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A Study on Functional Relationship between different Factors and Product in Paddy and Wheat Crop

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ABSTRACT: A study was conducted entitle functional relationship between different factors and product in paddy and wheat crop in Dabra block of Gwalior district M.P. Multistage random sampling method was used to acquire sample farmer, At the first stage of sampling, Dabra block was selected purposively, second stage of sampling, a list of the paddy and wheat growing villages were prepared from selected block (Dabra) then 20 villages were selected randomly, and the third stage of sampling, a list of paddy and wheat growers from each selected village was prepared then classified into five major categories on the basis of their land holding *i.e.* marginal (less than 1ha) small (1-2 ha), semi medium (2-4 ha), medium (4-10 ha) and large (10 ha or above).Then a sample of 30 farmers were selected in each category by simple random sampling technique under proportionate allocation from twenty villages treated as strata thus, 150 paddy and 150 wheat farmers were selected. After the analysis of data it was observed that , an overall farm level, the value of R^2 was observed very high *i.e.* 0.95 and 0.97 in paddy and wheat crops respectively which gives signal that all the factors viz. seed (X_1), fertilizer (X_2), human labour (X_3) machinery (X_1) plant protection (X_5) manure (X_6) and irrigation (X_7) were best fitted. The regression coefficient at overall farm under both the crops (paddy and wheat) were observed less than one which implied that decreasing return found under both the crops cultivation in the study area. The main challenge of study area was, to increase output with optimum combination of resources, and how we can enhance return to scale by using inputs.

Keywords: Functional relationship, Regression, input-output, production function, paddy and wheat.

INTRODUCTION

Production is a process, in which inputs are transformed into outputs. The inputs likewise seed, fertilizer, pesticide, labour, machinery etc. are uses in the production process as a independent variable. After the using of such a independent variable in the production to produce desired outputs is called product. The Production function can be used to determine the relationship between input and output, this function gives the information regarding the quantity of output that may be expected when input resources are combined in a specific manner (Reddy and Reddy 2013). In India paddy and wheat is mostly produce among cereals crop, the production of paddy and wheat is an important part of the national economy because paddy and wheat together feed more than half of the country's population. India is the second largest producer of paddy and wheat in the world after china. Paddy is one of the oldest cultivate crop and has been cultivated in India for several thousand years. In India paddy is cultivated under 43.79 million hectare with the production of 112 million tones and productivity 2578 Kg/ha whereas wheat occupies an area of 29.58 million hectare with a production and productivity of 99.70 million tonnes and 3371 kg/ha. In Madhya Pradesh, paddy is grown mainly as a kharif crop on 2.04 million hectare with the production of 4.12 million tones and productivity 2026 kg/ha while wheat is grown on area of 5.32 million hectare with a production and productivity of 15.91 million tonnes and 2993 kg/ha, respectively (Anonymous, 2018).Thus rice and wheat production not only makes the country food sufficient nation but also strengthen its agrarian economy. Since agriculture is the major source of income for most of the population of country, rice and wheat being the majorly grown crops plays key role in enhancing income of the farmers. Keeping the above importance of both the crop a study was conducted to study about functional relationship between different factors and product in paddy and wheat crop.

METHODOLOGY

The present study was confined to Gwalior district of Madhya Pradesh because this district has remarkable position under paddy and wheat crop in the gird zone, and also for the convenience of the researcher to get more accurate information. Gwalior district has four blocks namely Bhitarwar, Dabra, Morar and Ghatigaon. At the first stage of sampling, Dabra block was selected purposively, due to comprise maximum area under paddy and wheat cultivation (37710.03 ha and 47961.20 ha respectively), at the second stage of sampling, a list of the paddy and wheat growing villages were prepared from selected block (Dabra) then 20 villages namely Akbai Badi, Masudpur, Salaiya, Kardu, Beer Muhana, Lakhiya, Khareya, Girgheda, Patha Panihar, Anat Path, Beru Gawan, Kheri Parashasar, Rampura, Khidwae, Maharajpur, Chomo, Chhimak, Ikona, Patharra, and Ghamad Pura were selected randomly, and the third stage of sampling, a list of paddy and wheat growing farmers from each selected village was prepared then classified into five major categories

on the basis of their land holding i.e. marginal (less than 1ha) small (1-2 ha), semi medium (2-4 ha), medium (4-10 ha) and large (10 ha or above) (Reddy 2018), Then a sample of 30 farmers were selected in each category by simple random sampling technique under proportionate allocation from twenty villages treated as strata with the help of given formula.

$$ni = \frac{N_i}{N} \times n$$

Where, ni = i^{th} stratum sample size,
N_i = i^{th} stratum size, N = Population size and n = Total sample size.
Thus, in all 300 farmers (150 paddy growers and 150 wheat growers) were selected. After selection of respondent the primary data (2019-20, kharif and rabi) as regards quantity of input used with their price, yield, gross income etc. were collected through pre-tested interview schedule by survey method. Each selected respondent were approached personally for collecting the relevant data.

A. Analytical tools

Functional relationship between shows the relationship between dependent variable (output) and independent variable (inputs). The Regression model was used to determine input-output relationship, implicit form of regression model is given below (Shehu *et al*., 2017).

$Y = f(X_1, X_2, X_3, \ldots\ldots X_n)\ u$ (i)

Where,

Y = output, $X_1 \ldots Xn$ = variable inputs used during production process, u = random error term or random disturbance term. In addition, the explicit form of the model is given by:

$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 x_4 + .., \beta_n X_n + u$

Where,

β_o =Intercept or constant parameter

$\beta_1 \ldots..$, $\beta 7$ = The regression coefficients of the independent variables

$X_1 \ldots X_7$ =Independent variables used,

Ui= Stochastic disturbance term.

Linear, exponential, semi-log and double-log forms of the production function were fitted to the data. The double-log function revealed the best fit. therefore, chosen as the lead equation based on the number of entities that were significant, size of R^2 and F-Ratio, stochastic error term and the contributions made by the coefficients. (Adedeji, 2015). The Double-log lead equation is expressed in its explicit form as.

$\ln Y = \ln\beta o + \ln\beta_1 X_1 + \ln\beta_2 X_2 + \ln\beta_3 X_3 + \ln\beta_4 X_4 + \ln\beta_5 X_5 + \ln\beta_6 X_6 + \ln\beta_7 X_7 + ui$ (ii)

Where,

Y = output (quintal/ha)
X_1 = Quantity of seed (kg/ha)
X_2 = Quantity of fertilizer (kg/ha)
X_3 = Human Labour (man days /ha)
X_4 = Machinery Labour (hrs/ha)
X_5=Plant protection chemical (liters/ha)
X_6 = Quantity of manure tone/ha
X_7 = Number of irrigation /ha

B. Return to scale

The summation of all regression coefficients of all factors in the production function gives the return to scale. The addition of regression coefficient with respect to various resources in the estimated production function gives return to scale, which indicates the increasing in output when all inputs are increasing by one percent. if summation of regression coefficient is greater than 1 indicating increasing return, less than one decreasing and equal to one indicating constant return to scale.

C. Return to scale

$=\sum bi$ Where, bi = regression coefficient of inputs $X_1 \ldots X_7$

RESULTS AND DISCUSSION

The result of functional analysis between dependent variable and independent variable has been presented into two parts.

A. Functional relationship under paddy crop

The functional relationship was computed between different factors and products with the help of a regression model. The regression model was analyzed separately for each size of farms as well as for overall farm and coefficient of each factor viz.X_1 (seed kg/ha), X_2 (fertilizer kg/ha), X_3 (human labour man-days/ha), X_4 (machinery labour hrs/ha), X_5 (plant protection chemical liter/ha), X_6 (manure tone/ha) and X_7 (Number of irrigation /ha) were tested by student t-test and the results are presented in Table 1. The results depicted that, the value of R^2 (coefficient of multiple determinants) at the overall farm was observed 0.95 which indicated that 95 percent variation explained by all the independent variable in the dependent variable (output) of paddy (Dalvi *et al.*, 2018). In the case of categories, the value of R^2 was seen 0.98, 0.91, 0.84, 0.82 and 80 it implied that 98 per cent, 91 per cent, 84 per cent, 82 per cent, and 80 per cent impact of all independent variables (X_1, X_2, X_3, X_4, X_5, X_6, and X_7) together contributed in the production of paddy at marginal, large, small, medium, and semi-medium farm respectively. Thus the selected factors in the production function were the best fitted. The return to scale is the sum of the elasticities ($\sum$bi) of all factors which implied the changes in output due to changes in all inputs together in the same proportion. The return to scale (sum of regression coefficients) at the overall farm was observed 0.81 and on marginal, small, semi-medium, medium, and large size farms were observed 0.94, 0.82, 0.91, 1.027, and 0.64 respectively which clarify that decreasing return to scale was noticed, (Kumar and Gupta (2018); Dauda and Ibrahim (2014) at overall farm as well as in all size groups except medium farm. The value of coefficient of seed (X_1) at the overall farm observed 0.1184, in case of categories it was observed 0.0030 on the marginal farm, 0.3086 on small farm, 0.5455 on semi-medium farm, 0.2302 on medium farm and 0.0395 on large size of farm and it was observed non-significant at overall as well as in all the categories. The value of the coefficient of fertilizer (X_2) at the overall farm was found 0.4699 in the case of categories it observed 0.3837, - 0.0672, -0.2341, 0.0672, -0.1366 on marginal, small, semi-medium, medium, and large farms respectively. The factor X_2 noticed statistically significant on the marginal farm and overall farm at 1 per cent level of significance. The value of the coefficient of human labour (X_3) was found 0.1789 on the overall farm, in case of categories it observed 0.0130, 0.0467, 0.0129, 0.0322 and 0.045 on marginal, small, semi-medium, medium and large size farms respectively. The factor X_3 was observed statistically significant on overall farm at 5 percent level. It indicated that if we increase more units of labour during peak period at overall farm outputs will increase positively. The coefficient of machinery labour (X_4) was observed -0.0188 at overall farm. While in categories it found 0.2653, 0.5818, 0.2184, 0.0088, and 0.0026 on marginal, small, semi-medium, medium, and large size farms respectively. Factor X_4 was found to be significant only at marginal farm. The value of coefficient of plant protection (X_5) was noted -0.0632 on overall farm while on marginal, small, semi-medium medium and large farm it observed 0.031, 0.1817, -0.1216, -0.0639, 0.4834 respectively. The factor X_5 was observed statistically insignificant at the overall farm as well as across all categories except large farm, where it was noticed significant at 5 % level. The coefficient of manure (X_6) was noted 0.0715 at the overall farm and in case of categories it noted 0.2968, -0.1930, 05009, 0.6253 and 0.1952 on marginal, small, semi-

medium, medium, and large size of farm respectively. The factors X_6 at the overall farm was observed statistically significant as well as on all categories. it indicated that adding of manure in production output will increase. The coefficient of irrigation (X_7) was observed -0.0481 at the overall farm while in categories it observed 0.0475, 0.0502, -0.0086, 0.1270, 0.0117 on marginal, small, semi-medium, medium, and large size farms respectively. Factor X_7 observed significant only at marginal.

Table 1: Estimated Production function under the different sizes of farms in paddy production.

Particular	Size of farms											
	Marginal (N= 30)		Small (N= 30)		Semi-medium (N= 30)		Medium (N= 30)		Large (N= 30)		Overall (N= 150)	
Intercept	0.1691 (0.3815)		2.1329 (2.0059)		1.3135 (0.1928)		0.9796 (0.9275)		4.5757* (0.6997)		0.8650*** (0.3062)	
coefficient	b value	t vale	b value	t value	b value	t value	b value	t value	b value	t value	b value	t value
$\ln X_1$	0.0030 (0.0131)	0.23	0.3086 (0.1556)	1.98	0.5455 (0.4336)	1.25	0.2302 (0.1788)	1.28	0.0395 (0.0680)	0.58	0.1184 (0.0691)	1.71
$\ln X_2$	**0.3837*** ** (0.1017)	3.77	-0.0672 (0.4543)	-0.14	-0.2341 (0.1471)	-0.23	0.0672 (0.2517)	0.26	-0.1366 (0.1215)	-1.12	**0.4699*** ** (0.0992)	4.73
$\ln X_3$	0.0130 (0.1018)	0.128	-0.0467 (0.0943)	-0.49	0.0129 (0.1829)	0.07	0.0322 (0.0859)	0.37	0.0458 (0.0704)	0.65	**0.1789** ** (0.0908)	1.97
$\ln X_4$	**0.2653** ** (0.1074)	2.46	0.5818 (1.0611)	0.54	0.2184 (0.3786)	0.57	0.0088 (0.0372)	0.23	0.0026 (0.0151)	0.17	-0.0188 (0.0462)	-0.40
$\ln X_5$	0.0321 (0.0202)	1.58	0.1817 (0.9135)	0.19	-0.1216 (0.3817)	-0.31	-0.0639 (0.1605)	-0.39	**0.4834** ** (0.1940)	2.49	-0.0632 (0.0872)	-0.72
$\ln X_6$	**0.2968*** ** (0.0477)	6.21	-0.1930 (0.2677)	-0.72	**0.5009*** ** (0.1958)	2.55	**0.6253*** ** (.3198)	1.95	**0.1952*** ** (0.0773)	2.52	**0.1715** ** (0.0871)	1.96
$\ln X_7$	**-0.0475** ** (0.0211)	-2.24	0.0502 (0.0728)	0.68	-0.0086 (0.0732)	-0.10	0.1270 (0.0942)	1.34	0.0117 (0.0673)	0.17	-0.0481 (0.0785)	-0.61
∑bi	0.94		0.82		0.91		1.027		0.64		0.81	
R^2	0.98		0.84		0.80		0.82		0.91		0.95	

(Figure in Parentheses indicated standard error of respective variable
Note: The asterisks (** ***) indicate significance at the 5% and 1 % levels respectively

B. Functional relationship under wheat crop

The functional relationship was computed between different factors and products with the help of a regression model in the analysis of data. The regression model was analyzed separately for each size of farms as well as for overall farm and coefficient of each factor viz.X_1 (seed kg/ha), X_2 (fertilizer kg/ha), X_3 (human labour man-days/ha), X_4 (machinery labour hrs/ha), X_5 (plant protection chemical liter/ha) X_6 (manure tone/ha) and X_7 (number of irrigation /ha) were tested by student t-test and the results are presented in Table 2. The results depicted that, the value of R^2 (coefficient of multiple determinants) at overall level was observed 0.97 which is very high implied that 97 per cent variation explained by independent variable in the output of wheat. In case of categories the value of R^2 was observed 0.97, 0.93, 0.84, 0.82 and 0.81. It means 97 per cent, 93 per cent, 84 percent, 82 per cent and 81 per cent impact of all independent variables together in wheat production at semi-medium, small, medium, large, and marginal farm respectively. Hence the selected resource in the production function was the best fitted. The return to scale is the sum of the elasticity of all factors (∑bi) which implied the changes in output due to changes in all inputs together in the same proportion. The return to scale (sum of regression coefficients) was observed 0.95 at overall farm. While in case of marginal, small, semi-medium, medium and large size farms it were seen 0.93, 0.94, 0.98, 1.01 and 0.84 respectively which clarify that decreasing return to scale was operated (Shehu *et al* 2017) at the overall farm as well as in all size of farm except medium farm where increasing return to scale was seen. The value of coefficient of seed (X_1) was found 0.1879 on the overall farm while in the categories it was seen 0.1671 on the marginal farm, 0.088 on a small farm, 0.0616 on semi-medium farm, -0.967 on the medium farm, and 0.3482 on large farm size. Factor X_1 (seed) was observed significant at 1 per cent level at the overall farm as well as large farm, which indicating that use of improved variety production increase significantly. The value of the coefficient of fertilizer (X_2) was noted 0.199 at the overall farm while in categories it was seen 0.0255 on the marginal farm, 0.0162 on a small farm, 0.012 on the semi-medium farm, 0.0827 on a medium farm, and 0.3649 on large farm size. The factor X_2 was observed significant at the overall farm and large farms at a 1% level of significance. The value of the coefficient of human labour (X_3) was seen at 0.2057 on the overall farm whereas in of categories it observed 0.6315 on the marginal farm, 0.0504 on a small farm, 0.1366 on a semi-medium farm, 0.0785 at the medium farm, and 0.0733 on the large farm. The factor X_3 was found to be significant at the overall farm and for the marginal farm at a 1 per cent level of significance. The value of the coefficient of machinery labour (X_4) was observed 0.2791 on the overall farm while in categories it has seen 0.0742 on the marginal farm, 0.0436 on a small farm, -0.0173 outputs at the semi-medium farm, 0.4416 at the medium farm, and 0.0259 at the large farm. The factor X_4 was observed significant at the overall farm and for a medium farm at the one percent level. The value of the coefficient of pant protection (X_5) was noted -0.003 on the overall farm. While on marginal, small, semi-medium, medium, and large farm were noted 0.0913 -0.0021, 0.1136, 0.3530, and -0.026. Factor X_5 was observed insignificant at the overall farm as well as all sizes of the farm except for the medium size of the farm. The value of the coefficient of manure (X_6) was seen 0.0678 at overall farm whereas in categories it was seen 0.0541, 0.906, 0.6867, 0.1262, and 0.0213 on marginal, small, semi-medium, medium, and large size farms respectively. Factor X_6 for the small farm was observed significant at 1% level and the overall farm and semi-medium farms it was significant at 5 percent level of significance. The coefficient of irrigation (X_7) was seen 0.012 at an overall farm in the case of categories it was seen 0.0519, 0.004 -0.0147, 0.0241, and 0.0379 on marginal, small, semi-medium, medium, and large farm respectively. It observes insignificant at all sizes of farms.

Table 2: Estimated Production function at the different sizes of a farm in wheat production.

Particular	Size of farm											
	Marginal (N= 30)		**Small (N=30)**		**Semi-medium (N=30)**		**Medium (N=30)**		**Large (N=30)**		**Overall (N=150)**	
Intercept	1.35 (1.26)		1.27**(0.58)		1.95(0.35)		1.7714.**(0.77)		-0.22 (0.81)		0.308(0.268)	
coefficient	b value	t value	b value	t value	b value	t value	b value	t value	b value	t value	b value	t value
$\ln X_1$	0.1671 (0.2154)	0.77	0.0088 (0.1038)	0.08	0.0616 (0.0354)	1.73	-0.0967 (0.1535)	-0.62	**0.3482*** ** (0.1383)	2.51	**0.1879*** ** (0.0642)	2.92
$\ln X_2$	0.0255 (0.1241)	0.20	0.0162 (0.0743)	0.21	0.0121 (0.0347)	0.34	0.0827 (0.0994)	0.83	**0.3649*** ** (0.0512)	7.10	**0.1993*** ** (0.0492)	4.05
$\ln X_3$	**0.6315*** ** (0.1567)	4.02	0.0504 (0.0755)	0.66	0.1366 (0.2805)	0.48	0.0785 (0.0719)	1.09	0.0733 (0.0695)	1.05	**0.2057*** ** (0.0513)	4.00
$\ln X_4$	0.0742 (0.4522)	0.16	0.0436 (0.1106)	0.39	-0.0173 (0.0616)	-0.28	0.4416 (0.4796)	0.92	0.0259 (0.0245)	1.06	**0.2791*** ** (0.0474)	5.88
$\ln X_5$	0.0913 (0.3536)	0.25	-0.0021 (0.1719)	0.01	0.1136 (0.1501)	0.75	**0.3530** ** (0.1708)	2.06	-0.026 (0.0335)	-0.79	-0.0037 (0.0591)	-0.06
$\ln X_6$	0.0541 (0.0932)	0.58	**0.906*** ** (0.213)	4.25	**0.6867** ** (0.3080)	2.22	0.1262 (0.4821)	0.26	0.0213 (0.0383)	0.55	**0.0678** ** (0.0343)	1.97
$\ln X_7$	0.0519 (0.1621)	0.32	0.004 (0.064)	0.06	-0.0147 (0.0412)	0.35	0.0241 (0.1185)	0.20	0.0379 (0.0312)	1.21	0.0121 (0.0309)	0.39
∑bi	0.93		0.94		0.98		1.01		0.84		0.95	
R^2	0.81		0.93		0.97		0.84		0.82		0.97	

(Figure in parentheses indicated standard error of respective variable)
Note: The asterisks (** ***) indicate significance at the 5% and 1 % levels respectively.

CONCLUSION

It is concluded from the results that, at overall farm level, the value of R^2 was observed very high i.e. 0.95 and 0.97 in paddy and wheat crops respectively which gives signal that all the factors viz. seed (X_1),fertilizer (X_2), human labour (X_3) machinery (X_1) plant protection (X_5) manure (X_6) and irrigation (X_7) were best fitted. The summation of regression coefficient at overall farm in both the crops (paddy and wheat) were observed less than one which implied that decreasing return found under both the crops in the study area.

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Conflict of Interest. None.

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