORT AND CONSUMPTION IN CONTEXT OF INDIAN DATA

I. INTRODUCTION

Major part of the Indian population resides in the rural region of the country. Agriculture is unquestionably the greatest source of livelihood in India. Not only that, but agriculture plays a great role in the Gross Domestic product (GDP) of Indian Economy. Sustainable development is a need of time. Employment in rural India, Food security, Water and Soil conservation, Environmentally sustainable technology, optimum use of natural resources are the hot issues of present time. With the rapidly growing population of India it has become essential to increase the agricultural production. In agriculture production fertilizers play crucial role. Need of fertilizers can be fulfilled either by producing them in the country or by importing from other countries. Consumption of fertilizers effects on the fertility of soil and quality of soil. Since agriculture has a bigger role in Economy consumption of fertilizers also plays significant role in the GDP. Therefore it is essential to analyze the pattern of sources of fertilizers over the time.

In this paper an attempt has been made to study the relation between types of fertilizers, consumptions and import over the passage of time. Section-II is about the Database considered for the study. In Section-III Methodology is discussed. Analysis work has been carried out in section-IV which includes Regression analysis and Analysis of Variance (ANOVA). Section-V contains graphs related to comparative study of types of fertilizers and theirs sources. Conclusions based on our analysis are given in section-VI.

II. DATABASE

For the analysis work secondary data have been considered which are being published year to year by Government of India by means of Economic Surveys. Projections are made on the basis of suitable models.

Table 1.1 : Production, Imports and Consumption of Fertilizers (Thousand tonnes of nutrients)

		1970-71	1980-81	1990-91	2000-01	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15 (Apr.-Dec.) 2014)
	1	2	3	4	5	6	7	8	9	10	11	12	13
A.	Nitrogenous fertilizers												
	Production	830	2164	6993	11004	10900	10870	11900	12157	12259	12194	12338	9386
	Imports	477	1510	414	154	3677	3844	3447	4493	5240	4801	3920	3579
	Consumption	1487	3678	7997	10920	14419	15090	15580	16558	17300	16821	16750	na
B.	Phosphatic fertilizers												
	Production	229	842	2052	3748	3807	3464	4321	4223	4104	3541	3714	2860
	Imports	32	452	1311	396	1391	2927	2756	3802	4427	2797	1588	1760
	Consumption	462	1214	3221	4215	5515	6506	7274	8050	7914	6653	5633	na
C.	Potassic fertilizers												
	Imports	120	797	1328	1541	2653	3380	2945	4069	3335	1559	1926	2076
	Consumption	228	624	1328	1567	2636	3313	3632	3514	2576	2062	2099	na
D.	All fertilizers (NPK)												
	Production	1059	3006	9045	14752	14707	14334	16221	16380	16363	15735	16092	12246
	Imports	629	2759	2758	2090	7721	10151	9148	12364	13002	9157	7434	7415
	Consumption	2177	5516	12546	19702	22570	24909	26486	28122	27790	25536	24482	na

Source : Department of Fertilizers , Ministry of Chemicals & Fertilizers.
n a : Not Available

III. METHODOLOGY

Linear regression models are fitted to analyze the data. Different variables and models are defined below.

Y_i = i^{th} dependent variable (i= 1,2,……..11)

X_i = i^{th} independent variable

Y_1= Nitrogeneous Fertilizer Production

Y_2 = Nitrogeneous Fertilizer Imports

Y_3 = Niterogenous Fertilzer Consumption

Y_4 = Phospatic Fertilizer Production

Y_5 = Phospatic Fertilizer Import

Y_6 = Phospatic Fertilizer Consumption

Y_7 = Potassic Fertilizer Import

Y_8 = Potassic Fertilizer Consumption

Y_9 = Total(NPK) Fertilizer Production

Y_{10} = Total(NPK) Fertilizer Import

Y_{11} = Total(NPK) Fertilizer Export

X_i = Time (i^{th} Financial year, e.g Year 1970-71$\Rightarrow X_1$=1970)

Linear regression models have been considered for the analysis and are discussed below.

LINEAR MODELS

$$\mathbf{Y_i = \alpha_i + \beta_i X_j + U_i} \qquad \text{where i= 1,2,…8.}$$

α_i = Intercept term for the model of i^{th} variable

β_i = Regression co-efficient for the model of i^{th} variable

U_i = Disturbance term

IV. ANALYSIS

Analysis work has been carried out as under for different variables of fertilizers as defined in previous section.

1. Nitrogeneous Fertilizer Production

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.982[a]	.965	.960	925.144

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	165796013.522	1	165796013.522	193.711	.000[b]
	Residual	5991244.034	7	855892.005		
	Total	171787257.556	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-564836.099	41237.564		13.697	.000
	Year	287.044	20.624	.982	13.918	.000

a. Dependent Variable: Nitrogeneous Fertilizer Production

2. Nitrogeneous Fertilizer Imports

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.790[a]	.623	.570	1356.192

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21315290.062	1	21315290.062	11.589	.011[b]
	Residual	12874805.938	7	1839257.991		
	Total	34190096.000	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-203069.221	60451.188		3.359	.012
	Year	102.922	30.233	.790	3.404	.011

a. Dependent Variable: Nitrogeneous Fertilizer Imports

3. Niterogenous Fertilzer Consumption

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.993[a]	.986	.984	782.739

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	300074998.964	1	300074998.964	489.775	.000[b]
	Residual	4288759.036	7	612679.862		
	Total	304363758.000	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-760223.624	34889.948		21.789	.000
	Year	386.169	17.449	.993	22.131	.000

a. Dependent Variable: Niterogenous Fertilzer Consumption

4. Phospatic Fertilizer Production

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.959[a]	.919	.907	469.774

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17505186.157	1	17505186.157	79.321	.000[b]
	Residual	1544814.732	7	220687.819		
	Total	19050000.889	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-183514.763	20939.808		8.764	.000
	Year	93.271	10.473	.959	8.906	.000

a. Dependent Variable: Phospatic Fertilizer Production

5. Phospatic Fertilizer Import

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.763[a]	.582	.523	1086.995

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11538573.737	1	11538573.737	9.766	.017[b]
	Residual	8270899.819	7	1181557.117		
	Total	19809473.556	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-149456.294	48451.907		3.085	.018
	Year	75.725	24.232	.763	3.125	.017

a. Dependent Variable: Phospatic Fertilizer Import

6. Phospatic Fertilizer Consumption

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.943[a]	.889	.874	1011.544

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57629108.485	1	57629108.485	56.321	.000[b]
	Residual	7162545.737	7	1023220.820		
	Total	64791654.222	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-333410.811	45088.750		7.395	.000
	Year	169.232	22.550	.943	7.505	.000

a. Dependent Variable: Phospatic Fertilizer Consumption

7. Potassic Fertilizer Import

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.777[a]	.603	.547	850.966

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7714797.186	1	7714797.186	10.654	.014[b]
	Residual	5069000.370	7	724142.910		
	Total	12783797.556	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-121845.923	37931.119		3.212	.015
	Year	61.919	18.970	.777	3.264	.014

a. Dependent Variable: Potassic Fertilizer Import

8. Potassic Fertilizer Consumption

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.844[a]	.713	.672	670.262

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7813507.179	1	7813507.179	17.392	.004[b]
	Residual	3144755.710	7	449250.816		
	Total	10958262.889	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-122634.322	29876.378		4.105	.005
	Year	62.314	14.942	.844	4.170	.004

a. Dependent Variable: Potassic Fertilizer Consumption

9. Total(NPK) Fertilizer Production

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.980[a]	.960	.954	1316.260

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	291459589.900	1	291459589.900	168.227	.000[b]
	Residual	12127776.322	7	1732539.475		
	Total	303587366.222	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-748885.197	58671.215		12.764	.000
	Year	380.585	29.343	.980	12.970	.000

a. Dependent Variable: Total(NPK) Fertilizer Production

10. Total(NPK) Fertilizer Import

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.824[a]	.679	.633	2819.501

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	117795118.358	1	117795118.358	14.818	.006[b]
	Residual	55647089.864	7	7949584.266		
	Total	173442208.222	8			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-477172.194	125676.976		3.797	.007
	Year	241.950	62.854	.824	3.849	.006

a. Dependent Variable: Total(NPK) Fertilizer Import

11. Total(NPK) Fertilizer Export

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.983[a]	.967	.962	1934.416

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	769866951.880	1	769866951.880	205.739	.000[b]
	Residual	26193747.675	7	3741963.954		
	Total	796060699.556	8			

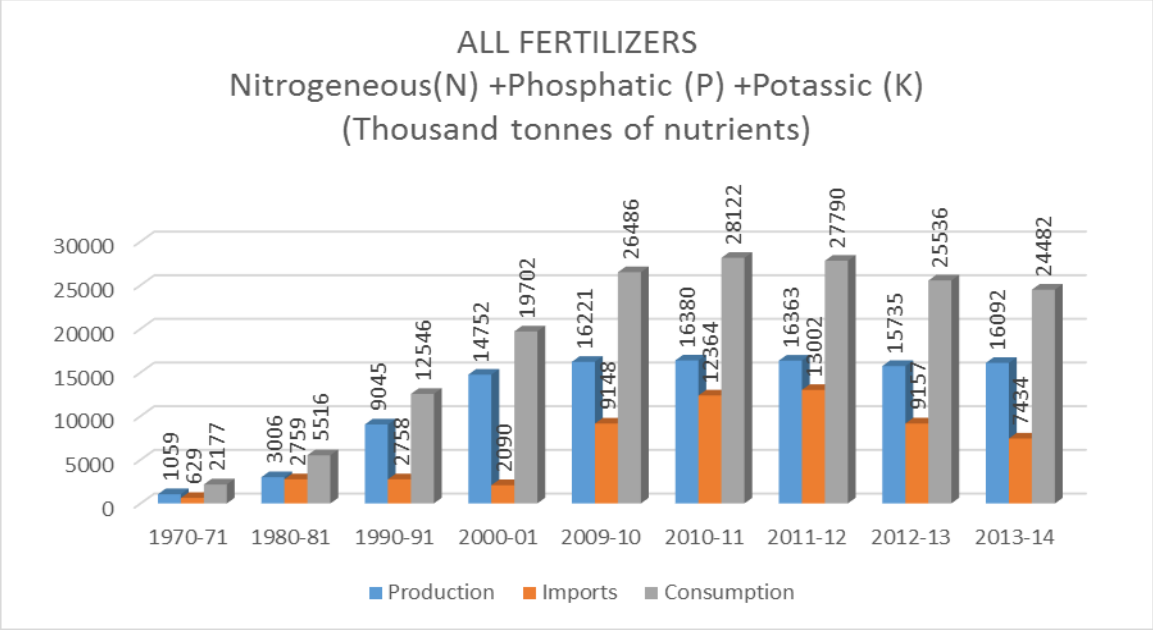
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1217591.507	86225.022		14.121	.000
	Year	618.543	43.123	.983	14.344	.000

a. Dependent Variable: Total(NPK) Fertilizer Export

V. GRAPHICAL REPRESENTATION

Figure 5.1



VI. CONCLUSIONS

On the basis of analysis carried-out in section-4 following conclusions have been derived.

1. A linear model is fitted for the Nitrogeneous Fertilizer **Production** against **Time(year)** where, Time (year) is considered as an independent variable and Production of Nitrogeneous Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 96% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.
2. A linear model is fitted for the Nitrogeneous Fertilizer **Imports** against **Time(year)** where, Time (year) is considered as an independent variable and Import of Nitrogeneous Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 62% of the variations is explained by the model. Also the values of t and F statistics are not significant thus the model fitted can not be considered appropriate.
3. A linear model is fitted for the Nitrogeneous Fertilizer **Consumption** against **Time(year)** where, Time (year) is considered as an independent variable and Consumption of Nitrogeneous Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 99% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.
4. A linear model is fitted for the Phospatic Fertilizer **Production** against **Time(year)** where, Time (year) is considered as an independent variable and Production of Phospatic Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 91% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.
5. A linear model is fitted for the Phospatic Fertilizer **Imports** against **Time(year)** where, Time (year) is considered as an independent variable and Import of Phospatic Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 58% of the variations is explained by the model. Also the values of t and F statistics are not significant thus the model fitted can not be considered appropriate.
6. A linear model is fitted for the Phospatic Fertilizer **Consumption** against **Time(year)** where, Time (year) is considered as an independent variable and Consumption of Phospatic Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost

89% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.

7. A linear model is fitted for the Potassic Fertilizer **Production** against **Time(year)** where, Time (year) is considered as an independent variable and Production of Potassic Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 60% of the variations is explained by the model. Also the values of t and F statistics are not significant thus the model fitted can not be considered appropriate.
8. A linear model is fitted for the Potassic Consumption **Imports** against **Time(year)** where, Time (year) is considered as an independent variable and Consumption of Potassic Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 71% of the variations is explained by the model. Also the values of t and F statistics are highly significant thus the model fitted can t be considered as an appropriate.
9. A linear model is fitted for the Total(NPK) Fertilizer **Production** against **Time(year)** where, Time (year) is considered as an independent variable and Production of Total(NPK) Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 96% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.
10. A linear model is fitted for the Total(NPK) Fertilizer **Import** against **Time(year)** where, Time (year) is considered as an independent variable and Import of Total(NPK) Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 68% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.
11. A linear model is fitted for the Total(NPK) Fertilizer **Export** against **Time(year)** where, Time (year) is considered as an independent variable and Export of Total(NPK) Fertilizer as a dependent variable. Parameters are estimated and Analysis of variance is carried-out. Here it is found that almost 97% of the variations is explained by the model. Also the values of t and F statistics are significant which shows that the model fitted is an appropriate.

VIII. ACKNOWLEDGEMENT

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