

An Analysis of Agricultural Inputs and their impacts upon Agricultural Production in Nepal

(A case study of Kavre Palanchowk District)

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INTRODUCTION AND OBJECTIVES

The study area 'Panchkhal Village Panchayat' is situated in Kabhre Palanchok District of Bagmati zone. It is 43 kilometres from east of Kathmandu, at an altitude of 960 metres above mean sea level. It lies in 85.38. east in longitude and 27.41 north latitude.

This panchayat as a whole has 900 houses and the total population is 4507. Among the total population 51% are male and remaining 49% are female.¹

This Panchkhal Panchayat is predominantly a farming village and only a few farmers are engaged in non-agricultural activities. Methods of farming are changing from traditional to modern ones, Arniko Highway has provided a good link of this village with Kathmandu city. Pressure of population is gradually increasing—mainly due to migration from hilly areas and also due to natural growth. Land fragmentation is also rapidly increasing. This Panchayat also suffers from different problems in agricultural field which are briefly explained below:

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1. Source: Gaun Panchayat Karyalaya, Panchkhal,

NEPAL

LOCATION OF STUDY AREA

SCALE 1:4000000

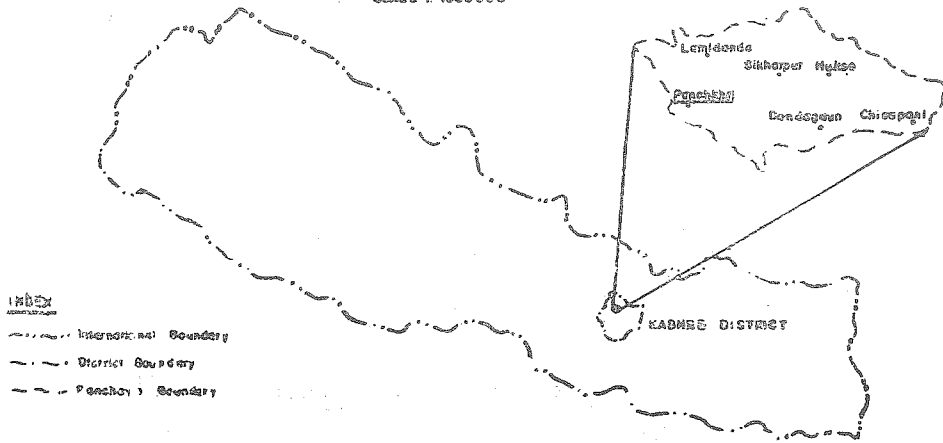
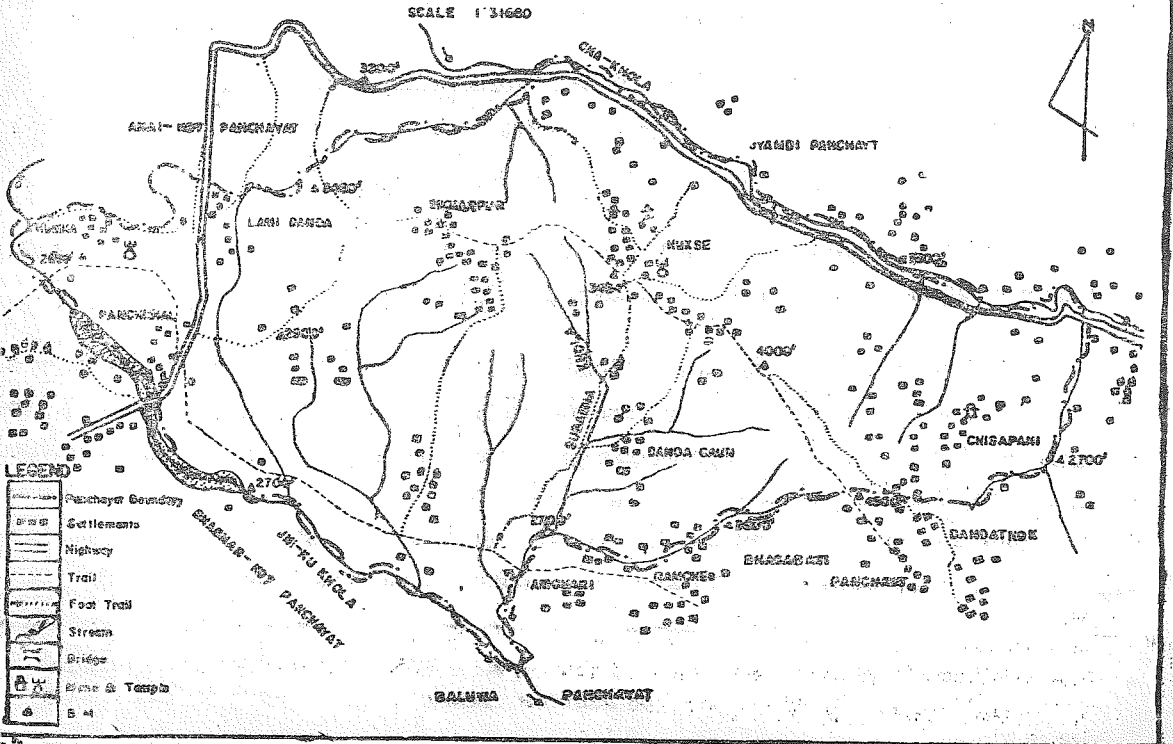


Fig 1

PANCH-KHAL VILLAGE PANCHAYAT

SCALE 1:31680



The fertile alluvial soil occurs only in the flat land areas of this village. In the hill sides land is not so fertile and in rainy season land slides destroy a lot of cultivated areas of hill. Water deficiency is the main obstacle for agriculture in this area. Though the flat land has a good favourable soil for agriculture but deficient water facilities causes low yield, the flat land suffers inadequate water specially in winter and due to so, many lands kept fallow in winter. Irrigation is the most essential factor to increase agricultural production but the farms lack proper irrigational facilities as the water from small rivulet Jhi-ku Khola is not sufficient. Due to the unavailability of irrigational facilities farmers have to depend entirely on monsoon. Therefore, there is low yielding due to uncertain and uneven rainfall of monsoon.

Though by the use of improved inputs (Chemical fertiliser) the production has increased but not satisfactorily. This happens mainly due to lack of technical knowledge of using chemical fertilisers and so on to the farmers. Farmers do not know how much quantity of fertilisers to be used for a plot of land. As the farmers report J.T.A. has not serving to them. Farmers do not find the required varieties of improved inputs in time and some times they suffer by the capital deficiency. The improved tools has not been used so much.

Agriculture is the only income source of farmers which provides money for their domestic economic affairs. But the savings from agriculture is almost zero and therefore, they have very small fund to invest in agricultural sector. On the one hand the income of the farmers being constant i.e. agricultural production is not increasing so significantly as previously due to different obstacle, the market price of chemical fertilisers, better seeds improved tools are rapidly increasing on the other. Hence, the economic standard of the farmers is declining.

These are the main problems faced by the farmers of Panchkhal Village. Due to these problems, the yield per ropani are gradually declining.

In the absence of agricultural development, farmers' condition can not improve and without any improvement of a farmer's condition, the development of a village can not be expected. Similarly to prevent the rising unemployment and continuing poverty of farmers the development in agriculture is very essential.

This study concentrates on the problem of agricultural development of Panchkhal Village Panchayat. Agriculture is the main source of income of villagers of this Panchayat and due to so, the study tries to depict about the agricultural condition of this rural area.

To analyse farmer's attitude and belief toward the modern technology and commercial farming is the general objective of this study. The specific objectives to be taken on the study are as follows:

1. To analyse the relationship between the farm size and the Production.
2. To determine the contribution of farms, labourers, chemical fertilisers and bullock - labourers, upon production.
3. To determine the relationship between the Production and area, bullock labour as inputs.
4. To examine the impact of chemical fertilisers and labourers upon production.
5. To determine the contribution of farms, labourers, chemical fertilisers and bullock - labourer upon Production.

Hypothesis to be tested

A. The following are the hypothesis to be tested in case of production function of rice in Panchkhal Village Panchayat.

1. There is significant positive correlation between Production of rice and labour used in rice production.
2. There is significant positive correlation between production of rice and amount of fertiliser used.
3. There is significant response of farm size upon production of rice.
4. There is significant response of bullock-labour upon production of rice.

B. Hypothesis to be tested in case of production function of potato in Panchkhal village are as follows :

1. There is significant positive correlation between the production of potato and number of labourers used under its cultivation.
2. There is significant positive response of fertiliser upon the production of potato.
3. An increase in farm size increases production of potato significantly.
4. An increase in bullock- labour days increases production of potato significantly.

2. METHODOLOGY

The production function seems to have been used in Nepal for the first time in the mid of 1960's. Many of the studies are done at micro level. One micro level study has been done by the joint effort of the existing Ministry of Economic Planning and the Department of Economics and Commerce, T.U.² The study attempted to compute for some physical input-output coefficients for some cereal crops in five different areas in Nepal by using Cobb-Douglas production functions. The Production function was estimated taking seeds, human labour and animal labour as independent variables. Role of chemical fertilisers was ignored.

Nepal Rastra Bank³ conducted the agricultural credit survey in 1969. It has been covering 3,195 sample households in 22 districts of Nepal. The survey made an extensive estimate of Cobb-Douglas production functions for all major crops and for large, medium and small farms in each of the 22 districts. The data were cross-sectional for the period 1969-70. The marginal value productivities were computed by farm size and by district with respect to seeds, manure, fertiliser, pesticides, human labour and bullock-labour.

Another study was conducted by consultancy services Division, Nepal Industrial Development Corporation (NIDC).⁴ Though the main aim of the study was to analyse the feasibility of opening a fertiliser production industry, but it also estimated fertiliser required for the Narayani and Bagmati Zone.

The present study is entirely based on primary source of data and the data are analysed by using Cobb-Douglas Production Function technique.

Selection of the study area

Panch Khal Village Panchayat of Kabhre Palanchok District of Bagmati Zone in selected for this study. The percentage sample taken from this Panchayat for the study represents the agricultural activities of the lowland basin part of the village. This basin is drained by Jhi-ku Khola. But the supply of water by this Khola is not adequate specially in winter. So, the basin

2. Ministry of Economic Planning and Department of Economic & Commerce, T. U., "Physical Input-Output characteristics of cereal production for selected agricultural areas in Nepal: crop year 1965-66," Kathmandu 1966.

3. Nepal Rastra Bank, Research Department, Agricultural Credit Survey Nepal, Vol. I-IV 1972.

4. Nepal Industrial Development Corporation, Econsultancy Services Division, Feasibility Report on Chemical Fertilisers, 2027-28

suffers by draught. The basin is divided in two parts by Jhi-ku Khola. One small part of the north western section of the basin is contained in Bhawarkot Panchayat and this is not included in the present study.

For the present study two commodities rice and potato were selected. Rice is the summer crop and potato is the winter crop of the study area.

Collection of Primary Data

In this study field survey data derived from interview of 35 farmers in case of rice and 28 farmers in case of potato were utilised.⁵ The survey is done on the basis of random sampling method.

Secondary data are used for a general understanding of agricultural production situation in Nepal. These are mostly based on the information derived from agricultural department of H.M.G., meteorological department and different bulletines and reports published by different government office and different instruction committee.

Types of Data

The data used in this study are cross-sectional data where production of rice and potato from different farmers in the same year 1979/80 are taken.⁶

Specification of Variables

The dependent and independent variables in this study are the following:

(a) Dependent variables

(i) Rice and (ii) Potato

(b) Independent variables

(i) Area (ii) Labour (iii) Fertilisers and (iv) Bullock-labour.

The independent variables are the cause and the dependent variables are the effect.

5. See Appendix - 1.

6. See Appendix 2 and 3.

Assumptions of the Model :-

The following are the assumptions taken in this study :

- (a) The sample is made to represent the rice and potato producer of panch khal Village of Kabhre District.
- (b) Inputs taken in this present study is sufficient to explain the output of study area.
- (c) Farmers do not use local fertiliser (i.e. compost mal) in that study area.
- (d) All lands are of the same irrigational facilities.
- (e) All labourers are of equal efficiency.
- (f) The type and fertility of soil is of homogeneous in that study area.
- (g) The impact of weather in study area is the same.

Definition of variables :-

The total variables in the present model to be estimated are the following :

- Q_R = Production of rice
- Q_P = Production of potato
- L_R = Human-labour used in rice production
- L_P = Human-labour used in potato production
- A_R = Area under rice cultivation
- A_P = Area under potato cultivation
- $Fert_R$ = Chemical fertiliser used in rice production
- $Fert_P$ = Chemical fertilisers used in potato production.
- B_R = Bullock-labour used in rice production
- B_P = Bullock-labour used in potato production.

Here estimation of the production of Cobb-Douglas type is made because with this production function it is convenient to interpret elasticities of production, marginal product

tion, marginal productivities and returns to scale. It benefits from simplifications of calculations from linear relationship by transferring to logs.

The Cobb-Douglas production function was formulated in 1928 by C.W. Cobb and P.H. Douglas. They jointly have proposed the general function as Cobb-Douglas production function: measuring X as output, K -quantity of capital and L -labour input. The generalised version of this function is:

$$X = AL^\alpha K^\beta U$$

Where α and β are elasticities with respect to labour and capital respectively, and U is a random disturbance

$$X > 0, K > 0, L \geq 0, \alpha \geq 0, \beta \geq 0, A > 0$$

All though the above production function is non-linear, it can be transformed into linear form by changing all the variables into log.

$$\text{i.e. } \log X = \log A + \alpha \log L + \beta \log K + \log U.$$

$$\frac{\text{Change in Log output}}{\text{Change in Log of labour}} = \alpha \text{ (K constant).}$$

The limiting value of absolute changes for infinitesimal increments is the concept of marginal product.

$$\frac{\% \text{ Change in output}}{\% \text{ Change in labour}} = \alpha \text{ (K-constant)}$$

$$= \text{MP of labour} \times \frac{\text{Labour unit}}{\text{Output}}$$

$$\text{So MP of labour} = \alpha \frac{\text{Output}}{\text{Labour}} = \alpha \text{ (Average product of labour)}$$

Where α is the factor of proportionality.

The Cobb-Douglas production function assumes that $\alpha + \beta = 1$. This means that there is constant returns to scale. Shortly speaking $\alpha + \beta$ is the degree of homogeneity

of the Cobb-Douglas production function. Let us say that labour and capital have increased by 10% in this case output would increase by 10%, i.e. $\alpha + \beta = 1$. Output would increase by less than 10% if $\alpha + \beta < 1$ and output would increase by more than 10% if $\alpha + \beta > 1$.

If $\alpha + \beta = 1$ constant returns to scale.

$\alpha + \beta > 1$ increasing returns to scale.

$\alpha + \beta < 1$ Decreasing return to scale.

Marginal physical productivity (MPP) of labour declines if $\alpha < 1$, as labour input is increased. If $\alpha = 0$, MPP is also equal to zero i.e. total product of labour is maximum.

In the present study, the production function we try to estimate in case of rice and potato is:

In case of rice

In non linear forms

$$\text{Model (a) :- } Q_R = b_0 L_R^{b_1} \text{ Fert}_R^{b_2}$$

$$\text{Model (b) :- } Q_R = b_0 A_R^{b_1} B_R^{b_2}$$

In log linear form :

$$\text{Model (a) :- } \log Q_R = \log b_0 + b_1 \log L_R + b_2 \log \text{Fert}_R + U$$

$$\text{Model (b) :- } \log Q_R = \log b_0 + b_1 \log A_R + b_2 \log B_R + U$$

We have $E(U) = 0$.

In case of potato

In non linear form

$$\text{Model (c) :- } Q_p = b_0 L_p^{b_1} \text{ Fert}_p^{b_2}$$

$$\text{Model (d) :- } Q_p = b_0 A_p^{b_1} B_p^{b_2}$$

In log linear form :-

$$\text{Model (c) :- } \log Q_p = \log b_0 + b_1 \log L_p + b_2 \log \text{Fert}_p + U.$$

$$\text{Model (d) :- } \log Q_p = \log b_0 + b_1 \log A_p + b_2 \log \text{Fert}_p + U.$$

We have $E(U) = 0$.

In this study attempts are made to study the response of human labour days and fertilisers once and that of area and bullock-labour days next in both cases.

The statistical hypothesis are :-

<u>null</u>	<u>alternate</u>
$b_0 = 0$	$b_0 > 0$
$b_1 = 0$	$b_1 \neq 0$
$b_2 = 0$	$b_2 \neq 0$

The hypothesis of the present study are the alternate hypothesis and these hypothesis are tested by using t - ratios.

Multiple regression analysis has been applied to explain relationship between the independent and dependent variables. The correlation between the observed value of Q and the corresponding Q is shown by the coefficient of multiple determination R^2 . R^2 is the percentage of variation explained by the fitted regression equation. It is a variable of known properties based upon the ratios of variation in the dependent variable explained by the hypothesis to the total variation.

$$R^2 = \frac{\text{Regression sum of square (RSS)}}{\text{Total sum of square (TSS)}}$$

When the number of parameters to be estimated is large or the sample size is small, the above calculations tend to over estimate R^2 . For this reason the adjusted coefficient of multiple determination is calculated as :

$$R^{-2} = 1 - \frac{\text{ESS}/df_1}{\text{TSS}/df_2}$$

Where ESS = error sum of squares and df_1 is its degrees of freedom ($n-1-k$).

TSS = total sum of squares and df_2 is its degrees of freedom ($n-1$).

n = sample size, K = number of independent variables.

F-ratio:- The relationship between the sums of squares can be shown conveniently in an analysis of variance table. F-ratio provides the overall test of significance of the model. The value of F-statistics is :

$$F_{(N_1, N_2)} = \frac{RSS/df_1}{ESS/df_2}$$

N_1 and N_2 are the degrees of freedom of numerator and denominator respectively.

t - ratio :- It tests the significance of the coefficient of independent variables. The interpretation of the coefficient of independent variables of our production function is based on t - test :

$$t_{b_i} = \frac{b_i}{\sqrt{\frac{ESS}{df_1} \times \frac{1}{i}}}$$

Where b_i = Coefficient of the i th element

i = diagonal element of the i th unit of inverse matrix.

Hypothesis Testing

I. Regressing output of rice and inputs the hypothesis are tested between -

- (1) Production of rice and human labour days.
- (2) Production of rice and chemical fertiliser.
- (3) Production of rice and farm-size.
- (4) Production of rice and bullock-labour.

II. In case of potato the hypothesis has been tested regressing -

- (5) Production of potato and human labour days
- (6) Production of potato and chemical fertiliser
- (7) Production of potato and farm size
- (8) Production of potato and bullock-labour days.

The above relationship that are based upon the hypothesis is tested using t-ratio which shows the significancy of the coefficients of the variable that are used in the models.

3 MAJOR EMPIRICAL FINDINGS

All the variables are measured in physical terms. Output is measured in Muri, chemical fertiliser is measured in Kg., bullock-labour is measured in bullock-labour days, labour is measured in human labour days and area has been measured in ropani.

Case-I. The Production Function of Rice

Model (a):—In this model rice has been regressed with labour and chemical fertiliser.⁷ The estimated log linear production function is:

$$\text{Log } Q_R = -1.511 + 0.91 \text{ Log } L_R + 0.78 \text{ Log Fert}_R$$

(7.98)* (7.5)*

Production function in non-linear form is :

$$Q_R = .03083 L_R^{0.91} \text{ Fert}_R^{0.78}$$

$$N = 35$$

$$R^2 = .6795 \quad F_{2,32} = 33.93^*$$

$$R^2 = .659$$

Model (b):—In this model rice has been regressed with area and bullock-labour days.⁸ The estimated log linear production function is :

$$\text{Log } Q_R = .75 + 0.86 \text{ log } A_R + 0.14 \text{ log } B_R$$

(3.97)* (.589)

Production in non linear form is :

* represents significant at 1 percent level.

7. See model a, Appendix-4.

8. See model b, Appendix-4.

$$Q_R = 5.623 A_R^{.86} B_R^{.14}$$

$$N = 35$$

$$R^2 = .929 \quad F_{2,3} = 209.37^*$$

$$R^{-2} = .924$$

Case-II. The production Function of Potato

Model (c):- In this model potato (the representative winter crop) has been regressed with labour and chemical fertiliser.⁹ The estimated log linear production function is :

$$\text{Log } Q_p = 0.529 + 0.7624 \log L_p + 0.1329 \log \text{Fert}_p$$

(9.67)* (1.96)**

Production function in non-linear form is:

$$Q_p = 3.38 L_p^{.76} \text{Fert}_p^{.13}$$

$$N = 28$$

$$R^2 = .945 \quad F_{2,25} = 217.33^*$$

$$R^{-2} = .941$$

Model (d):- Regressing potato with area and bullock-labour days the following log liner production function is obtained.¹⁰

$$\text{Log } Q_p = 0.7853 + 0.901 \log A_p + 0.063 \log B_p$$

(11.11)* (0.857)

Production in non-linear form is :

$$Q_p = 6.099 A_p^{.901} B_p^{.063}$$

* represents significant at 1 percent level.

** represents significant at 10 percent level.

9. See model c, Appendix-5.

10. See model d, Appendix-5.

$N = 28$

$R^2 = .955$ $F_{2,25} = 268.97^*$

$R^{-2} = .952$

Empirical Findings and their Interpretations

The interpretation of results is based on the following statistical table.

Case (1): The Production Function of Rice

Model [a] :- $\text{Log } Q_R = \log b_0 + b_1 \log L_R + b_2 \log \text{Fert}_R$

Model [b] :- $\text{Log } Q_R = \log b_0 + b_1 \log A_R + b_2 \log B_R$

Table 1

Findings Model	b_1	b_2	Efficiency	R^2	R^{-2}	$F_{2,32}$	MPP	Returns to scale	Share (in %)	N
Model - a	.91 (7.98)*	.72 (7.5)	.03083	.6795	.659	33.93*	MPP = .85 MPPFert = .71	1.69	L = 54% Fert = 46%	35
Model - b	.86 (3.97)*	.14 (.589)	5.623	.929	.924	209.37*	MPPA = 1.53 MPPB = .18	1	A = 86% B = 14%	35

Note : figures in parenthesis shows t-ratio

* represents significant at 1 percent level.

Model-a

(1) In this model¹¹ rice is regressed with labour and chemical fertiliser. The coefficient of labour and fertiliser both have the positive sign which means that there is positive relationship between input and output rice.

(2) The coefficient of labour and chemical fertiliser are significant at all levels. So the hypothesis that labour and fertiliser have significant positive correlation upon production of rice is accepted. Since b_1 and b_2 are significantly different from zero, the alternate hypothesis that $b_1 \neq 0$, $b_2 \neq 0$ are accepted.

(3) When all the variables are in logged then the co-efficient indicates elasticities. Output of rice is near elastic with respect to labour and fertiliser. Both the coefficient of labour and fertiliser is highly significant. If the human labour days is increased by 10 percent output of rice increases by 9.1 percent. If fertiliser is increased by 10 percent output of rice increases by 7.8 percent. The elasticity of labour is greater than that of fertilisers showing that labour is more needed for rice cultivation.

(4) This model (Model a) shows increasing returns to scale ($b_1 + b_2 = 1.69$). Low efficiency parameter (.03083) explains the increasing returns to scale.

(5) The Marginal physical productivity (MPP) of labour and fertiliser are found as follows.¹²

$$\text{MPPL} = 0.85$$

$$\text{MPP Fert.} = 0.71$$

The Marginal Physical productivity (MPP) of labour (0.85) indicates that a unit increase in human labour days increases production of rice by .85 muri. Similarly the Mpp of chemical fertiliser (0.71) shows that when chemical fertiliser is increased by one Kg. the production of rice increases by .71 muri. The MPP of labour is higher than that of chemical fertiliser. Since MPP of both labour and chemical fertiliser are positive and significantly different from zero production is operating in the economic region and total production of rice is still increasing as we increase those inputs.

(6) Since the coefficient of labour and chemical fertiliser are significant, near unit elastic and MPP of both of them are positive, so, it indicates that there is every possibility of increasing production of rice by increasing human labour and chemical fertiliser. It also indicates that there is lesser use of these inputs than what is required.

(7) R^2 is 0.6795 which means that 67.95 percent of the variation of our model- (model-a) is explained. \bar{R}^2 , the adjusted coefficient of multiple determination is .659 which means that 65.9 percent of the variance is explained.

(8) F-ratio is significant at 1 percent level of significance.¹³ This ratio shows the overall significance of the model (model-a). As F-ratio is significant at 1 percent level we are 99 percent sure in our analysis.

(9) Labour share is 54% and the contribution of chemical fertiliser upon production is 46%. It shows that human labour has greater contribution upon production of rice.

Model-b

This model tries to study the response of area and bullock labour days to the production of rice.

(1) In this model¹⁴ (model-b) the coefficient of area and bullock-labour days have the same positive sign which signifies positive correlation between inputs and output.

(2) The t-value for the coefficient of area is significant at 1 percent level but the coefficient of bullock-labour days is insignificant. Since the coefficient of area (b_1) is significantly different from zero, the hypothesis that area has significant correlation upon production is accepted, i.e. for b_1 the alternate hypothesis that $b_1 \neq 0$ is accepted and for b_2 the null hypothesis that $b_2 = 0$ is accepted (since b_2 is not different from zero).

(3) The coefficient of bullock-labour days is not significant even at 20 percent level, this is because there has been excessive use of bullock than what is required. Excess use of an input than necessary does not increase the output of rice significantly. The increment in bullock-labour days than what is required may increase output (since the sign of bullock labour

13. See model-a, Appendix - 4.

14. See model-b, Appendix - 4.

coefficient is positive) but not significantly. The actual dose of bullock-labour days upon production of rice is 1 to 1½ per ropani since from the interview with the farmers it was evident that most of the farmers use nearly 3 bullock-labour days per ropani. There is no scarcity of bullocks and they use them whatever they can afford. This causes the marginal product to fall. To stop the marginal product from falling the above analysis reveals the importance of curtailing bullock labour days up to the stated dose.

(4) The coefficient of the logged variables shows the elasticities. In this model (model-b) output is near elastic with respect to area, i.e. a hundred percent increase in area increases output of rice by 86 percent. The output of rice is elastic with respect to bullock-labour days, i.e. a hundred percent increase in bullock-labour days increases output of rice by 14%. It indicates that bullock-labour has less response upon the production of rice.

(5) In this model¹⁵ (model-b) R^2 is .929 showing that 92.9 percent of the variations is explained and 7.1 percent of the variations remain unexplained. \bar{R}^2 is .924 which means that 92.4 percent of the variance is explained. In this case \bar{R}^2 approaches to R^2 simply because of large number of observations that we have.

(6) F-ratio (209.37) is significant at all level significance. As the value of F is significant at all level of significance that we are 99 percent sure in this analysis.

(7) The marginal physical productivity (MPP) of area and bullock-days are as follows :

$$MPP_A = 1.53 \text{ muri}$$

$$MPP_B = .18 \text{ muri}$$

The MPP of area ($MPP_A = 1.53$ muri) shows that as area is increased by one ropani its MPP increases by 1.53 muri. Similarly an increment in one bullock-labour days increases production of rice by .18 muri ($MPP_B = .18$ muri). As the elasticity of area and bullock-labour days (i.e. .86 and .14 respectively) is less than one, it shows the diminishing marginal productivity of each input. The diminishing marginal productivity is due to excess use of these inputs though marginal productivity of area is higher than that of bullock. Since the marginal product of

15. See model-b, Appendix - 4.

bullock-labour day is not significantly different from zero production is operating at the boundary of economic region.

(8) This sum of elasticities of the particular production function gives us the idea of returns to scale to that function. Since the sum of the elasticities is equal to one ($b_1 + b_2 = 1$) there is constant returns to scale operating in rice production.

(9) The contribution of area in this model is higher (86%) than that of bullocks labour days (14%). Showing that area has greater share upon production of rice than that of bullock.

Case (II): The Production Function of Potato

The interpretation of the result of potato production is based on the following statistical table.

$$\text{Model [c] :- } \log Q_p = \log b_0 + b_1 \log L_p + b_2 \log \text{Fert}_p$$

$$\text{Model [d] :- } \log Q_p = \log b_0 + b_1 \log A_p + b_2 \log B_p$$

Table 2

Findings Model	b ₁	b ₂	Efficiency	R ²	R ²	F _{2,25}	MPP	Returns to scale	Share (in %)	N
Model - c	.7624	.1329	3.38	.945	.941	217.33*	MPP _L = .77	.895	L=85%	28
	(9.67)*	(1.96)**					MPP _F = .085		Fert=14.7	
Model - d	.901	.063	6.099	.955	.952	268.97	MPP _A = 2.19	.9644	A=93.4	28
	(11.11)*	(.857)					MPP _B = .101		B= 6.5	

Note : Figures in parenthesis shows t-ratio

* represents significant at 1 percent level.

** represents significant at 10 percent level.

Model (c):-

In this model¹¹ the production of potato has been regressed with labour and chemical fertiliser measured in human labour days and in Kg, respectively. The regression equation in log linear form is

$$\text{Log } Q_p = \cdot 529 + 0.7624 \log L_p + 0.1329 \log \text{Fert}_p$$

(9.67) (1.96)

(1) As the coefficient of labour and chemical fertiliser is significant at one percent and ten percent probability level respectively.¹⁶ The hypothesis that labour & chemical fertiliser have significant positive correlation upon production of potato is accepted. Since b_1 and b_2 are significantly different from zero. So, here the statistical alternate hypothesis that $b_1 \neq 0$ and $b_2 \neq 0$ is accepted.

(2) The elasticity of production with respect to labour and chemical fertiliser are lesser than unity. A hundred percent increase in human labour days increases output of potato by 76 percent which is near unit elasticity. A hundred percent increase in chemical fertiliser increases output of potato by 13 percent which is inelastic. It shows that output of potato is more elastic with respect to labour than that with respect to chemical fertiliser.

(3) In this model (model-c) 94.5% of variation is explained ($R^2 = \cdot 945$) and 94.1% of the variance is explained ($\bar{R}^2 = \cdot 941$).

(4) F ratio in this model (model-c) is significant at 1 percent significance level ($F_{2, 25} = 217.33$) it means that we are 99 percent sure in this analysis.

(5) The MPP of labour and chemical fertiliser are .77 muri and .085 muri respectively. It shows that as a human labour days is increased by one unit, output of potato increases by .77 muri and as chemical fertiliser increased by 1 Kg, output of potato increases .085 muri. As the coefficient of chemical fertiliser is different from zero its MPP also different from zero so production is operating in the economic region.** Since the coefficient of chemical fertiliser is significant only at a 10 percent probability level ($t=1.96$), the declining MPP of chemical fertiliser may have occurred either because there is excess use of chemical fertiliser or because there is insuffi-

** The Economic Region refers to the area of production function where MP of inputs are positive.

cient irrigational facilities. Since the contribution of chemical fertiliser is directly associated with irrigation. So, the shortage of it leads to a decline in marginal product of chemical fertiliser.

(6) This model (model-c) shows that decreasing returns to scale since the sum of exponent b_1 & $b_2 = 0.895$.

(7) The contribution of human labour is greater than that of chemical fertiliser. Labour share is 85% and fertiliser share is 15%.

(8) As the coefficient of labour is highly significant ($t=9.67$) and its MPP and share are also high (77 & 85% respectively). It shows that there is lesser use of labour than required and the unavailability of sufficient labour. It also indicates that there is no disguised unemployed labour in the field. So, we can say that there is possibility of increasing output of potato by increasing human labour.

Model (d):-

In this model output of potato is regressed with area and bullock-labour days.¹⁷ The estimated log linear production function is

$$\text{Log } Q_p = 0.7853 + 0.901 \log A_p + 0.063 \log B_p .$$

(11.11) (.857)

(1) In this model (model-d) the coefficient of farm size is highly significant ($t=11.11$) at one percent probability level. So, for b_1 the alternate hypothesis that $b_1 \neq 0$ is accepted. As the coefficient of bullock-labour days ($b_2 = .063$) is insignificant and not different from zero. So, for b_2 the null hypothesis that $b_2 = 0$ is accepted.

Since the coefficient of area is highly significant (significant at one percent probability level) production of potato can only be increased by increasing the area under its cultivation.

(2) R^2 and R^{-2} respectively is .955 and .952 in which case 95.5% of the variation 95.2% of the variance is explained.

(3) As F-ratio is significant at one percent probability level ($F_{2,25} = 268.97$), we are 99% sure in this model.

17. See model-d, Appendix - 5.

(4) The MPP of area and bullock is 2.19 and 0.101 respectively. If we increase the area by one ropani output of potato increase by 2.19 muri, in the same way if we increase one bullock-labour day, output of potato increases by 0.101 muri. So the MPP of bullock is negligible and not different from zero. In this case production of potato is operating at the boundary of economic region. As MPP of area is extremely high than that of bullock, production is operating in the economic region.**

(5) Regarding the contribution, 93.5% is contributed by area and only 6.5% is the contribution of bullocks for production of potato.

So the high contribution high marginal productivity and highly significant coefficient of area indicates the feasibility of increasing output of potato by increasing the area under its cultivation.

4. SUMMARY CONCLUSION AND RECOMMENDATIONS

Summary

In case of rice all the coefficients yielded significant result but the coefficient of bullock labour days yielded insignificant result. In the same way the production function of potato yielded significant coefficient except that of bullock-labour days which is insignificant. The difference is that the coefficient of fertiliser in case of rice is highly significant at one percent level and the same coefficient in case of potato yielded the t-ratio to be significant only at 10 percent probability level. This is because of the fact that rice is summer crop and in summer farm gets sufficient water. So that the response of chemical fertiliser is actually observed. But potato is a winter crop and in winter lack of water is the major problem for potato production. Though the land gets irrigation from Jhi-ku Khola but it is not sufficient in amount specially in winter. So, the response of chemical fertiliser may not be very high for winter crops.

The co-efficient of bullock-labour days in both the cases (rice and potato) are insignificant. There is no other reason than excess use of it as explained above to appear an insignificant coefficient.

The marginal productivity and contribution of area in both the cases (rice and potato) are high but the MPP and contribution of bullock labour days seems very low. In the same way the MPP and contribution of human labour days in both the cases (rice and potato) are high but the MPP and contribution of chemical fertiliser is very low in case of potato while

** The 'Economic Region' refers to the area of production function where MP of inputs area positive.

it is very high in case of rice. So, the significant coefficient and high marginal productivity of area, human labour and chemical fertiliser shows that there is every possibility of increasing production by increasing these inputs.

Conclusion and Recommendations

The conclusions drawn from the analysis will be of great help in policy suggestions in particular for the area covered by the present study. From this analysis, some conclusion and recommendations can be made as follows :

- (a) The coefficient of labour and chemical fertiliser in case of rice (Model-a) is near elastic and highly significant.¹⁸ There is greater response of human labour and chemical fertiliser upon the production of rice. So, there is possibility of increasing production of rice by increasing human labour and chemical fertiliser. Now a days the mechanisation of Nepalese agriculture is growing and the use of chemical fertiliser is also growing though at a slow rate. So, the farmer should be asked to used amount of chemical fertiliser upon rice production. The concerned greater department and agencies should facilitate the farmers to get required amount of chemical fertilisers in appropriat time.
- (b) The coefficient of human labour in case of potato is near elastic and highly significant but the coefficient of chemical fertiliser is inelastic though significant at 10% level.¹⁹ As the elasticity and contribution of chemical fertiliser in this case is low, this may be due to insufficient supply of water. So, in winter season there should be adequate supply of water in times of need on the potato farm under cultivation or the farmers should be asked to adjust the amount of chemical fertilisers according to the supply of water on Potato farm. To increase the marginal product of chemical fertilisers farms should be irrigated.
- (c) As there is lesser use of human labour in both the farm suggested by the coefficient so, the use of human labour should be increased in both the cases (rice & potato) in order to increase production.
- (d) The production of rice and potato is near elastic and highly significant with respect to area but inelastic and quite insignificant with respect to bullecek-

18. See Model-a, Appendix - 4.

19. See Model-c, Appendix - 5.

labour days.²⁰ The farm size shows greater response upon production but the bullock-labour days has no response in production in both the cases (rice and potato). So, to increase the production of rice and potato both the area under cultivations should be increased. As bullock-labour days shows insignificant effect upon production, the increase in the use of it will cause its marginal productivity to decline even more. So, by increasing the bullock-labour days output of rice and potato can not be increased. The insignificant coefficient of bullock labour days may have occurred due to substitution of more bullock for labour beyond the certain limits dictated by technology. This causes the labour productivity to increase and bullock productivity to decline. As we saw the significant coefficient of labour in both the models (model - a and model - c) and insignificant coefficient of bullock (Model - b and Model -d), this shows the lesser use of labour and greater use of bullock in both the cases, which causes the marginal productivity and the contribution of bullock to decline.

In this case the recommendation is that the use of labour should be increased up to a certain limit to increase the marginal productivity of the bullock-labour i.e. only by combining sufficient amount of labour with bullocks that the MP of bullocks can be increased.

Further Research need

Though the present study is subject to various short comings, it may certainly give some information for future research.

This study takes only two crops of panchkhal valley. Other crops such as wheat, maize etc. also can be studied in future. This study takes only four inputs e. g., labour chemical fertiliser, farm size and bullock labour days and other variables such as irrigated and non-irrigated farm size, rainfall and temperature etc. have been left for further research. The present study investigates the effect of chemical fertiliser in the aggregate farm whatever may be the types of fertiliser. The effect of various chemical fertiliser separately can also be a subject of study for the future. This study also leaves the Farmyard manure for further research. Other useful directions for further research can be taken as the study of the effects of different types of soils upon production and that how much the farmers are capable of using modern technology upon production can also be the subject of study for the future, researchers. The effect of the use of insecticides and pesticides upon production of crops also can be studied.

20. See Model-b of Appendix - 4 and Model-d of Appendix - 5.

APPENDIX A

Total Inputs and Production of Rice in Panchayat 1979-80

Observation numbers.	Total Production (in ropani)	Total Cultivated area (in ropani)	Total human labourers used for cultivation	Total Chemical fertilizers used (in kg)	Bullock Labour used.
1	325	53	400	500	100
2	61	10	100	50	30
3	183	23	200	150	69
4	56	9	95	100	18
5	53	6	70	150	15
6	30	5	40	50	12
7	17	3	30	20	10
8	31	5	35	75	16
9	42	8	56	50	24
10	17	2	20	50	5
11	180	30	230	250	70
12	158	22	200	200	55
13	151	30	210	150	70
14	55	10	70	50	28
15	37	6	110	50	18
16	33	6	100	25	12
17	89	16	180	100	32
18	153	23	161	150	46
19	90	13	91	75	39
20	13	2	20	25	6
21	34	5	50	50	15
22	52	9	60	100	20
23	191	24	200	325	48
24	75	16	70	100	35
25	103	25	125	100	45
26	40	5	65	100	13
27	33	5	50	50	18
28	170	22	200	240	44
29	107	18	120	250	36
30	87	13	100	200	30
31	77	13	90	150	29
32	80	11	100	150	33
33	42	7	60	50	20
34	210	30	210	250	70
35	163	17	119	200	40

APPENDIX B

Total Inputs and Production of Potato in Panchkhal Panchayat 1979-80

Number of observations.	Production (in muri)	Total area under cultivation (in ropani)	Total human labourers used	Chemical fertilisers used (in kg.)	Bullock labourers used.
1	40	5	35	300	15
2	62	11	67	400	22
3	12	2	10	75	4
4	16	2½	15	150	6
5	25	4	27	200	10
6	17	3	18	75	6
7	71	13	69	250	25
8	25	3	20	200	6
9	12	2	13	50	5
10	6	1	5	25	2
11	45	8	45	250	17
12	13	2	12	50	4
13	14	2	15	100	4
14	21	4	22	50	8
15	6	1	4	25	3
16	17	3	20	75	5
17	17	3	19	100	8
18	43	8	35	150	17
19	16	3	13	50	4
20	15	3	19	50	2
21	18	3	12	150	10
22	22	3	27	250	3
23	23%	4	25	150	6
24	30	5	30	200	11
25	23	4	24	100	4
26	63	10	60	500	20
27	30	5	32	150	6
28	17	2½	17	175	5

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Book Review

Shyam Prasad Adhikary. Rural Development in Nepal: Problems & Prospects, Sajha Prakashanko Chhapakhana. Pulchok, Lalitpur, Nepal, 1982, Pages 196 Appendices, Price : NC Rs. 25/- \$ 3.00.

Generally the authors have the tendency to pretend that their books have no relation with their government assignments; but the present author, Mr. Adhikary, does not dissociate himself with his present position of Joint Secretary in HMG's Ministry of Local Development.

Rural Development: By rural, the author means a social body which has cohesion, solidarity and spiritual quality of co-operation, in the personal respect and a certain degree of responsibility. And, by development, he means technology, administration, supplies, services, methods and procedures, plans and programmes. Rural development is a strategy with condition of a targeted group of prophets in rural areas. Group may comprise small farmers, tenants and landless. So the concept about rural development has been used in a broad spectrum as to include productivity, increase in employment, high income, fulfilment of minimum basic needs of shelter and health of the poor.

The author identifies Nepal's planning progress as to create frustations since beneficiaries' benefits have amounted to be ever low. And also that Nepal's resources in terms of manpower, agriculture, forest, minerals and more so in terms of the water potentials are, although adequately abundant, these potentials could not be harnessed productivity. So the book has the objective to examine the rural process in Nepal which has been helped by different agencies, both national and international. In this context, the book enumerates Nepal's development efforts which are termed as 'history of struggle' between imitation and tradition. Behind imitation of alien models of development, neglecting one's own traditional values and institutions, is a hindrance. So the book confirms imitation as death and originality as life. We should rectify our institutional values than ending them altogether. What the author says is that there should be no disruption of the society.

Indentification of the Rural Nepal is made as to constitute: (a) Majority of rural populace (94.3%), (b) under-subsistence farming, (c) underemployment before and after harvesting and sowing, (d) rural people either of the hills, mountains or of terai, are

generally poor, e) compulsion to own subsidiary works to meet daily and ritual needs, (f) ecological problems.

Agriculture has been the biggest economic sector of Nepal in view of dependence of population, on it, its contribution to GDP, export trade raw materials to industries. Despite this importance of agriculture its performance has been very poor. Reasons for desperately low agricultural growth are: (a) primitive mode of agriculture, (b) problem of investment due to difficulty of credit, (c) disguised unemployment, (d) paucity of marketing facilities, (e) discouragement to small industries, (f) vagaries of nature, (g) low irrigation facilities, (h) no maximum use of the land.

The other qualifying but adverse clauses of the rural poor are that they are incapable to confront adverse forces, because of their own ignorance and value system. About education in the rural areas, the author states that it was and still is a monopoly of the few Brahmins and the ruling elites whereas primary education at village level than at town level is facing big drop-outs. While evaluating the social values of the villages, the author takes them as to have retarding effect on development, because the villagers seem to be less mindful about future investment and income thereof, since loans are not productively used. Their food is faulty; it is malnutritious and its favour goes more to cereals. Health situation is not less hazardous because of doctors denial to serve backward areas.

The author quotes some measures taken up by His Majesty's Government of Nepal. These measures are: (a) The Tribhuvan Gram Vikash, having many things in common with India's Community Development Programme launched from 1952 with heavy emphasis on catering service to village /villagers' needs as to make it a self-sustained socio-economic unit. (2) The Panchayat Development during 1960's also did not forsake the inherited qualities of the village development programme as embodied in the Tribhuvan Gram Vikash. (3) The third kind of rural development model during and after 1970's is in the form of Integrated Rural Development programmes accompanied by the parallel rural development models of small Farmers Development programme (SFDP). It is notable that the author failed to quantify these programmes. With reference to IRDPs they have so far covered seven zones (out of total fourteen zones), twenty two lakh population (out of total population of fifteen million) twenty two districts (out of total districts numbering seventy five) against an expense of 1.5 billion rupees (US. \$ 120 million). Whereas SFDP's refer to marginal farmers, specifically speaking. Their total number is fifty four

with emphasis on different socio-economic activities. Both IRDP and SFDP's are package programmes.

Failures on the part of the author are: He completely failed to quantify problems. Edition of the book is the most current, but the figures, not only are they very meagre, but at the same time not so modern as to signify the most current development in the subject. He failed to insert the palpitative census figures on demographic trends in Nepal. Secondly, he fails to note ever low returns of the land. Although the diminishing trend in agriculture is as old as almost five years, he seems to be in oblivious condition, because, about agriculture, he says: Nepal produces enough to export its agricultural products abroad. Low ever figure is applied both to food and to other important exportable cash crops.

He equally commits mistake by limiting literacy figure of thirteen percent than stating percentage of literacy as nineteen.

As stated above, he also does not quote the figure as to qualify the extent of the progress made by different rural projects.

He should have, in his book, incorporated the fact that about one-fifth of the national income is derived from property and four fifths from human capital-that is from wages, salaries, self-employment and entrepreneurship. We will not inter into period of diminishing returns provided investments are made to improve schooling and health of farm people and to promote agricultural research and the dissemination of its contribution. Much will depend on improvement of incentives.

Above all, the book with rural bias is to have a big role to have an impact on general readers and teachers regarding exploratory works on the captioned subject. I believe, the author, having fund of experience about Nepal's area planning approaches, will have next edition in no time with latest knowledge about rural development programmes in similar other countries and in-depth study of Nepal's rural development projects and programmes.

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