Hierarchy of Agricultural Functions: A Study of Production and Marketed Output in Purnia (North Bihar, India)

Mahmood Ansari, Mahmood Ansari

Assam University

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Abstract

There may be a situation for classes of peasantry whereby a peasant-cultivator of a specific class location may not even make both ends meet. A peasant may be in debt. It may not be the net returns for a peasant of this class but the gross yield, which he/she may be seeking to maximize with the burden of debt allowed to be accumulating. In such circumstances, it is clearly futile to reduce all operators to the status of the profit maximizers. It is worth arguing that there cannot logically and realistically be a uniform technology adopted by the peasantry, who are differentiated on the basis of inequality in the resource endowments and land ownership base. In such a circumstance, the minimization of deviations from the average relation between inputs and output characterizing the least-square method of regression analysis to derive a production function is anti-thesis of the differentiation of peasantry. All the operators are not to be assumed to be uniformly profit-maximizers and a uniform technology may not posited to be accessible to all classes of peasantry. It is therefore posited that there are bound to be logically a hierarchy of production functions rather than a unique aggregate function in the agriculture. A unique production function is best suitable for a cross-section of uniformly controlled experimental farms, but not the diverse class of actual farms possessed by differentiated peasantry. What is true of an agricultural production function is equally true of a marketed surplus function. What must not be debatable is the assertion that there is logically a possibility of a hierarchy of marketed surplus functions on the divergent peasant farms of the differentiated peasantry in the district of Purnia in north Bihar, India.

Key Words: peasantry, price, labour, output, yield, acreage, regression coefficient, statistical test production function, marketed surplus function, class differentiation, rich peasant, small peasant, middle peasant, , district

Introduction

In the standard model, it is invariably assumed that a peasant owns and controls a profit-seeking production enterprise in agriculture. The objective of agricultural production is profit maximization. The production unit utilizes the inputs in technically efficient manner. The state of knowledge about the various methods that might be used to transform the inputs into agricultural outputs, that is, production technology in agriculture used by the peasant is assumed to be given for a given period of time. It is further posited that the inputs are perfectly divisible. These assumptions are at the core of neoclassical thinking in the mainstream economics. Under such postulates of theorists of the neoclassical economic analysis persuasions, a vital tool and technique of input-output relations have been devised in the literature. This is called the agricultural production function. In the perspective of the present work, the conceptual doubt towards such a technique of production analysis is premised on the fact that it simplifies the complex realities of the production process in agriculture. The concept of production function abstracts from the concrete economic differentiation among the peasantry, which is the core of

Marxist perspective on the peasantry. It is worth arguing that there are no motivational forces, which are definable, a priori for any peasant household independently of the entire gamut of production and market relations in which it is involved. It may not be all the time the profit-seeking.

There may be a situation for classes of peasantry whereby a peasant-cultivator of a specific class location may not even make both ends meet. A peasant may be in debt. It may not be the net returns for a peasant of this class but the gross yield, which he/she may be seeking to maximize with the burden of debt allowed to be accumulating. In such circumstances, it is clearly futile to reduce all operators to the status of the profit maximizers (Bhardawaj, 1974, pp.61-2). A given qualitatively identical materials, equipment and machinery, and therefore, almost uniform technology used by each cross-section of farms of peasantry is the crucial assumption of production function in agriculture, which is far from reality. It is worth arguing that there cannot logically and realistically be a uniform technology adopted by the peasantry, who are differentiated on the basis of inequality in the resource endowments and land ownership base. In such a circumstance, the minimization of deviations from the average relation between inputs and output characterizing the least-square method of regression analysis to derive a production function is anti-thesis of the differentiation of peasantry.

In the present work, all the operators are not assumed to be uniformly profit-maximizers and a uniform technology is not posited to be accessible to all classes of peasantry. It is therefore posited that there are bound to be logically a hierarchy of production functions rather than a unique aggregate function in the agriculture. A unique production function is best suitable for a cross-section of uniformly controlled experimental farms, but not the diverse class of actual farms possessed by differentiated peasantry. What is true of an agricultural production function is equally true of a marketed surplus function. What must not be debatable is the assertion that there is logically a possibility of a hierarchy of marketed surplus functions on the divergent peasant farms of the differentiated peasantry. Such postulates are tested with empirical data obtained from a district of north Bihar called 'Purnia' in the present paper. While undertaking a regression analysis on heterogeneous farms in Purnia, the production technique efficiency index is also estimated.

1. Conceptual Foundation

Peasantries are actually economically differentiated groups in the countryside. Such groups differ with each other not only in matter of ownership, control and operation of land but also the use and exploitation of outside labour hired on the farms. The degree of use of hired-in labour vis-à-vis family labour differentiates the peasantries into at least five economic classes: petty/poor peasant, small peasant, middle peasant, rich peasant, and landlord/capitalist. In order to classify the peasantry, Utsa Patnaik (1987) has put forward a labour-exploitation index in the following form:

Agricultural Production is organized by combining a number of non-land inputs with the land. The output obtained and the inputs applied bear a definite relation of association. Such relation is usually captured by the conventional input-output analysis with the help of a theoretical concept called an agricultural production function. It shows the technical relationship between the physical quantities of inputs used and output obtained on the agricultural farms. The method commonly used for statistical fitting of an agricultural production function in the literature is the least square method of the regression analysis. A production function in agriculture describes the maximum output for each specified combination of agricultural inputs. It refers to the physical relation between inputs and output. It represents the purely technical relations between inputs and output on the peasant farm. It describes the laws of proportions of inputs at any particular point of time. The basic theory of production then concentrates only on the efficient methods or processes or activity. A rational entrepreneur in agriculture is not assumed to be using any inefficient method of production. A production function can be represented mathematically in the form of algebraic equations, and diagrammatically by a series of isoquants (the negatively sloped curve in an input-output space). A production function describes not only a single isoquant but the whole array of the isoquants on the map, whereby each isoquant represents a method of economizing on the use of agricultural resources by the peasant-producer.

In the neoclassical literature, the popular empirical measure of agricultural growth is the statistical fitting of an aggregate production function for agriculture, and there are sophisticated tools available for the statistical fitting of the function, for example, the multiple regression analysis. The marketable and marketed output functions of individual crop as well aggregate food crop are fitted and statistically estimated with the help of simple and multiple regression analysis. There are debates surrounding the statistical estimates, and the associated measurement methods. These controversies belong to the domain of the statistical theory. It is affirmed that there may be a possibility of `specification bias' in fitting a production and marketed surplus functions. The specification bias arise when the specification of the list of relevant factors in a relation is either wrong or a particular factor is omitted. While fitting a production function in agriculture, the omission of variables like human labor, draft power, etc. are very much likely because of disregard of importance to measurement of the variable itself (Minhas, 1966, p. 176). In a statistical fitting of a production function of Cobb Douglas type, there are further serious problems of isolating the marginal productivity of human labor from that of other inputs like livestock (Bardhan, 1973). On methodological grounds, the statistical procedures employed to fit a function have been found to be unsatisfactory (Rudra, 1982; Bhardawaj, 1979; Jodha and Anderson, 1973; Sen, 1975). It is therefore asserted that such functions are usually too simple to capture adequately the complexities of the agricultural production processes (Booth and Sundaram, 1984, p.248). It is not to say that the function is not at all an improved and rigorous tool of analysis of the production activity of the peasantry on uniformly controlled experimental farms. The statistical fitting of an agricultural production function however involves a departure from the theoretical concept. The departure consists in the fact that the measurement of variables (i.e. input and / or output) in the value terms is possible on the assumption of a uniform "price regime. It is also the case that the statistical fitting affords only average or "expected" estimate of the functional relation. Its deviation from the "maximum" or maximal estimate (the theoretical concept of neoclassical vintage point) needs to be measured (Rudra, 1982, pp. 273-5).

2. Multiple Models of Regression Analysis

The most widely used and popular agricultural function is the Cobb-Douglas production function. It was a pioneering piece of economic work, which came up towards the close of the third decade of the present century (Cobb and Douglas, 1928, pp.139-65; Douglas, 1948, pp.1-41). It is a power production function. The function makes it possible to use the statistical data on the volume of labor and stock of fixed capital employed to plot the shape of the production map. The original Cobb-Douglas production function was represented symbolically as

$$\mathbf{P = b. L^{\kappa}. C^{1-\kappa},}$$

where P refers to the volume of product, L to volume of labor supply, C to stock of fixed capital, and b and k to the constants. This function made the theoretical selection of the constant returns to scale of production - homogeneous linearity- possible. The exponents were later made deliberately free by Douglas (1948) to account for the increasing and diminishing returns (Mitra, 1980, p.18). What was further needed later was to incorporate the vital input of agriculture called the land resource in the function. The land is a crucial input which explains the variation in the agricultural output. There emerged the possibility of incorporation of other inputs, for example, the land in the agricultural production function. The function for a particular crop is finally represented as:

$$\mathbf{Y = k. A^{n}. B^{m}.C^{l},}$$

where Y refers to the amount of gross product, A to the amount of land, B to volume of labor, C to capital stock, and k to a constant. The letters n, m and l represent the production elasticities (Mellor, 1986, p.24). The Cobb-Douglas production function has yet been controversial enough to warrant occasional critical appreciation. It has been argued that there is a vital input called the raw material, which has not been taken care of in this function (Mitra, 1980, pp.19-21). There have thus been attempts to broaden the functional form in later years. There exists today a general mathematical form also, which can be represented as

$$\mathbf{Y = f\,(L, K, R, S, \ddot{\upsilon}, \gamma),}$$

where L refers to the amount of labour, K to capital, R to the raw materials, S to land amount, $\ddot{\upsilon}$ to the returns to scale, and γ to the efficiency parameter. All the variables are flows, and measured per unit of time. The raw materials bear a constant relation to output for all levels of production and land can be assumed to be fixed for the economy, and thus may be lumped together with capital for individual firm. The abbreviated form of the function is

$$\mathbf{Y = f\,(L, K, \ddot{\upsilon}, \gamma)}$$

The variable $\ddot{\upsilon}$ is relevant only in the long run. If land and capital are constant, then the output is simply a function of the efficiency parameter only. The parameter refers to the entrepreneurial organizational aspects of the production (Koutsoyiannis, 1985, pp.67-70). According to Yujiro Hayami (1975), there may be residuals, which may remain unexplained by the growth in inputs. This residual may be explained by the changes in the rate of growth in total factor productivity. The changes in the rate of growth in total factor productivity may be explained by including non-conventional factors such as education of farmers, public expenditure on agricultural research and extension, and improvement in land infrastructures in a production function. The growth rate of agricultural output on the peasant farms across the historical junctures shows distinct growth phases – distinct regions of total factor productivity growth. It is influenced by the technology.

In the present analysis of cross-section of agricultural farms, the general linear production function is conceived as follows:

$$\mathbf{X_c = f\,(A, e, L, B, M, C, P_L)\; g + D + F}$$

A departure from the theoretical concept is made while statistically fitting an agricultural production regression function. The departure consists in the fact that the measurement of variables (i.e. input and / or output) in the value terms is possible on the assumption of a uniform "price regime. It is also the case that the statistical fitting affords only average or "expected" estimate of the functional relation. Its deviation from the "maximum" or maximal estimate (the theoretical concept of neoclassical vintage point) needs to be measured (Rudra, 1982, pp. 273-5). In the present work, the linear equation form is:

$$\mathbf{X_c = \alpha_0 + \alpha_1 A + \alpha_2 e^r + \alpha_3 L + \alpha_4 B + \alpha_5 M + \alpha_6 C + \alpha_7 P_L + D + F,}$$

where the notations $\mathbf{X_c}$ refers to the volume of output of a crop per acre, **A** to the amount of cultivated land area in acres, **e** to the percentage of cultivated area under artificial irrigation, **L** to the number of man days of human labor input per acre, **B** to the number of man days of bullock labor (or plough labor) per acre, **M** to the aggregate monetary value of material inputs of the seeds, manure, fertilizers, irrigation water, and pesticides per acre, **C** to the monetary value of expenses on the machinery like pump-sets, tractors, threshers, etc running on farms per acre, $\mathbf{P_L}$ to the annual money cost of hiring-in the permanent labor per acre, **g** to the random multiplicative error term, **D** to the dummy representing village effect, and **F** to the dummy capturing the land fertility effect. The letter **'f'** refers to the functional notation. The notations α_0 refer to the intercept value, and notations α_1 to α_7 to the respective regression coefficients with respect to relevant inputs. It is to be noted that the letter 'g' stands for an error term that arises from two sources: a stochastic-error-component, resulting from the effects on X_c of many omitted variables operating in different directions and each with a relatively small effect, and a measurement-error-component. All the variables are expressed in 'per-acre' terms to ensure homoskedasticity. The general linear model entails the restriction that the structure of the relationships is linear in the α_is. Furthermore, it is assumed that the independent variables are measured without error.

The production technique efficiency index on a farm is defined to be the ratio of field enumerated actual annual amount of gross output of crop per acre to the predicted amount of output of crop per acre. The predicted amount of output of crop per acre is obtained by reconstituting the set of statistically significant agricultural inputs in running a production regression analysis. The farms that attain the production technique efficiency index value, which is the ratio of field enumerated actual annual amount of output of crop per acre to the predicted amount of output of crop per acre on each peasant farm, greater than 1.00 are classified as the highly efficient farms, the farms with index value equal to 1.00 as just efficient farms, and those with index value lower than 1.00 as the production inefficient farms.

A simple linear cross-section marketed output function is likewise statistically fitted based on least-square method of multiple regression analysis in case of a crop in the following form:

$$\mathbf{S_i = f(\chi_p, \chi_j, P_{mi}, I) + M,}$$

where $\mathbf{S_i}$ refers to the proportion of net marketed output to net output of a crop over a year, χ_p to the annual volume of output of food crop per adult in quintals, $\boldsymbol{\chi_j}$ to the current market price-based value of output of a commercial crop per adult in rupees, and $\mathbf{P_{mi}}$ to the weighted average market price of a crop per quintal received by a household across season in the year, **I** to the average income of a peasant householding from non-crop production, and **M** to the dummy variable called the market-type chosen by a household in disposing the surplus of a food crop. The goodness of fit is estimated based on the significance of R^2 value of estimates, t-value of a pair of determinant variable and the value of standard error of estimate. The diagnosis of multi-collinearity is particularly taken care of.

3. Agricultural Functions: Generalized Results

In the case of **paddy crop**, the regression analysis is run over the aggregate sample of farms, and the statistical estimate of coefficients obtained. The linear **production function** fitted is found to be of the following reduced form:

$$\mathbf{P_p = \alpha_o - \alpha_2 e^r + \alpha_5 M + V}$$

The least-square criterion of linear regression analysis gives statistically non-significant values of slope coefficients for other input variables of the original regression model; these independent input variables are thus eliminated, and a trimmed model is run. The input variables are therefore reconstituted to consider only those explanatory variables, whose t-value was respectively statistically significant. It is revealed that even the slope coefficient value for dummy variable of land fertility index show insignificant t-value. Putting the estimated values of intercept and slopes or the regression coefficients of the considered inputs, we get

$$\mathbf{P_P = 8.75 + 0.001\,M - 0.02e^r + 3.64V}$$

The linear regression analysis has a 'goodness of fit'. The estimated F-value of the analysis of variance stands at 33.828, which is higher than the table value and therefore meaningful at 1 percent level of significance. What is more significant is the reading that the test of Durbin-Watson gives the value of 1.796, which is of course closer to two — a desirable trait. The collinearity statistics referred to as variance inflation factor (VIF) for all independent variables in the multiple regression equation is much less than 10, establishing that there is no concern for the multi-collinearity in the backward stepwise regression. In other words, there is no need of reconstituting the set of determining variables under consideration.

Table – 1

Linear Regression Analysis of the Determinants of Annual Volume of Paddy Output per Acre on a Farm in Rural Purnia, 1991-92

Mean Value: 10.37 quintals per acre
Standard Deviation: 3.65 quintals per acre

Regressors/Explanatory Variables	Regression coefficient statistics	Standard error	t- value	Significance
Constant	8.748	0.380	23.007	0.000
Total cost incurred on seeds, manure, fertilizers and irrigation per acre of operational land (rupees)	0.0007	0.000	5.082	0.000
Net area under irrigation as percentage of operated area	(-)0.018	0.006	(-)3.312	0.001
Paddy village dummy variable	3.641	0.399	9.131	0.000

In this regression analysis, the number of observations is 268 paddy farms of the sample peasantry in Purnia. The estimated R-value is 0.527. The R^2 value is the square of the correlation coefficient. The value of R^2 stands at 0.278. This R^2 value is important because it reveals how well the straight-line model fits the scatter of points in the regression plain. It is evident that it fits rather less well in the exercise under consideration. The statistical fitting of the cross-sectional paddy-crop production function is rather a poor one because it explains only 27.80 percent of the variation in the annual volume of the paddy output per acre. The intercept value is positive one; which is a high numerical figure closer to the mean value of output variable. In statistical theory, the adjusted R^2 reduces the R^2 by taking into account the sample size and the number of parameters estimated. In the present exercise, the adjusted R^2 is at the numerical figure of 0.269. Be that as it may. The F-value of the analysis of variance signals however that null hypothesis of no linear relationship is to be rejected. The contribution of the total cost incurred on seeds, manure, fertilizers and irrigation per acre of operational land to the paddy output per acre is positive. The contribution of the irrigation input in explaining the change in the paddy output is however negative one. This is expected in a rain fed farming area. The most important part is nonetheless played by the area and village specificity clubbed under the dummy of so-called 'paddy-producing village'. Theoretically, the standard error of the estimate is a measure of the accuracy of the estimates of the regression equation. It is analogous to the standard error of the mean but based on residuals i.e. the difference between the predicted and actual value of paddy output per acreage under the crop. It is of course found to be low presently. The standard error of the estimate is found to be equivalent to 3.117.

In the case of **jute crop**, a trimmed linear model of the regression analysis is statistically fitted on the aggregate sample of 268 peasant farms under consideration. This is again obtained by reconstituting the explanatory variables of the original regression model under consideration. The linear production function, which is statistically fitted, is found to be of the following reduced form:

$$\mathbf{P_J = \alpha_0 + \alpha_3 L + \alpha_6 C + \alpha_7 P_I + V}$$

The other input variables of the original model were dropped from the analysis to improve the "goodness of fit". The regression coefficients of the dropped variables have t-value, which was significant not even on 10 percent level of statistical significance. The estimated fit of the linear jute production function, obtained by least square method of multiple regression analysis with the statistical estimate of coefficients obtained, is as follows:

$$\mathbf{P_j = 2.50 + 0.01L - 0.0003M + 0.002P_1 + 2.03V}$$

The goodness of fit of the regression analysis of the annual volume of jute output per acre is established by the high numerical estimated and statistically significant F-value of analysis of variance. The estimated F-value, which stands at 45.098, is significant at 1 percent level of significance. The Durbin-Watson value is also closer to two; the estimated value is 1.772. The collinearity statistics referred to as variance inflation factor (VIF) for all independent variables in the multiple regression equation is much less than 10, which does unfailingly establish that there is no need of any concern about the multi-collinearity in the backward stepwise regression. In other words, there is no need of further reconstituting the set of determining variables under consideration.

Table – 2

Linear Regression Analysis of Determinants of Annual Volume of Jute Output per Acre on a Farm of a Peasant Household in Rural Purnia: 1991-92

Mean value = 4.85 quintals per acre
Standard deviation = 3.30 quintals per acre

Explanatory variables (Regressors)	Regression coefficient	Standard error	t-value	Significance
Constant	2.498	0.248	10.080	0.000
Total mandays of family, casual and contract labor employed per acre of jute production	0.009	0.001	9.294	0.000
Total cost incurred on seeds, manure, fertilizers and irrigation per acre of operational land (rupees)	(-)0.0003	0.000	(-)1.995	0.047
Cost incurred in employing the permanent labor per acre of operated land (rupees per acre)	0.0017	0.000	1.024	0.000
Jute village dummy variable	2.034	0.361	5.638	0.000

The number of observation is 268 peasant farms of jute crop. The estimated R coefficient is high at the figure of 0.638. The significant coefficient is however the R^2 which is 0.407. It means that 40.70 percent of the variation in the jute output per acre on the sample farms is explained by the input variables considered in the model. This is still high in a situation of a highly heterogeneous cross-section of farms of the sample. The adjusted R^2 value of course reduces to stand at 0.398. In other words, it is justifiable to use a straight-line relationship to model the selected variables. The contribution of the mandays of family, casual and contract labor per acre, and the monetary cost incurred on employing the permanent labor per acre on the jute farms are positive, along with the positive intercept value in the model. The role played by the annual cost incurred on seeds, manure, fertilizers and irrigation per acre of operational land in the change in the output of jute per acre is however negative. The village specific dummy variable is having a positive contribution in the changes in jute output on the farms. Be that as it may. The standard error of estimate is low at 2.561. It is worth a note that the regression equation of jute output can not be strictly compared with the regression equation of paddy output in terms of the goodness of fit, because the R^2 value in each case pertains to two different trimmed model altogether. This is despite it that the linearity characteristics of the models are common. Nonetheless, it is understood that the variation in the jute yield is robustly explained by the inputs under consideration.

In the case of **paddy crop** marketed by the cross-sections of aggregate sample farms, a rather trimmed model is run, because the variables relating to the income and dummy are dropped due to these being found statistically not significant. The **marketed output function** of paddy crop on the basis of reconstituted independent variables is of the following linear equation form:

$$\mathbf{S_p = A + \alpha_1 . \chi_p + \alpha_2 . \chi_j + \alpha_3 P_{mp},}$$

where **A** refer to the intercept value, the subscript **p** for the paddy crop, and α_1 to α_3 to the respective regression coefficients with respect to relevant independent variables. In the multiple regression analysis, the estimated values of intercept and regression coefficients give the following marketed output function for paddy crop:

$$\mathbf{S_p = -16.60 + 1.28\chi_p - 0.001\chi_j + 0.17\ P_{mp}}$$

Table – 3

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Paddy Crop on a Farm in Rural Purnia, 1991-92

Mean Value = 33.36
Standard Deviation=37.04

Explanatory Variables (Regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-)16.603	2.700	(-)6.149	0.000
Annual volume of paddy output per adult (quintals)	1.284	0.160	8.038	0.000
Annual market value of jute output per adult(rupees)	(-)0.0013	0.000	(-)3.472	0.001

Average market price of paddy per quintal (rupees)	0.165	0.011	15.033	0.000

The linearity assumption and the set of explanatory variables chosen gives a statistical 'goodness of fit' with a high and significant value of R^2 and F-value of analysis of variance. The standard error of the estimate is nonetheless high. The model has goodness of fit on the cross-section of farms under consideration. The number of observation is 268 paddy farms. The F-value of analysis of variance is pretty high at 170.064, which is significant at 1 percent level of significance. The Durbin-Watson value is 1.645. The estimated R-value is 0.812. The R^2 value is 0.659. In other words, the present linear model and the determining variables considered therein do explain 65.90 percent of the variation in the proportion of the net-marketed surplus of paddy. The adjusted R^2 value is of course a reduced value, that is, 0.655. The standard error of the estimate is high at 21.666. The intercept value is negative, which is of course expected. We get the negative intercept, which captures the fact that there is phenomenon of positive sales of marketed surplus along with negative phenomenon of repurchases. In case of a few peasant houses holding farm, the net-marketed surplus of paddy is a negative figure due to high repurchases and zero marketed surplus.

The contributions of the paddy output on the farm and paddy price in the market are positive to the variation in the proportion of the net-marketed surplus of paddy. It is but the role played by the market value earned by selling a commercial crop is negative. The annual jute output value per adult has otherwise weak significance in explaining the proportion of net marketed surplus to net output of the food crop of the sample farm. The three determining variables considered in the model, given the t-values estimated, are statistically significant. There is no need to reconstitute the set of variables considered, because the collinearity statistics referred to as variance inflation factor (VIF) for all independent variables in the multiple regression equation is much less than 10, establishing that there is no concern for the multicollinearity in the backward stepwise regression.

In case of **commercial crop of jute**, there is again the need to reconstitute the explanatory variables in the marketed surplus function. The income and dummy variables are statistically not significant. The trimmed model was therefore run. The statistically fitted **marketed output function** over the cross section of farms is of the following linear form:

$$\mathbf{S_j = A + \alpha_1 X_j + \alpha_2 P_{mj}},$$

where $\mathbf{S_j}$ refers to the proportion of net marketed output to net out put of jute in the year, $\mathbf{X_j}$ to annual volume of jute output per adult in quintals in the year and $\mathbf{P_{mj}}$ to the average current market price of jute per quintal in rupees received by a household. The least square method of the multiple regression analysis on the cross section of all sample farms gives the following marketed output function for jute crop estimate:

$$\mathbf{S_j = 1.85 + 0.181\, P_{mj}}$$

Table – 4

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm in Rural Purnia, 1991-92

Mean Value = 60.95
Standard Deviation = 38.83

Explanatory Variables(regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	1.850	1.236	1.496	0.136
Average jute market price per quintal (rupees)	0.181	0.003	56.499	0.000

The number of observation is 268 jute-producing farms. The model has a highly satisfactory goodness of fit. The Durbin-Watson value is highly close to the desirable value, it stands at 1.927. It is almost close to 2.0. The F-value is pretty high numerical figure; it is 3192.160. This estimated value is of course significant at 1 percent level of significance. The estimated R value is 0.961. The value of the R^2 is 0.923. In other words, almost 92 percent of the variation in the proportion of the jute-marketed surplus is explained by the trimmed linear model. The adjusted R^2 is 0.923. The standard error of the estimate is quite low at 10.791. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. This is highly expected in case of a commercial crop. The intercept value is quite low but positive. The jute marketed surplus function is a comparatively better statistical fit with linearity assumptions of regression analysis than the paddy marketed surplus function of the overall sample peasant farms.

3.1. “Class Differentiated” Results

Petty/Poor Peasant

It is worth the memory that the present cross-section agricultural food-crop production function captures the input-output relation as one moves from farm to farm. This is irrespective of the size and qualitative features of the farms. The peasant farms are however operationally quite different and diverse rather qualitatively due to the differing economic class-locations of the owner-peasantry. The linear paddy regression equations are estimated therefore for each cross sub-section of the paddy farms pertaining to the diverse agrarian locations of peasant classes. The linear production functions of paddy crop for the cross-sections of each peasant class farms, which are fitted and estimated, are all different. In the case of petty and poor peasant class farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_{pmg} = 7.50 + 0.014\, M - 0.04_{er} + 1.21V}$$

Table – 5

Linear Regression Analysis of the Determinants of Annual Volume of Paddy Output per Acre on a Farm of the Marginal Class of Peasant Household in Rural Purnia, 1991-92

Mean Value=10.26 quintals per acre
Standard Deviation =3.23 quintals per acre

Explanatory Variables	Regression coefficient	Standard Error	t-value	Significance
Constant	7.498	1.875	4.000	0.004
Total cost incurred on seeds, manure, fertilizers and irrigation per acre of operational land (rupees)	0.0144	0.008	1.886	0.096
Net area under irrigation as percentage of operated area	(-)00.043	0.029	(-)1.493	0.174
Paddy village dummy variable	1.207	1.877	0.643	0.536

The number of observation is only 12 farms. The estimated R-value of the regression analysis is 0.703. The R^2 coefficient is standing at 0.495. The adjusted R^2 is 0.305. The standard error of estimate is 2.699. The value of the Durbin-Watson value is 2.095. The F-value is 2.611, which is significant at 12.4 percent level of significance. The intercept value is positive. The monetary expenditures on the seeds, manures, fertilizers, and irrigation do contribute positively to the variation in paddy yield. The village dummy is also contributing to the variation in the paddy output per acre rather positively. The area under irrigation contributes rather negatively in the variation of paddy yield on the marginal farms of the peasantry.

An attempt is made to estimate the statistical fitting of jute-crop production function for the cross sub-sections of farms belonging to the diverse peasant economic class separately. The regression analysis is run in each case by dropping the input variables to improve the "goodness of fit" – trimming the model. In the case of petty and poor peasant class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_j^{mg} = 0.11 + 0.01L - 0.91V}$$

Table – 6

Linear Regression Analysis of the Determinants of Annual Volume of Jute Output per Acre on a Farm of Petty and Poor Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 1.19 quintals per acre
Standard Deviation = 2.79 quintals per acre

Explanatory variables (regressors)	Regression coefficient	Standard Error	t-value	Significance
Constant	0.112	0.168	0.668	0.521
Total mandays of family, casual and contract labor employed per acre of jute production	0.098	0.006	16.481	0.000
Jute village dummy variable	(-)0.906	0.451	(-)0.126	0.076

The number of observation is 12 jute farms. The estimated R is 0.986. The estimated R^2 is 0.972. In other words, almost 97 percent variation in the jute yield on the petty and poor peasant class farms is explained by the inputs under consideration in the model. The adjusted R^2 value reduces to stand numerically at 0.966. The standard error of estimate is 0.515. The Durbin-Watson value is found to be 2.118. it is of course closer to the desirable value of two. The F-value of the estimate is 156.580. This is significant at 1 percent level of significance. The intercept value is positive. The contribution of the jute specific village dummy is however negative. It is the mandays of human labor, which has a positive contribution to the jute yield on such farms.

The marketed surplus function of the paddy food crop across the cross-section of widely heterogeneous householding farms and its linear statistical fit does however serve merely as an approximation at best. It is not a true representation of farms belonging to diverse and divergent peasant class locations in the countryside. The linear paddy regression equations are estimated therefore for each cross sub-section of the paddy farms pertaining to the diverse agrarian locations of peasant classes. The linear marketed surplus functions of paddy crop for the cross-sections of each peasant class farms, which are fitted and estimated, are all different.

In the case of **petty and poor peasant** class farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_{ppp} = - 22.70 + 0.16\ P_{mp}}$$

Table – 7

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Paddy on a Farm of Petty and Poor Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 6.30
Standard Deviation = 35.60

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-)22.696	11.515	(-)1.971	0.077
Average market price of paddy per quintal (rupees)	0.161	0.049	3.304	0.008

The number of observation is only 12 paddy farms. The estimated R-value of the regression analysis of marketed surplus proportion of paddy is 0.722. The crucial R^2 value is 0.522. The adjusted R^2 value is 0.474. The standard error of estimate is 25.817. The Durbin-Watson value is highly close to the desirable value and stands at 2.152. The F-value of variance is 10.918. It is significant at 1 percent level. The intercept value is negative, which is of course expected. There is positive contribution of the paddy price received by the farmers in explaining the variation in the proportion of the paddy-marketed surplus.

The statistical fitting of linear marketed surplus function of jute crop across the cross subsection of householding farms belonging to different peasant economic classes gives the following form, based on estimates of intercept and coefficient values obtained from the least square method of multiple regression analysis. In the case of petty and poor peasant class jute- farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{Sj^{PP} = 0.009 + 0.21\ P_{mj}}$$

Table – 8

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm of the Marginal Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 14.62
Standard Deviation = 34.16

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	0.0092	0.267	0.034	0.973
Average jute market price per quintal (rupees)	0.214	0.002	134.0.22	0.000

The number of observation in this cross sub-section of paddy farms is in total 12. The estimated R-value is 1.000. The coefficient of determination, represented by the R^2 stands at 0.999. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.999. The standard error of estimate is 0.846. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 1.471. The F-value is higher than the table value for the degree of freedom under consideration. It is 17961.795, which is significant at 1 percent level of significance. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. The intercept value is quite low but positive.

Small Peasant

In the case of small peasant class farms, the statistical fitting gives the following linear form of regression equation for paddy crop:

$$\mathbf{P_p^{sp} = 7.71 + 0.02\ P_{LM} + 2.48V}$$

Table – 9

Linear Regression Analysis of the Determinants of Annual Volume of Paddy Output per Acre on a Farm of Small Class of Peasant Household in Rural Purnia, 1991-92

Mean Value=9.43 quintals per acre
Standard Deviation =2.93 quintals per acre

Explanatory variables	Regression coefficient	Standard error	t-value	Significance
Constant	7.714	0.542	14.229	0.000
Cost incurred in employing the permanent labor per acre of operated land (rupees per acre)	0.018	0.005	3.611	0.001
Paddy village dummy variable	2.482	0.724	3.427	0.001

The number of observation is 42 farms. The estimated R-value is 0.631. The R^2 is 0.398. In other words, close to 40 percent of the variation in the yield of paddy on small class farms are explained by the inputs considered in the trimmed linear model. The adjusted R^2 is 0.368. The standard error of estimate is found to be at 2.335. The Durbin- Watson value is closer to two at 2.250. It is found that the null hypothesis of no relation is to be rejected because the F-value is 12.911, and it is significant at 1 percent level. The intercept value is positive. The cost incurred in employing the permanent labor per acre of operated land contributes positively to the variation in the paddy yield on the small farms. The village dummy is also contributing to the variation in the paddy output per acre rather positively.

In the case of small peasant class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_j^{sp} = 0.64 + 0.02L + 2.97V}$$

Table – 10

Linear Regression Analysis of the Determinants of Annual Volume of Jute Output per Acre on a Farm of Small Class of Peasant Household in Rural Purnia: 1991-92

Mean Value = 2.82 quintals per acre
Standard Deviation = 3.21 quintals per acre

Explanatory variables (regressors)	Regression coefficient	Standard error	t-value	Significance
Constant	0.642	0.350	1.836	0.074
Total mandays of family, casual and contract labor employed per acre of jute production	0.0199	0.002	8.940	0.000
Jute village dummy variable	2.974	0.777	3.828	0.000

The number of observation in the present regression exercise is a cross sub-section of 42 jute producing farms. The estimated R-value is found to be 0.846. The estimated R^2 value is standing at 0.715. In other words, almost 71.5 percent variation in the jute yield on the small peasant class farms is explained by the inputs under consideration in the model. The adjusted R^2 value is a reduced one at 0.700. The standard error of estimate is pretty low at 1.759. The Durbin-Watson value is 1.823, which is close to two. The F-value of the analysis of variance is certainly positive. It is considerably high value at 48.938, which is significant at 1 percent level of significance. The intercept value is positive. The contribution of the jute specific village dummy is also positive. It is otherwise the mandays of human labor alone which has a positive contribution to the jute yield on the farms of the small class peasantry.

In the case of **small peasant** class paddy-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_p^{sp} = -\,20.22 + 0.18\,P_{mp}}$$

Table – 11

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Paddy on a Farm of Small Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 5.46
Standard Deviation = 33.70

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-)20.215	4.506	(-)4.486	0.00
Average paddy price per quintal (rupees)	0.181	0.022	8.200	0.000

The number of observation in this cross sub-section of paddy farms is in total 42 farms. The estimated R-value is 0.792. The coefficient of determination, represented by the R^2 stands at 0.627. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.618. The standard error of estimate is 20.778. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 2.021. The F-value of the analysis of variance is higher than the table value for the degree of freedom under consideration. It is 67.238, which is significant at 1 percent level of significance. The intercept value is negative, which is of course expected. There is positive contribution of the paddy price received by the farmers in explaining the variation in the proportion of the paddy-marketed surplus. It is evident that the farms, which do belong to the petty and small farmers, are influenced principally by the market price of the crop while taking a decision to market the food crop.

In the case of **small peasant** class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_j^{SP} = 1.18 + 0.18\ P_{mj}}$$

Table – 12

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm of Small Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 36.55
Standard Deviation = 41.63

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	1.182	2.550	0.464	0.645
Average jute market price per quintal (rupees)	0.182	0.009	20.749	0.000

The number of observation in this cross sub-section of paddy farms is in total 42. The estimated R value is 0.957. The coefficient of determination, represented by the R^2 stands at 0.915. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.913. The standard error of estimate is 12.288. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 2.079. The F-value of the analysis of variance is higher than the table value for the degree of freedom under consideration. It is 430.501, which is significant at 0.1 percent level of significance. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. The intercept value is quite low but positive.

Middle Peasant

In the case of middle-peasant class farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_p^{mp} = 9.26 - 0.03e^r + 3.44V}$$

Table – 13

Linear Regression Analysis of the Determinants of Annual Volume of Paddy Output per Acre on a Farm of Middle Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 9.69 quintals per acre
Standard Deviation = 2.90 quintals per acre

Explanatory variables	Regression coefficient	Standard error	t-value	Significance
Constant	9.256	0.570	16.238	0.000
Net area under irrigation as percentage of operated area	(-)0.027	0.120	(-)2.293	0.026
Paddy village dummy variable	3.436	0.746	4.605	0.000

The number of observation is 51 farms. The estimated R stands at 0.558. The estimated R^2 value is 0.311. Accordingly, the adjusted R^2 value is 0.282. The standard error of estimate is 2.460. The Durbin-Watson value is little far off from the desirable value of two at 1.341. The F-value is 10.830, which is significant at 1 percent level of significance. The intercept value is positive. The village dummy is also contributing to the variation in the paddy output per acre rather positively. The contribution of the net area under irrigation as percentage of operated area to the paddy yield on the middle class farms is negative.

In the case of middle-peasant class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_j^{mp} = 1.24 + 1.29A + 1.57V}$$

Table – 14

Linear Regression Analysis of the Determinants of Annual Volume of Jute Output per Acre on a Farm of Middle Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 4.12 quintals per acre
Standard Deviation = 3.63 quintals per acre

Explanatory variables (regressors)	Regression coefficient	Standard error	t-value	Significance

Constant	1.239	0.450	2.756	0.008
Annual acreage under jute crop (acres)	1.287	0.159	8.097	0.000
Jute village dummy variable	1.570	0.723	2.171	0.035

The number of observation is 51 sample jute farms. The estimated R-value of the present regression analysis is 0.795. The estimated R^2 value is 0.633. It is clear that the form of the trimmed models is changing across the divergent peasant class jute-farms, and the coefficient of determination value is subsequently decreasing. The adjusted R^2 value is 0.617. The standard error of estimate is found to be at 2.244. The Durbin-Watson value is a little far off from the desirable value; it is at the numerical figure of 1.629. The F-value of the analysis of variance is high enough at 41.341. It is significant at 1 percent level of significance. The intercept value is positive. The contribution of the jute specific village dummy is also positive. In the case of the middle peasant farms, there is a positive contribution of the acreage under jute to the jute yield.

In the case of middle-peasant class paddy-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_p^{MP} = -\,11.14 + 1.05\ X_p + 0.15\ P_{mp}}$$

Table – 15

Linear Regression Analysis of the Determinants of the Proportion of
Net Marketed Output to Net Output of Paddy on a Farm of Middle Class of Peasant
Household in Rural Purnia, 1991-92

Mean Value = 33.46
Standard Deviation = 26.09

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-) 11.141	4.304	(-)2.588	0.013
Annual volume of paddy output per adult (quintal)	1.054	0.306	3.440	0.001
Average market paddy price per quintal (rupees)	0.147	0.017	8.865	0.000

The number of observation in this cross sub-section of paddy farms is in total 51 farms. The estimated R value is 0.860. The coefficient of determination, represented by the R^2 stands at 0.739. This is certainly a high numerical figure. In other words, almost 74 percent of the variation in the proportion of marketed surplus of paddy on the middle class farms is explained by the paddy output and its price being considered in the trimmed linear model. There is positive contribution of both the paddy volume produced on the farms as well as the price received by the farmers in explaining the variation in the proportion of the paddy-marketed surplus. The adjusted R^2 reduces to the value of 0.728. The standard error of estimate is 13.600. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 1.795. The F-value of analysis of variance is higher than the table value for the degree of freedom under consideration. It is 67.992, which is significant at 1 percent level of significance. The intercept value is negative, which is of course expected.

In the case of middle-peasant class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_j^{MP} = 1.61 + 0.19\, P_{mj}}$$

Table – 16

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm of Middle Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 51.70
Standard Deviation = 42.37

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	1.604	2.218	0.723	0.473
Average jute market price per quintal (rupees)	0.190	0.007	29.133	0.000

The number of observation in this cross sub-section of paddy farms is in total 51. The estimated R-value is 0.972. The coefficient of determination, represented by the R^2 stands at 0.945. In other words, almost 94 percent of the variation in the proportion of marketed surplus of jute on the middle class farms is explained by its price being considered in the trimmed linear model. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.944. The standard error of estimate is 9.999. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 1.468. The F-value is higher than the table value for the degree of freedom under consideration. It is 848.712, which is significant at 1 percent level of significance. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. The intercept value is quite low but positive.

Rich Peasant

In the case of rich peasant class farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_p^{rp} = 9.64 - 0.02e^r + 0.04P_L + 4.03V}$$

Table – 17

Linear Regression Analysis of the Determinants of Annual Volume of Paddy Output per Acre on a Farm of Rich Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 10.47 quintals per acre
Standard Deviation = 3.49 quintals per acre

Explanatory Variables	Regression coefficient	Standard error	t-value	Significance
Constant	9.639	0.452	21.429	0.000
Net area under irrigation as percentage of operated area	(-)0.017	0.007	(-)2.351	0.021
Annual number of mandays of plough labor hired-in per acre of operated land	0.044	0.020	2.198	0.030
Paddy village dummy variable	4.027	0.658	6.116	0.000

The number of observation in this cross sub sectional regression analysis is 108 farms. It is estimated that the R-value is 0.585. The estimated R^2 is 0.343. In other words, almost 34 percent of the variation in the yield of paddy on rich class farms are explained by the inputs considered in the trimmed linear model. The adjusted R^2 value is 0.324. The standard error of estimate is pretty low at 2.872. The Durbin-Watson value is 2.042. Of course, it is closer to the desirable figure of two. The F-value stands at 18.066. This establishes that the regression estimate is meaningful at 0.1 percent level of significance. The intercept value is positive. The mandays of plough labor hired-in contributes positively but the area under irrigation rather negatively to the variation in the paddy yield on the rich class farms. The village dummy is also contributing to the variation in the paddy output per acre rather positively.

In the case of rich peasant class jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_j^{rp} = 4.53 + 0.003L + 0.03\ P_L + 1.81V}$$

Table – 18

Linear Regression Analysis of the Determinants of Annual Volume of Jute Output per Acre on a Farm of Rich Class of Peasant Household in Purnia, 1991-92

Mean Value = 6.18 quintals per acre
Standard Deviation = 2.28 quintals per acre

Explanatory variables (regressors)	Regression coefficient	Standard Error	t-value	Significance

Constant	4.534	0.380	11.934	0.000
Total mandays of family, casual and contract labor employed per acre of jute production	0.0025	0.001	2.790	0.006
Annual number of mandays of plough labor hired-in per acre of operated land	0.0279	0.014	2.005	0.048
Jute village dummy variable	1.813	0.413	4.387	0.000

The number of observation in this regression analysis is 108 jute farms belonging to the rich class peasantry. The estimated R-value is 0.501. The estimated R^2 value is 0.251. In other words, merely 25 percent of the variation in the yield of jute on the rich class farms is explained by the inputs considered in the trimmed linear model. A non-linear model would be probably a better fit. The adjusted R^2 value is 0.229. The standard error of estimate is 2.001. The Durbin-Watson value is 1.998, which is very close to the value of two. The F-value of the analysis of variance is comparatively low at 11.605. This is however significant even at even 1 percent level of significance. The intercept value is positive. The contribution of the jute specific village dummy is also positive. There is definite contribution of the mandays of human and plough labor to the yield of jute on the farms of the rich peasantry. The t- values of the regression coefficients of these agricultural inputs are of course are statistically significant at 5 percent level of significance.

In the case of **rich-peasant** class paddy-farms, the statistical fitting gives the following linear form of regression equation:

$$S_p^{RP} = -10.71 + 1.14\ Xp - 0.002\ X^v_j + 0.16\ P_{mp}$$

Table – 19

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Paddy on a Farm of Rich Class of Peasant Household in Rural Purnia, 1991 - 92

Mean Value = 35.63
Standard Deviation = 36.17

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-) 10.711	5.163	(-)2.075	0.040
Annual paddy output per adult (quintal)	1.140	0.309	3.695	0.000
Annual value of jute output per adult (rupees)	(-) 0.002	0.001	(-)3.166	0.002
Average paddy price per quintal	0.165	0.019	8.546	0.000

(rupees)				

The number of observation is 108 paddy farms. The value of estimated R is 0.770. The value of the coefficient of determination, R^2 is 0.592. The adjusted R^2 is 0.580. The standard error of estimate is 23.429. The Durbin-Watson value is 1.677. The ANOVA F-value is 50.355. It is significant at 0.1 percent level of significance. The intercept value is negative, which is of course expected. There is positive contribution of the paddy price received by the farmers in explaining the variation in the proportion of the paddy-marketed surplus. The contribution of the market value realized by selling the commercial crop is of course negative.

In the case of **rich-peasant class** jute-farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_J^{RP} = 6.30 + 0.17\,P_{MJ}}$$

Table – 20

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm of Rich Class of Peasant Household in Rural Purnia, 1991- 92

Mean Value = 79.14
Standard Deviation = 24.13

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	6.299	4.332	1.454	0.149
Average jute market price per quintal (rupees)	0.170	0.010	17.478	0.000

The number of observation is in total 108 paddy farms. The estimated R value is 0.862. The coefficient of determination, represented by the R^2 stands at 0.742. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.740. The standard error of estimate is 12.302. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 2.138. The F-value of analysis of variance is higher than the table value for the degree of freedom under consideration. It is 305.498, which is significant at 1 percent level of significance. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. The intercept value is quite low but positive.

Landlord/Capitalist Class

In the case of landlord class farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_p^{cp} = 10.68 - 0.02B + 2.90V}$$

Table – 21

Linear Regression Analysis of Determinants of Annual Volume of Paddy Output per Acre on a Farm of Landlord and Capitalist Class of Peasant Household in
Rural Purnia, 1991-92

Mean Value = 11.57 quintals per acre
Standard Deviation = 4.74 quintals per acre

Explanatory Variables	Regression coefficient	Standard error	t-value	Significance
Constant	10.676	0.883	12.096	0.000
Annual number of mandays of plough labor hired-in per acre of operated land	(-)0.0185	0.009	(-)2.144	0.037
Paddy village dummy variable	2.899	1.183	2.450	0.018

The number of observation is 55 paddy farms belonging to the well to do peasantry. The estimated R value is 0.437. The estimated R^2 value is 0.191. In other words, merely 19 percent of the variation in the yield of paddy on landlord class farms is explained by the inputs considered in the trimmed linear model. A non-linear model would be a better fit. Be that as it may. In the present linear model, the adjusted R^2 value is 0.160. The standard error of estimate is found to be at the numerical figure of 4.346. The value of the Durbin-Watson value is 1.917. Undoubtedly, it is closer to two. The F-value is at 6.126, this is lower than the table value. This is significant only at 5.0 percent level. The intercept value is positive. The contribution of annual number of mandays of plough labor hired-in per acre of operated land to the yield of paddy on the landlord farms is negative. The village dummy is however contributing to the variation in the paddy output per acre rather positively.

In the case of landlord and capitalist class jute farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{P_j^{cp} = 2.96 + 0.01L - 0.0004C + 0.003P_1}$$

Table – 22

Linear Regression Analysis of Determinants of Annual Volume of Jute Output per Acre on a Farm of Landlord and Capitalist Class of Peasant Household in
Rural Purnia, 1991-92

Mean Value = 5.24 quintals per acre

Standard Deviation = 3.40 quintals per acre

Explanatory variables (regressors)	Regression coefficient	Standard error	t-value	Significance
Constant	2.959	0.645	4.587	0.000
Total mandays of family, casual and contract labor employed per acre of jute production	0.0073	0.002	4.137	0.000
All modern powered equipment and machinery value per unit of area operated (rupees)	(-)0.00035	0.000	(-)2.430	0.019
Cost incurred in employing the permanent labor per acre of operated land (rupees per acre)	0.0030	0.001	3.342	0.002

The number of observation is 55 jute farms. The estimated R-value is 0.555. The estimated R^2 value is 0.308. The adjusted R^2 value is 0.268. The standard error of estimate is 2.909. The Durbin-Watson value is 1.620. The F-value of the analysis of variance is 7.580, which is significant at 1 percent level of significance. The intercept value is positive. The contribution of the jute specific village dummy is nil, that is, statistically not significant at all. The human labor mandays used per acre and the cost incurred on hiring-in the permanent labor do have statistically significant contributions to the jute yield on the landlord farms. It is surprising to note that the expenditures incurred on the tools and machinery do contribute to the jute yield on the farms of this peasant class only, and that too rather negatively.

In the case of **landlord and capitalist peasant** class paddy farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_p^{LP} = -1.26 + 1.15\, Xp - 0.002\, X^v_j + 0.15\, P_{mp}}$$

Table – 23

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Paddy on a Farm of Landlord and Capitalist Class of Peasant Household in Rural Purnia, 1991-92

Mean Value = 56.02
Standard Deviation = 33.73

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	(-)1.262	8.769	(-)0.144	0.886
Annual paddy output per adult (quintal)	1.114	0.248	4.486	0.000
Annual value of jute output per adult (rupees)	(-)0.0016	0.001	(-)2.476	0.017

Average paddy price per quintal (rupees)	0.147	0.031	4.751	0.000

The number of observation is 55 farms. The estimated R is 0.758. The value of R^2 is 0.575. The adjusted R^2 value is 0.550. The standard error of the estimate is 22.062. The Durbin-Watson value stands at 1.165. The F-value of analysis of variance is 23.017, which is of course significant at 1 percent level. The intercept value is negative, which is of course expected. There is positive contribution of the paddy price received by the farmers in explaining the variation in the proportion of the paddy-marketed surplus. The contribution of the market value realized by selling the commercial crop is of course negative.

In the case of **landlord and capitalist class** jute farms, the statistical fitting gives the following linear form of regression equation:

$$\mathbf{S_j^{LP} = 1.43 + 0.18\ P_{mj}}$$

Table – 24

Linear Regression Analysis of the Determinants of the Proportion of Net Marketed Output to Net Output of Jute Crop on a Farm of the Landlord and Capitalist Class of Peasant Household in Rural Purnia, 1991 – 92

Mean Value = 62.55
Standard Deviation = 37.46

Explanatory Variables (regressors)	Regression coefficients	Standard error	t-value	Significance
Constant	1.430	1.957	0.731	0.468
Average market price of jute per quintal (rupees)	0.179	0.005	36.354	0.000

There are 52 paddy farms in this cross sub-section of observations. The estimated R-value of the regression analysis is 0.981. The coefficient of determination, represented by the R^2 stands at 0.961. This is certainly a high numerical figure. The adjusted R^2 reduces to the value of 0.961. The standard error of estimate is 7.425. The crucial test of the goodness of fit of the regression analysis is nonetheless performed by checking the value of the Durbin-Watson. It stands at the value of 1.536. The ANOVA F-value is higher than the table value for the degree of freedom under consideration. It is 1321.642, which is significant at 0.1 percent level of significance. There is no concern for the multi-collinearity phenomenon. The market price of the jute crop received by the farmers is the sole explanatory variable worth consideration. The intercept value is quite low but positive.

4. Economic Class Differentiated Technique Efficiency on Farms

In the case of paddy crop, the regression analysis is run over the aggregate sample of farms, and the statistical estimate of coefficients obtained. The linear regression function fitted is found to be of the following reduced form:

$$P_p = \alpha_o - \alpha_2 e^r + \alpha_5 M + V$$

The least-square criterion of linear regression analysis gives statistically non-significant values of slope coefficients for other input variables of the original regression model; these independent input variables are thus eliminated, and a trimmed model is run. The input variables are therefore reconstituted to consider only those explanatory variables, whose t-value was respectively statistically significant. It is revealed that even the slope coefficient value for dummy variable of land fertility index show insignificant t-value. Putting the estimated values of intercept and slopes or the regression coefficients of the considered inputs, we get

$$P_P = 8.75 + 0.001\,M - 0.02e^r + 3.64V$$

The linear regression analysis has a 'goodness of fit'. The estimated F-value of the analysis of variance stands at 33.828, which is higher than the table value and therefore meaningful at 1 percent level of significance. What is more significant is the reading that the test of Durbin-Watson gives the value of 1.796, which is of course closer to two — a desirable trait. The collinearity statistics referred to as variance inflation factor (VIF) for all independent variables in the multiple regression equation is much less than 10, establishing that there is no concern for the multicollinearity in the backward stepwise regression. In other words, there is no need of further reconstituting the set of determining variables under consideration.

In the case of jute crop, a trimmed linear model of the regression analysis is again statistically fitted by reconstituting the explanatory variables of the original regression model under consideration. The linear regression function, which is statistically fitted, is found to be of the following reduced form:

$$P_J = \alpha_0 + \alpha_3 L + \alpha_6 C + \alpha_7 P_I + V$$

The other input variables of the original model are dropped from the analysis to improve the "goodness of fit". The regression coefficients of the dropped variables have t-value, which is significant not even on 10 percent level of statistical significance. The estimated fit of the linear jute production function, obtained by least square method of multiple regression analysis with the statistical estimate of coefficients obtained, is as follows:

$$P_j = 2.50 + 0.01L - 0.0003M + 0.002P_1 + 2.03V$$

The goodness of fit of the regression analysis of the annual volume of jute output per acre is established by the high numerical estimated and statistically significant F-value of analysis of variance. The estimated F-value, which stands at 45.098, is significant at 1 percent level of significance. The Durbin-Watson value is also closer to two; the estimated value is 1.772. The collinearity statistics referred to as variance inflation factor (VIF) for all independent variables in the multiple regression equation is much less than 10, which does unfailingly establish that there is no need of any concern about the multi-collinearity in the backward stepwise regression. In other words, there is again no need of further reconstituting the set of determining variables under consideration.

Table – 25

Distribution of Paddy-producing Sample Farms in Purnia: Peasant Economic Class-wise and Technique-Efficiency-Index-Group-wise, 1991–92

Economic Classes of Peasantry	Technique Efficiency Groups of Paddy Farms			
	Inefficient Farm	Highly Efficient Farm	Just Efficient Farm	All-group Farms
Petty and Poor class	6	5	1	12
Small class	30	10	2	42
Middle class	32	16	3	51
Rich class	58	49	1	108
Landlord and Capitalist class	24	31	Nil	55
All Classes of Peasantry	150	111	7	268

Source: Field Survey, 1991-92

It is found that the numerical value of the production efficiency index for paddy producing farms ranges from 0.38 to 2.02. There are in total 150 paddy producing farms, which are inefficient, 7 just efficient and 111 highly efficient ones. It is also of interest to see whether the distribution of farms based on technique efficiency index has any non-monotonic statistical relations with the distribution of farms based on the labour-exploitation index. The row–column table is reduced to the 3 x 3 contingency table by combining the petty and small peasant class farms on the one hand and rich and landlord and capitalist class farms on the other. The estimated Chi-square value is 14.807 with the degree of freedom at 4 and the contingency coefficient value is 0.229, which is not significant at 1 percent level. The insignificant chi-square value and contingency coefficient value in case of paddy crop farms rules out any non-monotonic relation between peasant class groupings and technique-efficiency index based farms grouping. In other words, the efficient and inefficient farms are scattered across all peasant classes.

Table – 26

Distribution of Jute-producing Sample Farms in Purnia: Peasant Economic Class-wise and Technique-Efficiency-Index-Group-wise, 1991–92

Economic Classes of Peasantry	Technique Efficiency Groups of Jute Farms			
	Inefficient Farm	Highly Efficient Farm	Just Efficient Farm	All-group Farms
Petty and Poor class	10	2	Nil	12
Small class	26	16	Nil	42
Middle class	26	25	Nil	51

Rich class	41	65	2	108
Landlord and Capitalist class	28	27	Nil	55
All Classes of Peasantry	131	135	2	268

Source: Field Survey, 1991-92

It is the same exercise, which is repeated for the jute producing farms. In this case, the technique efficiency index ranges from 0.30 to 3.36. In the case of jute producing farms, the number of inefficient farms is equally 131, just efficient merely 2, and highly efficient farms 135 in total. In the arrangement of the 3 x 3 contingency table, the estimated Chi-square value is 10.582 with the degree of freedom standing at 4 and the contingency coefficient value is 0.195, which is statistically significant. In case of jute producing farms, there exists a relation between the two groupings. The highly efficient jute farms are mostly owned and operated by the dominant peasant classes, whereas the inefficient jute farms are mostly operated by the exploited peasant classes.

Conclusion

There are heterogeneous agricultural farms in Purnia. These heterogeneous farms belong to the economically differentiated peasant households in the countryside. Such farms differ in matter of production efficiency. The farms are quite different in matter of both the production technology adopted as well as the behavior with regard to the crop sales on the market. There are therefore different trimmed linear models applicable to the cross sub-section of the sample peasant farms in Purnia. The marginal productivity of inputs are also dissimilar across the farms of different peasant classes, and therefore shows variations in the technical-organizational complex of farms.

The significance level of linear regression analysis of the determinants of annual volume of paddy output per acre under cultivation of the petty and poor peasant class farms as well as the landlord and capitalist class farms are quite low. A single linear production function for all 268 farms in the sample is not at all warranted. The only commonality is the linearity characteristics of the production function, and the positive role-played the village-specific dummy variable in explaining the variation in the paddy output per acre in all exercises, except the farms belonging to the landlord class. It is otherwise human labor alone which has a positive contribution to the jute yield on the farms of the marginal and small class peasantry. In the case of the middle peasant farms, there is a positive contribution of the acreage under operated land to the jute yield. The intercept value of the regression analysis of the jute yield on the rich class farms is positive. The contribution of the jute specific village dummy is also positive. There is definite contribution of the mandays of human and plough labor to the yield of jute on the farms of the rich peasantry. In the case of the landlord jute farms, the intercept value is positive. The contribution of the jute specific village dummy is nil, that is, statistically not significant at all. The human labor mandays used per acre and the cost incurred on hiring-in the permanent labor do have statistically significant contributions to the jute yield on the landlord farms. It is surprising to note that the expenditures incurred on the tools and machinery do contribute to the jute yield on the jute farms of this peasant class only and that too rather negatively. In other words, the conclusion of analysis on statistical fitting of production functions of subsistence and commercial crops on a sample of farms in Purnia is sharp: the two functions do differ. In case of both paddy as well as jute farms, the statistical fitting of production functions on farms belonging to different economic class of peasantry are different. A homogeneous peasantry in terms of input–output relations of crop farms is again merely a misnomer.

The behavior of divergent classes of peasantries with regard to the marketing a proportion of the net output is equally interesting in Purnia. In case of petty as well as small class farms, the proportion of paddy surplus marketed is explained by merely the paddy price factor. In case of middle class farms, the marketed surplus volume is however explained by both price as well as paddy output variables. In case of rich and landlord class farms, almost three variables explain the marketed surplus: price of paddy, output of paddy and jute output value. The current value of jute output per adult does contribute of course in the negative way. What is not to be missed is the implication brought about by these regression exercises is that the economic classes of peasantry are significant principal factor in the hierarchy of marketed surplus function of paddy. In the case of farms of the peasantry of the marginal and petty class and landlord class, the regression models have comparatively much better 'goodness of fit'. The linearity of the model and its fitness on these two sub sections of farms are as good as the statistical fitness on the aggregate cross section of 268 jute farms under consideration. On the jute farms of the peasants of middle class, the degree of goodness of statistical fit of the marketed surplus functions is equally satisfactory. The same in case of rich peasant class jute farms is however not as good. The number of observations, that is, the size of sample of cross section of farms of each peasant class is different, and therefore, the sampling error of estimates cannot be ruled out. Be that as it may. On the farms of the commercial crop, the price is the most significant explanatory variable of marketed output for all classes of peasantry; the output volume of food and commercial crops is however explanatory variable on the farms of the rich and landlord classes of peasantry in case of marketed output of the paddy. The intercept and the coefficient value of the jute price variable are quite different to further establish that the degree of commercialization are quite different among the farms of peasant households across the diverse class positions in the agrarian countryside of Purnia. In short, there exist a hierarchy of marketed output functions of both food as well as commercial crop across the farms of different peasant sectional clusters, and the best fit for the rich peasant class is probably a non-linear marketed output function. In such a situation, it is highly plausible to argue that the commercial and distress sales exist coexist and affect upon the diverse factions of peasantry differently.

References

Acharya, S. S. (1988), Agricultural Production, Marketing and Price Policy in India, Mittal Publication, New Delhi

Anderson, J. R. and N. S. Jodha (1973), "On Cobb-Douglas Production Function and Related Myths", *Economic and Political Weekly* (Reviews of Agriculture), June

Bharadwaj, Krishna (1985), "A Note on Commercialization in Agriculture" in Raj, K. N., N. Bhattacharya, S. Guha and S. Padhi (1985) (Eds.), Essays on the Commercialization of Indian Agriculture, Oxford University Press, Delhi

Kritsman, L. N. (1984), "Class Stratification of the Soviet Countryside", in Terry Cox and Garry Littlejohn (1984) (Eds.), Kritsman and the Agrarian Marxists, Frank Cass, London

Leonard, W.H. and J.H. Martin (1963), Cereal Crops, Macmillan, New York

Lewis-Beck, Michael (1980), Applied Regression: An Introduction, Sage Publications, Beverly Hills, London

Mitra, Manoshi (1985), Agrarian Social Structure: Continuity and Change in Bihar, 1786-1820, Manohar Publishers, New Delhi

Patnaik, Utsa (1975), "Output and Marketable Surplus of Agricultural Products: Contribution by Cultivating Groups in India, 1960-61", *Economic and Political Weekly*, vol. 10, no. 52

Patnaik, Utsa (1987), Peasant Class Differentiation: A Study in Method with Reference to Haryana, Oxford University Press, Delhi

Rahman, Atiur (1986), Peasants and Classes: A Study of Differentiation in Bangladesh, Oxford University Press, New Delhi

Raj Krishna (1962), "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop", *Indian Journal of Agricultural Economics*, vol.18, no.3

Roy Chaudhury, P. C. (1963), Bihar District Gazetteer: Purnea, Government of Bihar, Patna

Sarkar, G. K. (1989**),** Jute in India: An Economic Analysis**,** Oxford University Press, Calcutta

Shanin, Teodor (1972), The Awkward Class: Political Sociology of Peasantry in a Developing Society, Russia 1910-25, Oxford University Press, London

Soloman, S. G. (1977), The Soviet Agrarian Debate: A Controversy in Social Science, 1923-1929, West View Press, Boulder, Colorado

Thorner, Daniel, et al. (1966), A. V. Chayanov: On the Theory of Peasant Economy, Richard Irwin Inc., Homewood

Wolf, Eric (1966), Peasants, Englewood Cliffs, New Jersey

Wolf, Eric (1969), Peasant Wars of Twentieth Century, Harper and Row, New York

Zedong, Mao (1926), "How to Differentiate the Classes in the Rural Areas?" in Zedong, Mao (1967), Selected Works, Foreign Languages Publishing House, Beijing

Zedong, Mao (1933), **"**An Analysis of the Classes in Chinese Society" in Zedong, Mao (1967), Selected Works, vol. I, Foreign Languages Publishing House, Peking