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Farm inputs and its contribution on crop production : a production function approach – a case study

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ABSTRACT

In the present study data for consumption of farm inputs and production value of various crops for 11 successive years were analysed to study the contribution of farm inputs on crop production. The compound annual growth rate for total value of production was 3 per cent and those for seed and fertilizer consumption were 4.2 and 1.59 per cent respectively. The compound annual growth rate of pesticide, farm implement, farm machinery and plant protection equipment were negative. Strong correlations were observed not only between the total crop production values with the farm inputs but also among the inputs resulting in multicollinearity among themselves. Principal component analysis identified two, components contributing 97.8 per cent variation. Functional form of production with the extracted two principal components showed that though fertilizer and pesticide had significant contribution towards crop production at 0.01level of significance other inputs have also substantial effect on crop output.

Key words: Compound growth rate, contribution to production of crops, farm inputs, multicollinearity and PCA

Inputs are material aspects of technology, application of which can increase the yield vis-à-vis income in an enterprise. The inputs mostly required for agricultural purposes are seed or seed materials, nutrients, water, protection chemicals, implements and machinery, power, credit and information as reported by Ray (1991).

Seed is the basic input which needs the maximum attention of the farmer for an increased crop production (Singh, 2006). Studies showed that the use of certified seeds contributed 10 per cent to production growth, and that there was 15 to 20 percent yield advantage in using hybrid seeds. (Anonymous, 2008). By the year, 2020, the World population is expected to be 8 billion (Anonymous, 2009). To feed this population, food grain production will have to increase from the current level. Intensification of the output on existing land must account for most of the growth, and the amount of fertilizer use will need to increase from 123 million tones of nutrients in 1994/95 to over 300 million tones in 2020 (Rengej, 1998). The use of pesticides helps to reduce crop losses, provide economic benefits to farmers and ensure food safety and security. As reported by Kumarasamy (2008) at present only about 20 per cent of the area gets crop protection; the remaining 80 per cent of the area in developing regions like Northeast India, rain fed areas, small holdings etc. do not receive any pesticides treatment The same report highlighted that our country is losing annually Rs. 1,40,000 crore worth of crops to insect pests, diseases and weeds (Kumarasamy 2008). If pesticides are used in extended area, we shall be able to save substantial part of this loss. Mechanization also enables efficient utilization of inputs such as seeds, fertilizers, irrigation water etc. An increase of 15 per cent in productivity and a reduction of 20 per cent in the cost of cultivation can be achieved by engineering interventions such as adoption of farm machinery, implements and equipments (Pandey, 2007). The role of agricultural inputs in crop production has been focused by many researchers (Hossain, 2000; Rajendran, 2003; Bhattacharjee, 2006; Pandey, 2007; Rajendra Pradas and Bhaskaran, 2008 and Kumarsamy, 2008). However, it is very much needed as to know whether all the agricultural inputs contribute significantly in production individually or collectively or not. With this pretext an attempt was made to study the significant contribution of farm inputs in crop production in South 24 Parganas district of West Bengal.

MATERIALS AND METHODS

South 24 Parganas district in West Bengal, located between 21° 26′ to 22° 38′ North latitude and 87° 57′ to 89° 09′ East longitude is characterized by its uniqueness. The famous Sundarban delta is included in the district. It is nearby to the State head quarter, both irrigated and rainfed farming are followed. As such wide range of crops are grown in the district. As a result the present study was purposively conducted in South 24 Pargans district of West Bengal. Information were collected personally from the Department of Agriculture, Department of Food Processing Industries and Horticulture, Office of the Principal Agricultural Officer (South 24 Parganas), Office of

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the District Marketing Officer (South 24 Parganas), Directorate of Animal Resources and Animal Health, Govt. of West Bengal as well as from West Bengal State Seed Corporation, West Bengal Agro Industries Corporation and other companies dealing with agricultural inputs with respect to consumption of various agricultural inputs and production of various crops for the last eleven successive years.Various web sites like www.wbfpih.org; http://banglarkrishi.nic.in; www. nhb. gov. in; www.faidelhi.org; http:// agricoop. nic. In /farmprices etc. were also consulted. Production value obtained for field crops, vegetable crops, fruits, flowers and plantation crops and seed, fertilizer, pesticide, and farm implement, farm machinery and plant protection equipment were selected for the study based on the experts' judgment considering the objectives of the study. Different descriptive statistics like coefficient of variation, correlation coefficients, principal component analysis etc were used to fulfill the objectives of the study. Among the competitive growth model the exponential type of model was found to give better R^2 value as such this model has been retained for calculation of growth rate. Compound growth rate = $(b_1 - 1) \times 100$ derived from the equation $Y_t = b_0 . b_1^t$; where Y_t = realized value of series at the time t and b_0, b_1 are the parameters of the equation. To study the technical relationship between the agricultural inputs in one hand and the outputs on the other hand widely used Cobb-Douglas type of production function $Y = aX_1^{b1}.X_2^{b2}.X_3^{b3}.X_4^{b4}..... e^u$; where, Y = Production output, X_1, X_2, X_3, X_4..... are the different agricultural inputs; b_1, b_2, b_3, b_4..... are the co-efficient of respective variables, a is constant and e^u = disturbance term, was used and estimated. The analyses were done using using SPSS statistical package.

RESULTS AND DISCUSSION

Consumption of various agricultural inputs for crop production

1. Field crop and vegetable seed consumption

In recent times, integration of the desired combination production parameters like – high yielding short duration, fertilizer responsive, insect-pest and disease resistance, moisture/ flood / saline/ drought resistance varieties have resulted a revolution in crop yields in the district under study as well as in the state. Certified and quality seeds of different crops are distributed to the farmers in the district under various programmes for which the use of quality seeds in the district is gradually increasing. But the total consumption of vegetable seeds has been decreased recently. This is possibly due to the fact that the farmers now-a-days are using hybrid seeds in raising important vegetables such as tomato, brinjal, lady's finger, beans, cole crops etc. and the requirement of hybrid seeds is comparatively less than the traditional seed to cover same area of vegetable crops. The coefficient of variation of vegetable is more (46.77 per cent) than the same of field crop seed (17.24 per cent) as depicted in table 1. CGR calculated separately for vegetable seed in one hand and for field crop seed on the other hand indicate that though the growth rate of field crop is positive in nature, that for vegetable crop is negative (4.7 and -9.83 per cent for field and vegetable crops respectively). The negative growth rate in vegetable seed is due to reason given above. The compound growth rate for the same is 4.20 per cent showing increasing trend in consumption of field crop seeds (Table 2 and Figure 1)

2. Fertilizer and pesticide consumption

Table 1 depicts that the C. V. of N.P.K. consumption is 9.67 per cent. The growth rate for chemical fertilizer consumption is 1.59 per cent showing somewhat increasing trend in consumption of chemical fertilizer in the district though the trend was erratic depending upon the supply (Figure 2). As outcome of various activities including promotion of IPM the pesticide consumption has been reduced thereby registering a compound growth rate of -3.41 per cent coupled with the C.V. percent of 12.95 per cent (Table 1). The slow growth rate in consumption of fertilizer, pesticide is because of the fact that use of inputs greatly depends on the use of irrigation and steady supply of all these inputs. During the study period not a major change has taken place in irrigation front. Couples with the fact that there has been lesser use of pesticide as a result of implementation of IPM practices during the period under study.

3. Utilization of farm implement, farm machinery and plant protection equipment

Table 1, depicts that the C.V. of country plough is 46.52 per cent showing a wide variation. The b_1 value for number of country plough is 0.7872 and the compound growth rate is -21.28 per cent due to drastic decrease in number of country plough over years (Figure 4). Mechanization has been recognized as a vehicle for removing the drudgery and increasing the level of farming so as to improve the life and work environment of farmers. The number of power tiller and tractors in the district has increased recording a compound growth rate of 3.49 per cent in use of these implements (Table 2 and Fig. 5). However, the total number of

implement, farm machinery and plant protection equipment has reduced because of the enhanced efficiency of the modern implements compared to conventional farm implements (Table 2 and Fig. 6).

Agricultural outputs

The production values of field crops, vegetable crops, fruits, flowers and plantation crops were taken to get the total value of agricultural production i.e. outputs. With the introduction of HYV of rice and wheat in mid sixties and with the creation of irrigation facilities and its expansion, the level of food grain production has been increased considerably since independence in this district in spite of erratic change in food production value. The C. V of field crop production value is 12.37 (Table 1). The b_1 value from production value of field crops is 1.0187 and accordingly the growth rate for the same is 1.87 per cent showing increasing trend in production value of field crops (Table 2 and Fig. 7).

The district produces significant quantities of traditional vegetables and which is increasing day by day resulting in the compound growth rate of 4.02 per cent as depicted in table 2 and figure 8.

The fruit production as well as its values are increasing gradually since 1997- 98 as depicted in figure 9. The C. V. of fruit production value is 16.95 per cent with compound growth rate of 5.24 per cent showing increasing trend in production value of fruits in the district (Table 2 and Figure 9).

The South 24 Parganas district also enjoys favourable situations to grow some of the high value exotic flowers like rose, tube rose and gladiolus etc. and the cultivation of seasonal flowers is increasing rapidly in this district since 2002-03. The C. V. of production value from flowers is 86.35 per cent showing high variation. The b_1 value from production of flower is 1.2267 and accordingly the growth rate for the same is 22.67 per cent showing increasing trend in production value of flowers in the district (Table 2 and Fig. 10).

The C. V. of production value from plantation crops is 12.85 per cent. The overall growth rate of values from all plantation crops in the district is 3.86 per cent (b_1=1.0386) showing increasing trend in production value of all plantation crops in the district (Fig. 11). The C. V. of production values from all crops is 11.99 per cent as depicted in table 1. The b_1 value from production value of all crops grown in 24 Parganas district of West Bengal is 1.030 and accordingly the growth rate for the same is 3.00 per cent showing increasing trend in production values of all crops (Table 2 and Fig. 12). Differential coefficient of variation among the parameter under study really reveals that there has been non-uniform changes with respect to different inputs and outputs. Value of the produce is the combined effect of the quantity produce and the unit price of the product. In the present study there has been smooth increase in value of the produce, particularly field crops. Out of the two components the study reveals that the growth in value of the produce is mainly attributed by the positive growth in current prices of the produce, not much significant improvement in per hectare production of the crop is recorded. On the contrary the productivity of the vegetables and flowers has increased along with the unit price of the crop, thereby resulting in the growth value the produce. Thus, the study suggests for immediate attention in enhancing the productivity as well as the production of field crops in the study area.

Correlation between farm inputs and production value of crops:

To judge the associationship between the individual inputs and outputs, correlation analysis was taken up. It is evident from table 3 that the independent variables had shown significant relationship with the total production value. However, the pesticide consumption and plant protection equipment, farm implement and machinery had negative relationship with the total production value. Due to modernization of agriculture with the help of increased modern implements and modern plant protection method like power tiller, tractor, IPM, INM etc., there has been drastic decrease in number of implements. For example, a tractor can plough the amount of land which could have been ploughed by hundreds of country plough. Similarly, the use of IPM there has been judicious application of all these inputs in agriculture, thereby recording negative correlation of these inputs with the output.

Table 1: *Per se* performance of agricultural inputs and output in South 24 Parganas district

Variables	Unit	Minimum	Maximun	Average	Std.Dev.	C.V. %
Agricultural inputs						
Field crop seed	Tonnes	3742.25	7298.06	5605.53	966.30	17.24
Vegetable crop seed	Tonnes	96.06	361.00	189.26	88.52	46.77
Total seed	Tonnes	4012.95	7414.85	5794.79	924.21	15.95
Fertilizer	Tonnes	51242.00	72532.00	64127.91	6198.99	9.67
Pesticide	Tonnes	211.04	298.01	251.57	32.57	12.95
Country plough	Number	2409.00	110000.00	67129.73	31231.21	46.52
Power tiller & tractor	Number	2600.00	3691.00	3190.09	360.05	11.29
Total FI,FM,PPE	Number	122377.00	203212.00	173844.27	22636.51	13.02
Agricultural outputs						
Field crops	Lakh Rs.	79320.16	124006.50	107867.97	13339.44	12.37
Vegetable crops	Lakh Rs.	52383.03	89810.48	67329.61	12268.81	18.22
Fruits	Lakh Rs.	8265.31	14695.98	11578.72	1962.19	16.95
Flowers	Lakh Rs.	92.93	841.65	274.05	236.66	86.35
Plantation crops	Lakh Rs.	23908.44	35804.30	29714.96	3818.37	12.85
Total crops	Lakh Rs.	167598.83	251616.60	216765.32	25981.70	11.99

FI = Farm implement, FM= Farm machinery, PPE= Plant protection equipment; C.V. =Coefficient of variation

Table 2: Compound growth models of agricultural inputs and output values in South 24 Pgs district

	b_0	b_1	CGR (Per cent)	R^2
Agricultural inputs (Independent variables)				
Field crop seed	4191.90	1.0471	4.71	0.7080
Vegetable crop seed	319.26	0.9017	-9.83	0.5525
Total seed	4473.08	1.0420	4.20	0.6694
Fertilizer	58081.70	1.0159	1.59	0.2691
Pesticide	307.54	0.9659	-3.41	0.8058
Country plough	215695.00	0.7872	-21.28	0.5486
Power tiller & tractor	2580.78	1.0349	3.49	0.9757
Total FI, FM and PPE	216809.00	0.9625	-3.75	0.8047
Agricultural outputs (Dependent variable)				
Field crops	95807.4	1.0187	1.87	0.2140
Vegetable crops	52346.40	1.0402	4.02	0.5200
Fruits	8409.49	1.0524	5.24	0.9573
Flowers	61.36	1.2267	22.67	0.8453
Plantation crops	23496.40	1.0386	3.86	0.9313
Total crops	180296.00	1.0300	3.00	0.6061

Fig. 1-6: Compound growth rate (CGR) for consumption / utilization of various farm inputs in South 24 Parganas from 1997-98 to 2007-08

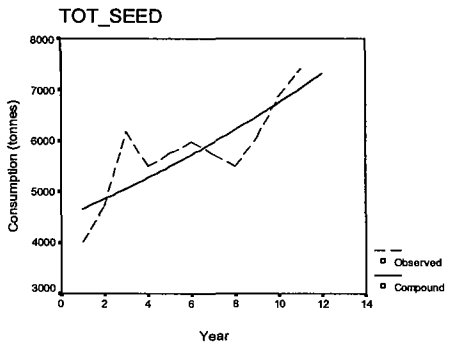

Fig. 1: CGR for consumption of seed

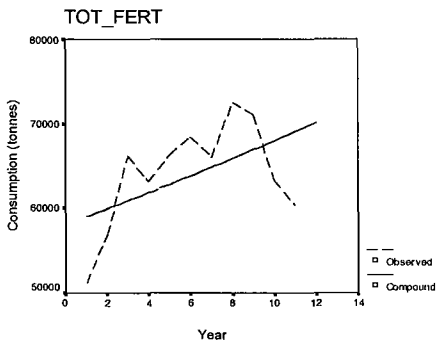

Fig. 2: CGR for consumption of fertilizer

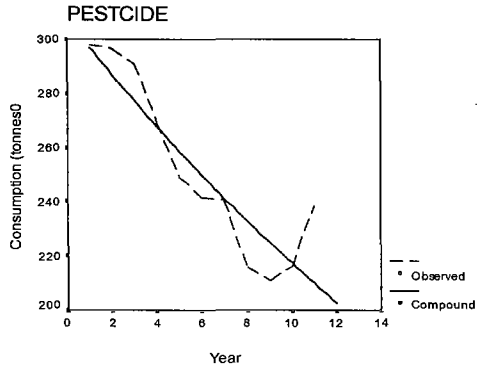

Fig 3: CGR for consumption of pesticide

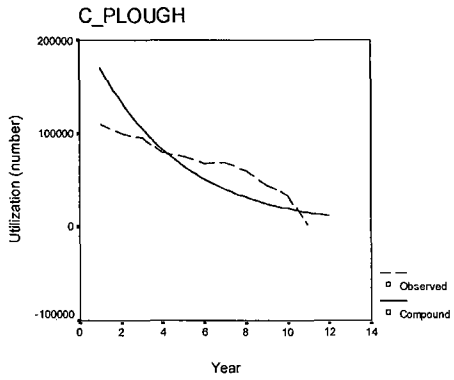

Fig 4: CGR for utilization of plough

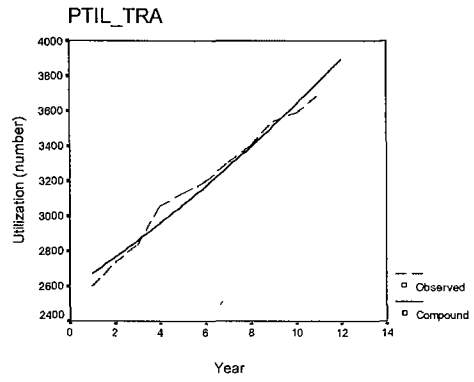

Fig. 5: CGR for utilization of power tiller and tractor

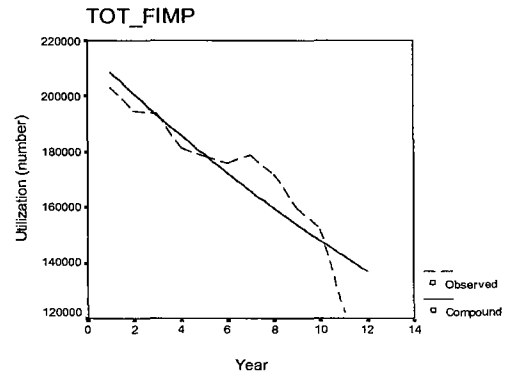

Fig. 6: CGR for utilization of of FI, FM and PPE

Fig. 7-12: Compound growth rate (CGR) for production values of various agricultural crops in South 24 Parganas from 1997-98 to 2007-08

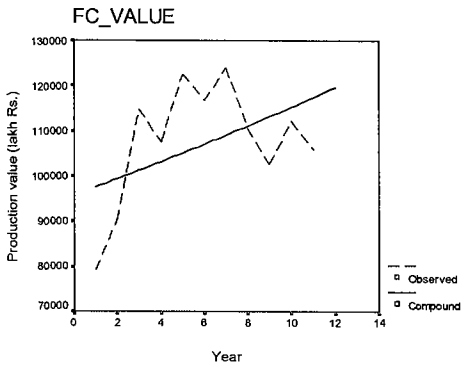

Fig 7: CGR for production value of field crops

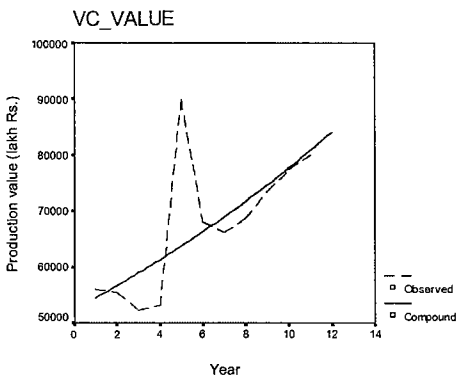

Fig 8: CGR for production value of vegetable crops

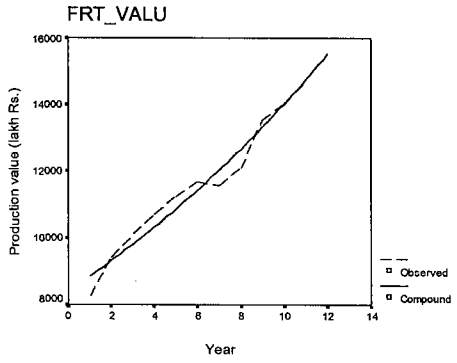

Fig 9: CGR of production value of fruits

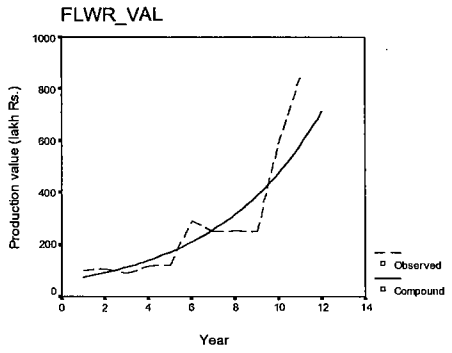

Fig 10: CGR for production value of flowers

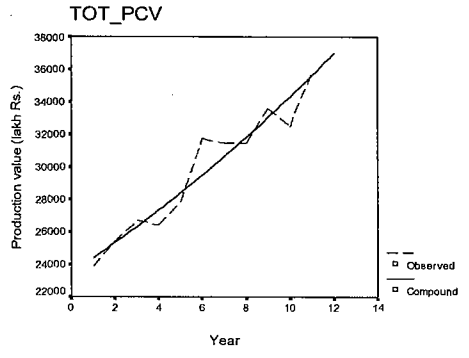

Fig 11: CGR for production value of plantation crops

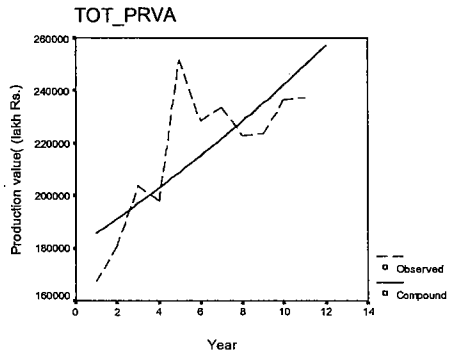

Fig 12: CGR for production value of all crops

Table 3: Correlation coefficients between independent variables and dependent variable

Independent variable	Correlation coefficient	Sig. level
Seed (P_1)	0.754**	.007
Fertilizer (P_2)	0.653*	.029
Pesticide (P_3)	-0.779**	.005
Farm implement, machinery and plant protection equipment (P_4)	-0.665*	.025

*,** Significant at the 0.05, and 001 level respectively

Table 4: Inter-correlation matrix

Inputs	A. Seed	B. Fertilizer	C. Pesticide	D. FI, FM & PPE
A. Seed	1.000			
B. Fertilizer	0.434	1.000		
C. Pesticide	-0.608*	-0.709*	1.000	
D. FI, FM and PPE	0.858**	- 0.263	0.708*	1.000

Note: *FI, FM, PPE = Farm implement, farm machinery and plant protection equipments.*
*, ***Significant at 0.05 and at 0.01 level respectively.*

Multicollinearity among the farm inputs

Results show (Table 4) that individual inputs are also associated among themselves, so the possibility of multicollinearity cannot be ruled out.. There has been quantum increase in fertilizer use and pesticide during the year, in contradiction with the decrease in number farm implements, as such the negative correlation among fertilizer and farm implements, and seed and pesticide are record In presence of multicollinearity, it is not wise to use Ordinary Least Square Technique in estimating the parameters of functional relationship of total production and factors of production like seed, fertilizer, pesticide and PP equipments and farm implements; Principal Component Analysis (PCA) was adopted. The Principal Component Analysis with the values of factors of production indicates that two principal components with varimax rotation are sufficient to explain more than 98 per cent of the variation (Table 5).

Table 5: Rotated component matrix

Inputs	Rotated Principal Component	
	Component 1	Component 2
Seed	**0.967**	0.199
Fertilizer	0.219	**0.967**
Pesticide	-0.649	**-0.752**
FI, FM and PPE	**0.797**	0.577
% Variation Explained	82.744	15.031

As per Varimax Kaiser Normalization Rotation seed, farm implement, farm machinery and plant protection equipment were extracted in the first component, and fertilizer and pesticide in the second component (Table 5). Thus the Principal Component Analysis resulted in two principal components and with help of these principal components the original values of the factor of production were converted into principal component score values. Theses Principal Component score values were used for determination of Cobb Douglas production function. Ultimately, the Cobb Douglas production function found is

$Y = 26668.59 .P_1^{-0.131} .P_2^{0.349}$, $R^2 = 0.762$

From the above, it can be concluded that component 2, that is, fertilizer and pesticide had significant impact on the total production value and the combined effect of all the components like seed, farm implement, farm machinery and plant protection equipment, fertilizer, and pesticide had significant impact on the total production value coming from the value of field and plantation crops, vegetable crops, fruits and flowers, though, the component 1, that is, seed, and farm implement, farm machinery and plant protection equipment had no significant impact on the value of the crop production.

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