CHAPTER I

INTRODUCTION

1.1 Background

Nepal lies between two big countries of Asia Continent China and India and the southern slope of Himalayas. It covers 0.03% of the total area of the earth and 0.3% of the total area of Asian Continent. Nepal is the third largest country among SAARC countries. India is 22 times bigger than Nepal and China is 65 times bigger than Nepal. The location of Nepal is $26^0 22'$ N to $30^0 27'$ N in latitude and $80^0 4'$ E to $88^0 12' E$ in longitude and its length is 885 km. (East to West) whereas mean width is 195 km (North to South) covering 1,47,181 sq.km. Area. (CBS, 1992).

The production of the cash crops has the share of more than 24% of the total production of crops. Potato is the major important cash crop. It is used to make different varieties of food items as vegetable and available in different parts of the world in all the days of the year. It is also known as the king of vegetables. Different varieties of potato are grown in Nepal. It can be stored throughout the year. It has almost 34.3% share in the total production of cash crops of the nation in1991/92. It was cultivated in 85300 hectares land of Nepal. The average yield of potato is about 8.62 M.T. per hectare in the year 1991/92. (MOF, 1992).

The country has been divided into seven federal states, seventy-five districts. The Village Municipality (Gaun Palika) is the lowest local level administrative unit till our study. But our study had done during 2072 B.S. It is because Hemja has been presented here as a place of producing potato for the purpose of cash crops. It is located in the northern part of beautiful city Pokhara and eastern part of Annapurna GP.

The focus of our study is the production analysis of potato in Hemja area of Pokhara. Kaski is a major district of potato production of Gandaki zone in Nepal. Potato was cultivated in 850 hectares of land in Kaski district which was 0.996 of the potato cultivated land of Nepal. The share of production of potato of Kaski district was 6,860 M.T. which was 0.936% out of the national production of 7,32,860 M.T. of potation 1991/92. (ADB, 1992).

Potato (Solanum tuberosum L.) is one of the most important crops of Nepal. It is used as a major vegetable in Terai and mid- hills and as a staple food in the high hills and mountains. (www.narc.gov.np retrieved on May 5, 2017). Even though there is a large demand of potato in many growing cities of Nepal, there is less production in quantity. Potatoes amounting to Rs.3.99 billion was imported in the first five months of current fiscal year (www.npdp.gov.np retrieved on April 1, 2019).

1.2 Statement of the Problem

The way of cultivating potato is still of traditional type even we are running in twenty first century. Farmers are using both traditional (manure) and modern fertilizer (chemical fertilizer). On the one side some farmers are using bullock and at the same time some others are using tractor. Attempt have been made in this study to see whether the responses of Manure (M), Labor (L), Chemical Fertilizer (F) in potato farming have positive significant effect on outputs or not. Some other important inputs like bullock labor, tools, variety of seeds, irrigations, insecticides, pesticides etc. are included here in the form of capital to make our study easy.

In fact, the problems of the present study can be summed up under the following research questions:

1. Is there significant effect of Manure (M), Labor (L), Chemical fertilizer (F) on potato production?
2. Is there significant difference using local manure and chemical fertilizer on potato production?
3. What are the problems faced by farmers of our study area to grow potato?
4. What are the ways of removing the problems in potato production?

1.3 Objectives of the study

The main objective of the present study is to estimate a potato production function taking output as the dependent variable and Labor (L), Manure (M), Chemical fertilizer (F) as the explanatory variables. Some specific objectives are as follows:

1. To examine the response of inputs Labor (L), Manure (M), Chemical fertilizer (F) on the production of potato.

2. To study whether the effects of inputs are significant or not.

3. To identify the problem faced by farmers to grow potato.

4. To provide some recommendations for the potato production.

1.4. Hypothesis

Two types of hypotheses are used in our study. They are:

i. Null Hypothesis (H_0)
There is no statistically significant relationship between inputs and potato production.

ii. Alternative Hypothesis (H_A)
There is statistically significant relationship between inputs and potato production. Specification of variables and the related methodologies have been presented in methodology chapter.

1.5 Significance of the Study

In Nepal, cash-crops like potato, coffee, tea etc. have played the significant role in the agricultural production. It has contributed to increase national income and to raise per capita income. By knowing this significance of this sector, we have made an attempt to study this area at micro level. Potato is a nutritional vegetable. It covers almost 34.3 percent in the total production of cash crops in Nepal. It is because we have selected to study the output relation of potato.

Potato can be grown in most of the regions including Terai to hilly regions. Hemja is a hilly area of Nepal. The produced potato is tasty and there is high population density in Pokhara Metropolis for the consumption if farmers produced potato in large scales too.

This study will add one more step in the production of cash- crops demonstration in Nepal. This study will also help for the future researcher who are interested in the field of potato production. This study will help to develop the polies of NARC, NPDC and other such agricultural organizations. This study also help to all related parties those who concern with potato production.

1.6 Limitations of the Study

This study has been limited to the Hemja area of Pokhara-27 of Kaski district of Nepal. We have used only three inputs in this study. But to estimate the real production function, other inputs are excluded owing to the unavailability of data, time factor and money factor.

1.7 Organization of the Study

The entire study has been organized into five chapters. The first chapter is Introduction which includes Background, Statement of the Problem, Objectives of the Study, Hypothesis, and Significance of the Study and Organization of the Study. The second chapter is Review of the Literature which includes Theoretical Framework, Review of Related Studies and Research Gap. Theoretical Framework consists Production Function, Types of Production Functions, Elasticity's of Production, Returns to Scale, Isoquants, Iso Cost Line, Marginal Physical Product of Inputs, Marginal Rate of Technical Substitution, Isoclines, Least Cost Combination of the Factors. The third chapter is Methodology which consists Study Area, Research Design, Sampling Procedure, Data Collection Procedure, Specification of the Variables, Coefficient of Multiple Determination, Adjusted Coefficient of Multiple Determination, F-test, T-test, Significance of the Models, Hypothesis Testing, Procedures of Data Procession. The fourth chapter is Data Analysis which includes Descriptive Analysis, Multiple Regression Analysis, Isoquants, Marginal Rate of Technical Substitution and Isoclines, Least Cost Combination of Inputs, Output Elasticity and Returns to Scale, Average Inputs and Outputs, Marginal Physical Productivity. The last fifth unit is Summary and Conclusions which includes Summary, Conclusions and Recommendations. Appendices and Bibliography have been attached in the end of the thesis.

CHAPTER II

REVIEW OF THE LITERATURE

Under review of the literature, theoretical framework and review of related literatures and research gap have been explained.

2. A Theoretical Framework

Our study has been done under the certain theoretical frame theories have been studied under the production function.

2.1. Production Function

Production is a transformation of physical inputs into physical output. The output is thus a function of input. The functional relationships between physical inputs and physical output of a firm is known as production function. In other words, the relationship between the inputs and outputs firm is known as production function (Ahuja, 1979).

A production function is a technique which represents the technology involved in the process. The output of a commodity depends upon the employed inputs so the physical relationship between the output and the unit of employed inputs is known as production function (Sing, Parashar & Singh, 1977).

The relationship between the inputs and outputs of a firm is known as production. A production function is a technique which represents the technology involved in the process of production. The output of a commodity depends upon the employed inputs, so the physical relationship between the output and the units of employed inputs is known as production function.

Production is the result of co-operative effort on the part of various factors of productions. Since there is technical relationship between output and input, Hence, Production function is the technical relationship telling the amount of output capable of being produced by each and every set specified input. It is defined for a given state of technical knowledge.

Mathematically, the production function can be expressed as

$$Q_t = f(x_{1t}, x_{2t}, \ldots, \ldots, \ldots, x_{nt})$$

where,

Q_t = output at time 't', f = the functional relationship

X_{it} = inputs (1, 2, …, n) measured at time 't' .

In econometrics analysis, different modes of production have been used by different experts. There is a great significance of the study of production in economics. This is because economics is a science which is particularly concerned with the efficient allocation of the scare resources. In this respect we are interested with marginal productivities of the various factors of production, marginal rate of technical substitution, returns to scale, isoquants, isoclines etc. for the optimum use of inputs. So, these all quantities can be diverted by the help of the production function estimation. In economics, the producer will be in equilibrium in regards to the choice to input or he used the inputs optimally when the ratio of the marginal productivities is equal to their respective prices. Mathematically, it can be expressed as:

$$\frac{fx_{1t}}{fx_{2t}} = \frac{px_{1t}}{px_{2t}}$$

$$fx_{it} = \frac{Q_t}{x_{it}}$$

Px_{it} = Price of x_i at time‘t’.

Simplifying it $\frac{dQ_t}{dx_1} \cdot \frac{dx_2}{dQ_t} = \frac{px_1}{px_2}$ or $\frac{\mathrm{dx}_2}{\mathrm{dx}_1} = \frac{px_1}{px_2}$

2.2 Types of Production Function

Production function is the technical relationship output and inputs. Hence there are various ways of representing this relationship. Different types of mathematical forms can be assumed but the question is whether the function assumed is valid or not. In this respect, here comes the question of goodness of fit to the model assumed of the power of the model assumed to describe the parametrical relationship. The production function that are widely applied in these days are some important types of production functions which have been dealt with as given below:

2.2.1 Constant Elasticity of Substitution (CES) Production Function

This production function was derived by two different groups of economists- one consisting of K.I. Arow, Chenery; B.S. Minhas and R.M. Solow and other groups consisting M. Brown and De Cani. Although their derivations were different, the result was the same (Singh, Parashor & Singh 1977). This function is characterized by the constant elasticity of substitution (not necessarily equal to unity). So, the production function is called the ‘Constant Elasticity of Substitution (C.E.S.) production function’. The group consisting of K.J. Arrow, Chenery, Minhas and Solow suggested the C.E.S. production function which can be expressed as:

$Q = A\,[dx_1^{-a} + (1\text{-}d)\, x_2^{-a}]^{-1/a}$ (A>0, 0<d<1, a>-1)

where, Q = Output ,

x_1 = Capital input

x_2 = Labor input

a = Substitution parameter

A = Technical efficiency coefficient

D = Coefficient of capital intensity

(1-d) = Coefficient of labor intensity.

The above production function is homogeneous of degree 1. When the substitution parameter is kept 1, we get the cob –Douglas production function in the above function. Thus, Cobb –Douglas production function is called to be a special case of CES production function. Although this production function seems to be general. But its main defect is that it cannot be estimated in the linear form (waters, A.A, 1963). So, on the one hand it is very difficult to estimate and on the other it is applicable only for two various. Hence, in general practice, this form of production function is not used in our study.

2.2.2 Quadratic Production Function

The Quadratic production function can be written in the following form as:

$$Q = a_0 + b_1 x_1 + b_2 x_2 + b_3 x_1^2 + b_4 x_2^2 + b_5 x_1 x_2$$

(For variables x_1 and x_2)

In this production function, we have need to calculate five parameters for two independent variables and it is non- linear. When the number of independent variables increases, the parameters also geometrically increase. In practice, it is very difficult to estimate the production function for more than two variables by this method. So, we do not use this form also.

2.2.3 Cobb-Douglas Production Function

Cobb-Douglas production function is widely used in econometrical studies of the production function. It has been developed by Paul H. Douglas and C.W. Cobb in 1928. In the original form of this production function the sum of the elasticity is equal to 1. But later the suggestion of Durand restrains that the sum of the elasticity of production function should equal to unity has been relaxed and a new function which is also called as power function came into existence, which is linear in logarithmic form. The function is called as Cobb-Douglas production function (Hady, E.O & Dillon, J.K.). The generalized form of this function is:

$$Q = Ax_1^{\alpha} x_2^{\beta} \; (A>0, \alpha, \beta \geq 0)$$

where A is a positive constant and is known as production technology because any effect of any other variables should be in A. x_1 and x_2 are two factors of production applied in the production process α and β are the exponents of the factors of production x_1 x_2 respectively and they give the respective elasticity α and β are assumed to be a constant over the production surface.

The condition $\alpha > 0$, $\beta > 0$ indicate that the factor inputs should have always positive effect upon production. This is because, no one will invest if the factor inputs have negative effect even, they are free, again when $x_1 = 0$ or $x_2 = 0$, then, Q=0 i.e. both inputs are essential for production.

2.2.4 Properties of Cobb-Douglas Production Function

i. If $\alpha + \beta = 1$, it is linearly homogeneous.

ii. If it is linear and homogeneous of degree one then elasticity of substitution equal to unity. i.e.

$$\sigma = \frac{\partial\left(x_2 / x_1\right) x_2 x_1}{\dfrac{\partial\left(Px_1 / Px_2\right)}{Px_1 / Px_2}}$$

where,

σ = Elasticity of substitution

Px_1 = Price of input x_1

Px_2 = Price of input x_2

iii. It is homogenous of degree ($\alpha + \beta = 1$) one.

iv. Its isoquants are negatively sloped throughout and strictly convex for the positive values of x_1 and x_2.

Along the various type of production discussed above, we have been selected the Cobb-Douglas production function for our present study. Because of its convenience in interpreting elasticities of production, least cost combination of the factors of scale it involves fewer degrees of freedom which allow increasing or decreasing return to scale in the production.

The Cobb-Douglas production function which three independent variables can be written as:

$Q = b_0 \, x^{b1}{}_1 \;\; x^{b2}{}_2 \;\; x^{b3}{}_3 10^{u}$

where,

Q = Output

x_i = Factors of production (i = 1,2,3)

b_i = Parameters to estimated (i = 1,2,3)

b_0 = Constant

u = disturbance term

The input-output analysis of potato farming has been done on the basis of Cobb –Douglas production function and is written in non-linear form as:

$Q = b_0 \, L^{b1} \, M^{b2} \, F^{b3} \, 10^{u}$ ………… (2.1)

where,

Q = Output of potato in kilogram per hectare

L = Labor input in Mandays per hector

M = Manure in Dokos per hectare

F = Fertilizer in Kilograms per hectare

b_i = Parameters to be estimated (i = 1,2,3)

b_0 = Constant

u = Disturbance term

Taking logarithms in both sides on the above function we will get a linear function in logarithmic form and which can be expressed as:

$\text{Log } Q = \log b_o + b_1 \log L + b_2 \log M + b_3 \log F + U$

This can be expressed algebraically as:

$Y = b_o^* + b_1 x_1 + b_2 \; x_2 + b_3 \; x_3 + U$

where,

Y = log Q t

B_o^* = $\log b_o$

x_1 = log L

x_2 = log M

x_3 = log F

log 10 =1

2.3 Elasticity of Production

The coefficients of the equation (1.1) i.e. b_1 (i =1,2,3) are the elasticity's of production with respect to inputs L, M and F respectively and they can be used directly. Our production function is:

$$Q\ t = b_o L^{b1} M^{b2} F^{b3} 10$$

Differentiating partially the above function with respect to L we have

$$\frac{\partial Q}{\partial L} = b_0 b_1 L^{bi-1} M^{b2} F^{b3} 10^u$$

$$\text{Or, } \frac{\partial Q}{\partial L} = \frac{b_o b_1 L^{b1} M^{b2} F^{b3} 10^u}{L}$$

$$\text{Or, } \frac{\partial Q}{\partial L} = \frac{b_1 Q}{L}$$

$$\therefore b_1 = \frac{\partial Q}{\partial L} \times \frac{L}{Q} = e \text{ (elasticity).}$$

By definition, $\frac{\partial Q}{\partial L} \times \frac{L}{Q}$ is Labor elasticity of quantity. Similarly, b_2 & b_3 gives the elasticity of production with respect to Manure and Fertilizer. Each component of the factors of production explain the combination of an input to the output where all other inputs are held constant.

2.4 Returns to Scale

The sum of the coefficients of (or elasticity) indicates the nature to return to scale. With sum b_i = j, with a given percentage increase in all inputs will result an equal percentage increase in output.

Let us take the previous production function having three inputs.

$$Q = b_o b_1 L^{b1} M^{b2} F^{b3} 10^u$$

If we increase all the inputs by R times, then the new production function will be:

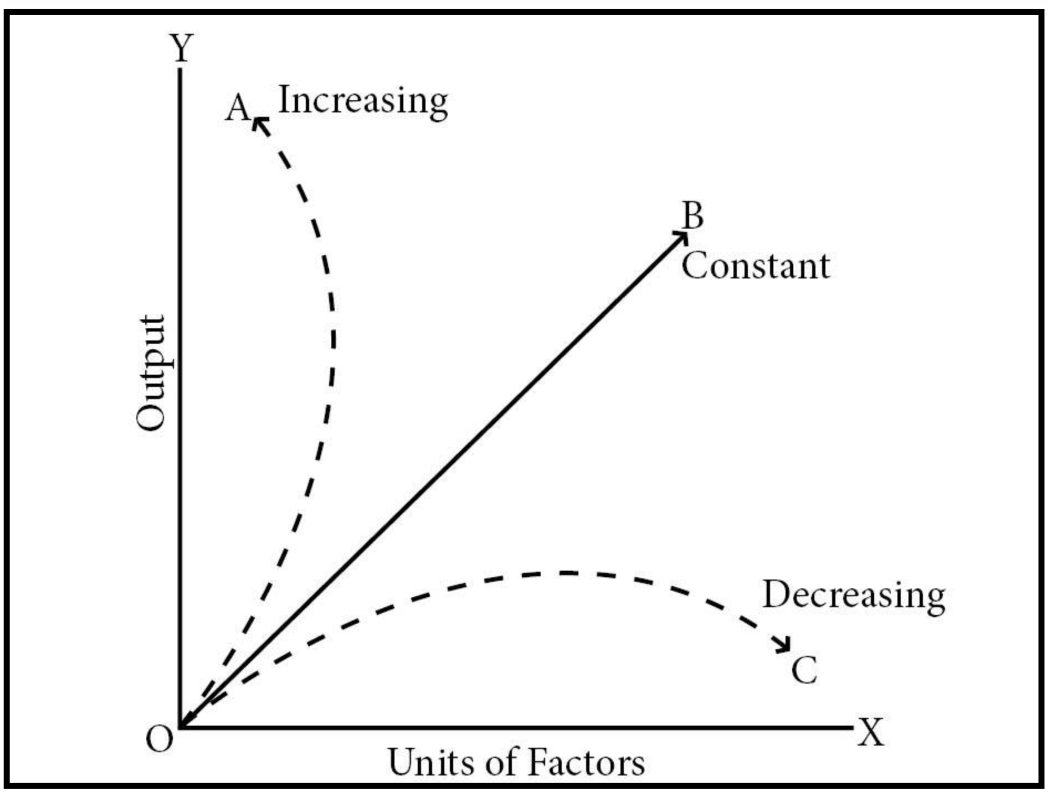
$Q = b_0 (RL)^{b1} (RM)^{b2} (RF)^{b3}$

$= R^{b1+b2+b3}$ $(bol^{b1}M^{b2}\ F^{b3}$

$= R^{b1+b2+b3}\,Q$

Hence, it is obvious that if $\sum_{i=1}^{3} bi = 1$, then with an equal increment in each input by R times, output will also increase by the same R times. So, if $\sum_{i=1}^{3} bi = 1$, then it gives the constant returns to scale, otherwise if $\sum_{i=1}^{3} \mathrm{bi} > 1$ then it gives the increase returns to scale and if $\sum_{i=1}^{3} \mathrm{bi} < 1$, it gives the decreasing to scale. These three types of returns to scale can be shown with the help of figure.

FIGURE (2.4) RETURN TO SCALE



This figure shows that if inputs combinations increase double, output also increase more than double, then it is the case of increasing returns to scale which is shown with the help of OA curve. If the increase output is identical with the increase in inputs combinations, that is constant returns to scale, which is shown by the OB line, 45^o angle with OX axis. If input combines increasing do not response output or it will say output is not increased by the increased amount of inputs that is said to be decreasing returns to scale, which is represented by the OC line in the above figure.

2.5 Isoquants

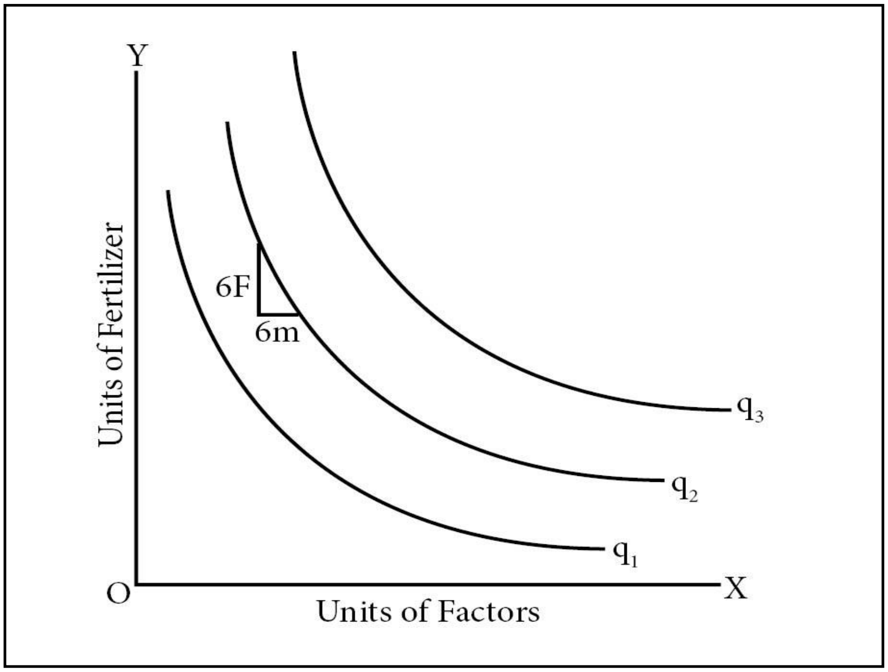
Isoquants or the product curve is the production indifferent curve. It represents the different combinations of two factors of production which are capable of producing the same level of output. In other words, it is the locus of the different combinations of inputs yielding same level of output. The isoquant of the Cobb-Douglas production function is negatively sloped and strictly convex for the positive values of factor of production (M and F).

We have the production function: $Q = b_0 L^{b1} M^{b2\ Fb3}$

Isoquants equation can be derived where F is expressed as a function of L, assuming M as constant and the function can be written as follows:

$F = \left(\frac{Q}{b_O L^{b1} M^{b2}} \right)^{\frac{1}{b3}}$. This equation shows the isoquants of the production function is asymptotic to the input axes. By asymptotic we mean that if the value if one input is kept zero, the resulting input which is function of the first will be infinity (α). Similarly, if M is made a function of F assuming the value of F equal to zero, the resulting value of M will be infinity (α).

Figure (2.5) Isoquants



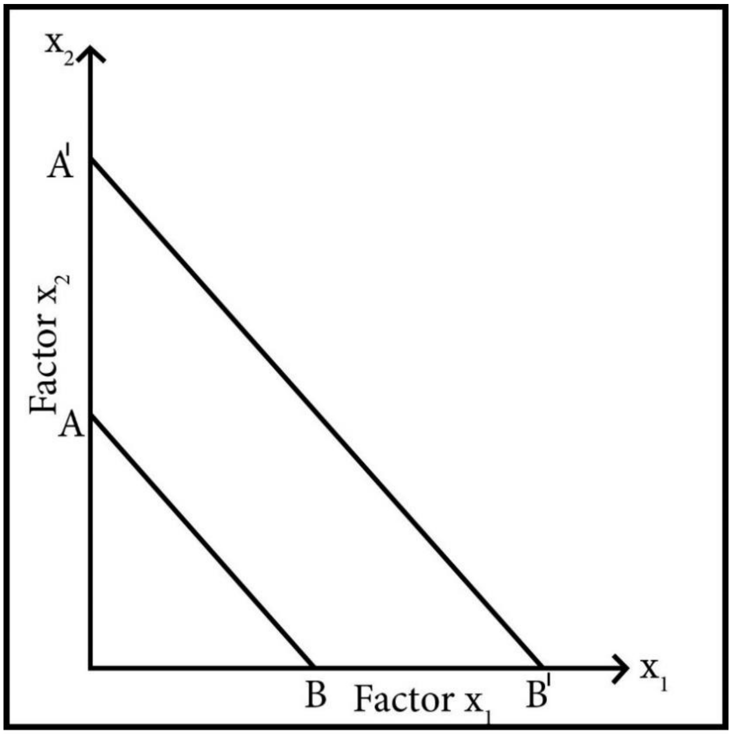
This figure shows that different combination of manure and fertilizer. Here, q_1, q_2, q_3 are isoquants. At any point of isoquant, we have maximum level of output with the certain combination of inputs, but higher isoquant provides higher level of output. Hence, $q_1 < q_2 < q_3$. The scope of isoquant is the marginal rate of technical substitution

i.e. $MRTS_{FM} = \frac{-\partial M}{\partial F} = \frac{b3}{} = \frac{M}{F}$ (from equation 2.5) negative sign shows the negative slope of isoquant.

2.6. Iso-cost Line:

The price of factors are represented by iso-cost line. An iso-cost line shows various combinations of two factors that the firm can buy with a given out lay. Thus, it can be purchased for the given total cost. The iso-cost line is also called price line or out lay line which can be shown with the help of following figure.

Figure (2.6). Iso-Cost Line



In this figure, AB is the iso-cost line and X_1, X_2 are the inputs of production. In case of given outlay, the iso-cost AB and if there is any changes in the out lay of the inputs combination, it will shift the iso-cost line to the right i.e. A^1 B^1. The iso-cost line depends upon the following things.

a. Price of the factors of production, and

b. The total expenditure or outlay of an input. The slope of iso-cost line is equal to the ratio of the prices of two factors. In figure, the slope of iso-cost line AB is:

$$\text{Slope of AB} = \frac{\text{Price of input } x_1}{\text{Price of input } x_2} = \frac{Px_1}{Px_2}$$

2.7 Marginal Physical Productivities of Inputs

The change in the total production due to change in the units of an input given that other inputs are kept constant is known as marginal physical productivity of that input. Hence, it is the addition to the total product as a result of an additional unit of that variable input given that other inputs are held fixed. So the Marginal Physical Productivity (MPP) of any input can be derived by taking the first partial derivatives of the given production function with respect to the particular input.

Let us take the production function mentioned above:

$$Q = b0\ L^{b1}\ M^{b2}\ F^{b3}$$

Now, taking the first partial derivative of the function with respect to L, MPP equation for L is:

$$\frac{\partial Q}{\partial L} = b_o\ b_1\ L^{b1-1}\ M^{b2}\ F^{b3}$$

$$= \frac{b_1}{L}(b_o\ b_1\ L^{b1}\ M^{b2}\ F^{b3})$$

$$= \frac{b_1}{L}\ Q = b1\ \frac{Q}{L}\ \ldots\ \ldots(2.2)$$

where Q and L are the arithmetic mean of the output and labor respectively and b_1 is the estimated co-efficient for the labor input.

In the similar manner we can get the MPP of manure and fertilizer which is given below:

$$\frac{\partial Q}{\partial M} = b_2 \frac{Q}{M}\ \_\_\_\_\_\ (2.3) \text{ and } \frac{\partial Q}{\partial L} = b_3 \frac{Q}{L} \ldots\ \ldots\ (2.4)$$

The above equation (2.2), (2.3) and (2.4) give the MPP of the inputs L, M and F respectively. If the exponents b_1, b_2 and b_3 are less than one then there will be diminishing marginal productivities at the respective inputs. But when the exponents b_1, b_2 and b_3 are greater than one, then they give the increasing marginal productivities of the corresponding inputs and when the exponents b_1, b_2 and b_3 are equal to one then there will be constant marginal productivities of the corresponding inputs.

If the second order partial derivatives of the production function with respect to the input is negative, then they will give an idea of Diminishing Marginal Productivity (DMP).

Taking the second order partial derivative of the function with respect to F is:

$$\frac{\partial^2 Q}{\partial F^2} = \frac{\partial(\partial Q)}{\partial(\partial F)} = \frac{\partial}{\partial F}\left(\frac{b_3 Q}{F}\right) = b_3 \frac{\partial}{\partial F}\left(b_o L^{b1} M^{b2} F^{b3}\right) = \frac{b_3}{F^2} Q^{b3-1}$$

If b_3 is less than one, then the value within the bracket negative, Hence, the second order partial derivatives of the function with respect to labor will be negative which means the negative slope of the isoquant equation.

2.8 Marginal Rate of Technical Substitution

In the production function with more than one variable input, the different combination of inputs can produce a given level of output, Marginal Rate of Technical Substitution indicates the rate at which factors can be substituted at the margin without altering the level of output. Thus, the marginal rate of technical substitution (MRTS) is the slope of isoquant which can be derived from the above production function.

Now, let us take the production function of form $Q = f(X_1, X_2)$ are the factors of production. Then the total differentiation of the production function is:

$$d Q = f x_1 \, d x_1 + f x_2 \, d x_2$$

where fx_1, and fx_2 are the partial derivatives of Q with respect to x_1 and x_2 or the MPP of x_1 and x_2 respectively. Since $dQ = 0$ for Q is constant along an iso-quant.

Now, $fx_1 \, dx_1 + fx_2 \, dx_2 = 0$

$$\therefore \text{MRTS} = \frac{dx_1}{dx_2} = \frac{fx_2}{fx_1} = \frac{MPPx_2}{MPPx_1}$$

Hence, the marginal rate of technical substitution between inputs is equal to the ratio of the marginal physical productivities of inputs.

Taking the production function (2.1)

$$Q = b_0 L^{b1} M^{b2} F^{b3}$$

The equation for the marginal rate of technical substitution between F and M is:

$$\text{Therefore, } \frac{\partial M}{\partial F} = \frac{b_3}{b_2}\frac{M}{F} = MRTS_{FM} = MPP_F / MPP_M$$

where,

MPP_F = Marginal physical productivity of fertilizer

MPP_M = Marginal physical productivity of manure

From equation (2.3) and (2.4) we have

$$MPP_F = \frac{\partial Q}{\partial F} = b_3 \frac{Q}{F}$$

$$MPP_M = \frac{\partial Q}{\partial M} = b_2 \frac{Q}{M}$$

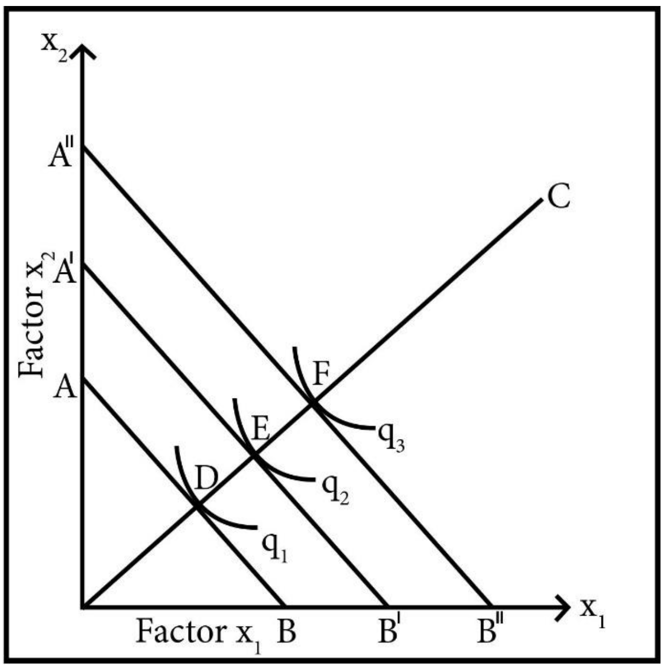
$$\text{Therefore, } \frac{\partial M}{\partial F} = \frac{b_3}{b_2}\frac{M}{F} = MRTS_{FM} \cdots \; \ldots (2.5)$$

This is the linear function in M and F. If here, M and F are increased in constant proportion, the marginal rate of technical substitution remains constant even though the level of output changes. Similarly, we can get the marginal rate of technical substitution of other inputs.

2.9 Isoclines

An isocline is the locus of the points along which the marginal rate of technical substitution is constant. Since, it is the straight line passing through the origin, and works as scale line which indicates a fixed proportion of two inputs in the function. Because of these characteristics Cobb-Douglas production function denotes that the ratio in which two inputs are combined should remain the same regard of the level of output. In the following figure, inputs X_1 and X_2 are increased by the same amount.

Figure (2.9) Isocline



Here, AB, A'B' and A" B" are the iso-cost lines and also similarly q_1, q_2 and q_3 isoquants where $q_1<q_2<q_3$. The tangency point of iso-cost lines and isoquants are D, E and F by joining these points we get the OC line, which is known as isocline.

The isocline can be derived from the MRTS equation. (2.5) by setting the derivative $\frac{\partial M}{\partial F}$ equal to a constant say (k) to represent a given MRTS or a price ratio. So the equation of the isocline is given by:

$$MRTS_{FM} = \frac{-\partial M}{\partial F} = \frac{MPP_F}{MPP_M} = K \text{ is a constant.}$$

From equation (2.5) we find that $MRTS_{FM}$ is equal to

Or, $\frac{b_3}{b_2} = \frac{M}{F} = K$

$$M = \left(\frac{b_2}{b_3}\right) KF \quad \ldots \ldots (2.6)$$

Similarly, $$F = \left(\frac{b_3}{b_2}\right) KM \quad \ldots \ldots (2.7)$$

Hence, equation (2.6) and (2.7) are the equation of isoclines for our model given in equation (2.1).

2.10 Least Cost Combination of the Factors (Inputs)

(Producer's Equilibrium in regard to the choice of inputs)

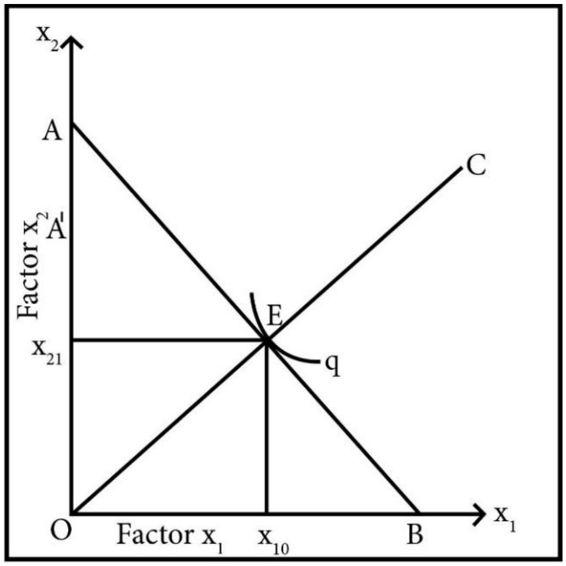
The least cost combination of factors is the producer's equilibrium in regards to the choice of inputs. Every entrepreneur may desire to minimize his cost of production of a given level of output of maximize his output level of the given cost or outlay.

If any entrepreneur has already decided about the level of output to be produced, then entrepreneur will try to choose that combination of factors which minimize his cost of production by which he will be maximized his profits.

Thus, a producer will produce a given level of output will least cost combination of factors. This cost combination of factors will be optimum for the economic producer.

This least cost combination of factors will be attained if there is tangency point of the given isoquant curve with an iso-cost line (prices line or outlay line). The tangency point indicates the maximum level of output. In this connection, the isoclines show the maximum level of output by employing the least cost combination of factors. It can be shown with the help of figure.

Figure (2.10) Least Cost Combination of Inputs



In the above figure, two inputs as $x_1$and x_2 used in the production. AB is the iso-cost line and Q shows the isoquant. At point E there is optimum level of output by OX_{10} units of x_1 and OX_{21} units of x_2 inputs combination. The point E indicates the optimum allocation of factors of production, implies that optimum level of output is attained. According to the producer's point of view, point E indicates that the profits is maximized by the producer.

How entrepreneur will arrive at the level of least cost combination can also be explained mathematically with the help of MRTS equation and iso cost line.

Let us consider the general model as,

$$Q= b_0 \, L^{b1} \, M^{b2} \, F^{b3} \; u$$

So, the optimal condition of factor use is given by,

$$MRTS_{FM} = \frac{-\partial M}{\partial F} = \frac{MPP_F}{MPP_M}$$

where,

P_F = Price of fertilizer

P_M = Price of manure.

Hence, form the equation (2.3) and (2.4) we have,

$$MPP_M = b_2 \frac{Q}{M} \text{ and } \quad MPP_F = b_3 \frac{Q}{F}$$

Substitute their values we have:

$$\frac{-\partial M}{\partial F} = \frac{b_3}{b_2}\frac{Q/F}{Q/M} = \frac{b_3}{b_2}\frac{M}{L} = \frac{P_F}{P_M}$$

$$\text{Or, } \frac{M}{F} = \frac{P_F}{P_M}\frac{b_2}{b_3}$$

This gives the optimum allocation of factors use.

2.B Review of Related Studies

It is essential at first to have a literary assessment of the matter to be dealt with while identifying the problem in any research work. The related empirical evidences are essential for research.

Therefore, theoretical concept has little significance without any empirical observation. Various attempts have been made to carry down the concepts of economics into the level of mathematical interpretations. When we have to come with certain results on the basis of the analysis made on any case study, we have to use the mathematical devices. As early as 1958 agriculture economist began to estimate the economic benefits of scientific research in agriculture. Now numerous micro and macro level studies have been made in the field of quantitative agricultural economic research in Nepal more efficiently.

Yadav (1979) was done a study on the paddy production in Lalitpur district as a case study of Kusunti village. He attempted to estimate the production function of paddy taking output as dependent variable and inputs labor, farmyard manure and chemical fertilizer as independent variables. The data were cross-sectional for the 1978 and eight models were fitted with 49 sample size. The Cobb-Douglas production function was used to analyze the data. His major findings were (a) there was significant effect of input factors in the production of paddy (b) labor and chemical fertilizer were positively significant with output in the case of Abal land but the farmyard manure had been found insignificant and (c) all the inputs variables except labor were significant in the case of Doyam land.

Buddhacharya (1982) had another study on the factor response in paddy production of Ghachok Village Panchayat of Kaski district. He used cross-sectional data for the Cobb- Douglas production function and the sample size was 71. Production function were estimated for overall data together with sub-division in land type, irrigation facility caste and land size. His major findings were (a) all the input coefficients were positively significant except that of the farmyard manure for Brahmin farmers and land size having more than 0.1 hectare and the coefficients of farmyard manure was negatively significant for the Sim and Chahar land (b) the summation of the elasticities of the output with respect to nitrogen farmyard manure and labor was less than one in all six models. So, in Ghachok, agricultural sector was characterized by the diminishing returns to scale (C) the marginal physical productivity of labor was positive and significant in all the models.

Sutihar (1984) has made a study on the production process and the input-output relationship of wheat production of Saptari district by fitting linear transcendental and Cobb-Douglas production model. The sample size was 95 households and the data were cross-sectional for the year 1982/83 in Bishahariya Village Panchyat of Saptari district.He fitted 13 different types of production models taking six independent variables namely labor, bullock, manure, chemical fertilizer, irrigation and seeds for irrigated farm, unirrigated farm and irrigation as a dummy. The findings were (a) bullock and seed were not significant at 95% confidence level in almost all the models labor. Labor and bullock are not significant (b) the analysis of data also showed that the linear and Cobb-Douglas type production models were not significantly different in the coefficient of determination (c) the sum of the elasticity's was less than unity, showing the decreasing returns to scale in wheat cultivation.

Sutihar (1981) made another study on the input-output relationship in the context of wheat farming in Saptari district. The data were cross-sectional collected from primary source by the researcher himself. The sample size was 90 drawn from Bishariya village Panchayat of Saptari district for the year 1980. Cobb-Douglas production function was fitted to the data with four independent variables namely Farmyard manure, chemical fertilizer, human labor and bullock labor. The production function was estimated by overall data ad also estimated by subdividing the data for experienced farmers and irrigated land. Finding were that the coefficients of Farmyard manure, chemical fertilizer and human labor were positively significant at 0.01 level. But the coefficient of bullock labor was negatively significant at 0.01 level. The major findings of his study were (a) the average production in irrigated farms is higher than general model (b) the average production in the model concerning with experienced farmer is higher than any other model.

Upadhya (1977) has made a study in input-output relationship in the context of maize farming in lalitpur district. Data were cross-sectional for the year 1975 and were collected from Agricultural Development council (ADC). He has fitted a Cobb-Douglas production function for the three independent variables namely farmyard manure, nitrogen and labor. Production function was estimated for the overall data and also for the data classifying into soil type, land size and caste of the farmer. Maize isoquants were also predicted indicating the marginal rate of technical substitution for labor and nitrogen. All the coefficients were positive and significant except that of the labor. Coefficients or multiple correlations was good enough to show the relationship between the inputs and input. His major findings were (a) elasticity of nitrogen was quite high and showed the fact that the doses of nitrogen applied is less than what is technically required (b) for the farmers with farm size greater than 0.051 hectare, the doses of labor were insufficient than in the small farm (c) elasticity of nitrogen in A and B type of land were less than in general model where all types of land were taken together.

Yadav (1990) has made a study to estimate the production function of paddy taking out the production as the dependent variable and inputs human labor, bullock labor and capital investment as explanatory variables, in Saptari district. The study is based upon primary field survey data collected from Aurahi village panchayat of Saptari district in 1985/86. The sample size was 30 households from different economic classes. Cobb-Douglas production function was fitted to the data. He found the coefficients of human labor and bullock labor positive and significant at 0.6 level and 0.01 level respectively. But the coefficient of capital investment was found negative and insignificant.

Agrawal and Foreman (1966) had studied the response of inputs namely land labor, capital services and capital assets on output of wheat in Uttar Pardesh of India. The sample size was 60 for wheat production for the year 1955/56. They found that the coefficient of land, capital services and capital assets were positive but the coefficient of labor was negative. Only land and capital services inputs were significantly different form zero at a probability of 5%. The sum of elasticities was 0.93 which indicates that the prevalence of decreasing return to scale in wheat production in Uttar Pradesh. They were also found that the marginal productions of land, labor, capital services and capital assets were $ 18.44 per acre, $ 8.04 per month, $ 8.21 per $ and 2.43 per $ respectively. The coefficient of multiple adjusted determination was found 0.81.

Nepal Rastra Bank (1991) has made an study in order to assess whether the small farmers development program has been able to reach the target group and to study the impact on land use pattern as well as productivity of the farmers. The sample was chosen from 297 SPOS and 7455 groups. The sample of 10% or 30 SPOS were selected. From among these sites 373 groups were chosen which constituted 5 % of total number of groups. Finally, 1492 farmers were sampled from 373 groups spread over 25 districts representing the two ecological zones (i.e. the Hills and Terai) form all five development regions of the country. The study was a descriptive one. Information was collected from the farmers, ADB branches and SPOS. This information was collected from the tables and comparative analysis of these tables presented. The major findings were that in the project group, per hectare yield of maize was 1061.03 kg, and the per hectare yield of irrigated maize was 1190.44 kg. So the per hectare yield of the irrigated maize was higher than the unirrigated one. Similarly, maize cultivation was found less profitable except in irrigated area in the project group. In most cases net returns were negative in both ecological zones as well as for both project and control groups since non cash cost far exceeded the cash cost in maize cultivation.

Dhakal (1992) had made another attempt in order to find out the input-output relationship of maize production in Kharireni tar VDC, Tanahun. The analysis was performed with the help of Cobb-Douglas production function. The cross-sectional data were used and out of 1203 households of Khairenutar Village Development Committee 120 households were collected randomly for the particular cropping year 1991. Three inputs: farmyard manure, bullock labor and human labor were taken as independent variables and output of maize as dependent variable. He had studied different 6 production function models for overall data. In order to identify the relationship between dependent and independent variables, multiple regression analysis was performed and T-test, F-test were employed to test the model. Some major findings of his research work were (a) there was significant relationship between inputs and output of maize production in general (b) the use of labor was excess and the use of bullock labor was less (c) the summation of the elasticities of the output with respect to farmyard manure, bullock, labor and labor were less than one in all six models. So, Khairenitar VDC'S Agricultural sector was characterized by the decreasing returns to scale (d) the marginal physical productivity of input bullock is positive and significant and very high in comparison to other inputs farmyard manure and labor (e) the average production of improved seeds was higher than local seeds. So the farmers should use improved seeds in maize production (f) there is not significant relationship between output and farmyard manure and labor due to the use of huge amount and unscientific manner of preparing farmyard manure and disguised unemployment.

Chhetri (1992) had made studied on the potato seed flow for the selected districts of Nepal. He in his study, tried to analyse the potato seed flow in the selected districts of Nepal the main objectives of the study were to identify key intervention sites for potato improvement efforts in the Hills of Nepal.Primary data for the study were collected under the sampling procedure for the year 1988/1990 form 43 districts, of the 43 districts surveyed nine each were located in the Eastern and Central Development Region, ten in the Western Development Regions, eight in the Mid-Western Development Region and seven were in the Far-Western Region. Cross-selection data were used in the analysis. The findings were (a) some farmers in the seed growing areas in the study were found to select seeds immediately after harvest. Small farmers tended to obtain seeds just before plantation (b) only farmyard manure (FYM) was used in the majority of the areas and in some places chemical fertilizers were found to be used. Information generated form the first phase of the seed Flow study shows that out of six districts in the EDR namely Dhankuta, Terathum, Sankhuwasabiha, Taplejung, Illam and Panchthar only Panchthar did not reveal the use of chemical fertilizers. Of the five districts revealing chemical fertilizer use 40 % of the sample households of Dhankuta used chemical fertilizers and roughly 3.5 % in Taplejung. The second phase seed flow study revealed that chemical fertilizers were in use in Nuwakot (CDR). Palpa, Gulmi (WDR), Rukum (MWDR), Achham and Baitadi (FWDR) (c) blight was prevalent in all the areas surveyed. The severity of blight was not same in all the areas. Insects like red ants and white grubs were also rampant in all the areas surveyed. The second phase seed flow study shows that brown rot was encountered in Rasuwa, Nuwakot and Dolakha of the CDR, Syangja, Parbat, Baglung of WDR and Darchula and Achham of the FWDR (d) the storage systems were found to be traditional (Bamboo baskets, spreading in a room) pill storage field store. The methods are based on what they have been practicing form time immemorial (e) Seed production areas in most of the districts were found to be located mostly in the high hill areas (f) sufficient land was not available in the hills for adequate crop rotation (g) the farmers/merchants were found to engage in barter transaction. Equal volumes of grains were found to be exchanged for potatoes. Farmers were also found to borrow seeds prior to plantation from their neighbors.

Sharma (1994) had studied the importance relation of potato production in Nepal as a case study Setidovan Village Development Committee of Syangja District. He has developed 25 models in view of getting the trend and of potato production in the selection area.

Even though, there are different explanation of reviewed studies, the present study is based on the response of inputs and output of potato cultivation. The reviewed literatures have played significant role in our study.

2. C Research Gap

Most of the previous studies were concentrated in village areas only. But our study is based on Hemja of Pokhara- 27 which has been considered a famous place for potato production. Till now no one has done research in this area. Our study will join the trend and tendencies of potato production in Urban area with the village area. Potato of Hemja is well famous and is regarded most tasty. Further quantitative and qualitative investigations and researches can be done relating to the potato production of Hemja area.

CHAPTER III

METHODOLOGY

3.1 The Study Area and Population

There are three Village Municipality or Gaun Palika (GP) and Pokhara metropolis in Kaski district. On the bases of topography of this district, it can be divided into two regions hilly region which is spread until Himalaya and valley region. We have selected Hemja for our study because of famous for potato production of this district. Firstly, it is similar to the other GP of district in respect to soil, productivity, climate, labor supply and other socio-economic factors and secondly it represents the Kaski district in the topographic features. The sample which we have used here represents the potato growers of Pokhara- 27, Hemja of Kaski district. The population for my study is the total housefamily in Hemja of Kaski district engaged in potato cultivation. Total number of households were 990 and most of these were engaged in potato cultivation actively in this area. The climate, labor supply condition, soil productivity and socio-economic conditions are more of less similar in different wards of the Pokhara metropolis.

3.2 Research Design:

Research Design plays significant role in the research process. The research has been designed to fulfill the purposes given above in the first chapter. Data were collected form the Pokhara-27, Hemja of Kaski district by the researcher himself. The present study is based upon cross-sectional data for the particular year 2018. By cross-sectional it means observations at an instant of time from several economic units. Cross-sectional data are obtained from specially designed survey from that economic units. In my study potato growers of Hemja Pokhara-27 of Kaski district refer to economic units. Descriptive cum analytical research design have been used in our study.

3.3 Sampling Procedure

To get the required information for present study about 5% of the total households of Hemja have been selected as the sample. The data were collected by using simple random sampling method. The total size for this study consists of 49. The potato growers have been interviewed to collect the desire information's by developing an appropriate questionnaire presented in Appendix-D.

3.4 Data Collection Procedure

Necessary data were collected from the farmers of Pokhara-27, Hemja of Kaski district. The data were collected by the direct interview method. Questions were asked to the farmers by the researcher himself. A structural interview was used in which objectives of questions were well defined and aimed at specific type of information with the help of interview information on the area of field and gross product was gather by the researcher himself.

3.5 Specification of the Variables

Variables are those quantity whose value varies according to time, place and condition. The variable is defined as quantity which can assume different values at different points of observation. We have selected two type of variables in the present study. They are as follows:

i. Dependent variable

ii. Independent variable

All the variables have been represented by symbols as:

$$Q = f(L, M, F)$$

where, Q the output of potato stands for the dependent variable and L, M and F namely labor, manure and fertilizer respectively stand for independent variables. The way inputs are measured and defined is very important in controlling specification errors which occur in aggregation of inputs. It is not possible to specify and fit the true production which is relevant to a given production process because of the functional form and complete range of variables are not known on one hand and on the other hand they cannot be included due to the unavailability of data and limited time and resources. So, the computation procedure and units of measurement adopted here are explained below in brief:

a. Output (Q)

The production of potato is denoted by the output (Q) and there is no quality variation in the output. The output has been measured in kilograms per hectare, briefly kg/ha.

b. Labor (L)

The labor is an input for potato production. It has been measured in man days per hectare. It includes both the hired and labor. A man day has been taken as an adult male working for 8 hours a day as government's rule.

c. Manure (M)

Manure is prepared form the dung of cow, buffaloes, goats etc. mixing with dried leaf and steams of plants. The manure is frequently used by farmers in the hilly regions of Nepal. It is prepared in the courtyard and is carried to the field with the help of "Doko" which is a special type of bamboo basket carried on the back supported by roap fixed at forehead. Hence, we have taken Doko as a measuring unit of manure per hectare in the present study.

d. Fertilizer (F)

The chemical fertilizer is the third input. It has been measured in kilograms per hectare. Most of the farmers not use chemical fertilizer in hilly regions. They have not modern technique to use chemical fertilizer and potato cultivation. People have taken chemical fertilizer separately.

Obviously, Q depends on L, M and F which clearly shown the conditions that any change in Q should primarily be accompanied by the change in input or inputs L, M and F.

3.6 Coefficient of Multiple Determination (R^2)

The percentage of the variation in the observed y values that is explained by the fitted regression equation is denoted by the coefficient of multiple determination R^2. It is estimated by:

$$R^2 = 1 - \frac{\sum e^2}{\sum y^2} = 1 - \frac{ESS}{TSS}$$

where,

$\sum e^2$ = Error sums of square (ESS)

$\sum y^2$ = Total sums of square (TSS)

3.7 Adjusted Coefficient of Multiple Determination ($\bar{R}^2$)

When the number of parameters to be estimated is large or as often happens in production function estimation by the number of the small sets of the observation then the above calculation tends to overestimate R^2. To take account of this R^2 may be used. It is estimated as:

$$R^2 = 1 - \frac{\sum e^2/(n-k)}{\sum y^2/(n-1)}$$

$$= 1 - \frac{ESS/df}{TSS/df}$$

where,

ESS = Error sums of square

TSS = Total sums of square

df = The degree of freedom of the respective sums of square

n = no. of observations
k = No. of parameters

3.8 Significance Test of the Regression Equation (F-Test)

To Test the significance of regression equation, F-test is used, it is calculated by:

$$F = \frac{R^2 / K - 1}{\frac{(1 - R^2)}{N - K}}$$

$$F = \frac{Expained \text{ var} iance}{un\exp lained \text{ var} iance}$$

If this calculated value of F is greater than the table value of F with k (n-1-k) degrees of freedom, then the regression equation significant.

3.9 Significance Test of The Regression (t- test)

To test the significance of regression coefficients t-statistic used. It is given by:

$$t = \frac{\text{Re}\, gressioncoefficient}{\text{Re}\, spectives \tan darderror}$$

$$t = \frac{bi}{\sqrt{Var.\text{cov}.(bi)}}$$

where, bi = Regression coefficient

Var.co. (bi)= Variance covariance of bi

If the calculated value of t is greater than table value of t with a degree of freedom (n-k) then the respective coefficient is significant.

3.10 Specification of the Models

These are the models used in the present study.

i. $Q= b_0\, L^{b1}\, M^{b2}\, F^{b3}\, 10^u$
(For those farmers who are using fertilizers in both lowland and upland).

ii. $Q= b_0\, L^{b1}\, M^{b2}\, F^{b3}\, 10^u$
(For those farmers who are using fertilizers in only upland) .

iii. $Q = b_0\, L^{b1}\, M^{b2}\, F^{b3}\, 10^u$
(For all upland)

iv. $Q= b_0\, L^{b1}\, M^{b2}\, F^{b3}\, 10^u$
(For all lowland)

v. $Q= b_0\, L^{b1}\, M^{b2}\, F^{b3}\, 10^u$
(For all observations)

vi. $Q= b_0 L^{b1} M^{b2}$

(For those farmers who are not using fertilizers in both lowland and upland)

vii. $Q= b_0 L^{b1} M^{b2}$

(For those farmers who are using fertilizers in only lowland)

viii. $Q= b_0 L^{b1} M^{b2}$

(For those farmers who are not using fertilizers in only upland)

ix. $Q= b_0 M^{b2} F^{b3}$

(Breaking model)

where,

Q= Output of potato in kg/ ha

L= Labor in Manday/ha

M= Manure in Doka/ha

F= Fertilizer in kg/ha

b_0= Regression constant

b_1= Regression coefficients (i = 1,2,3)

3.11 Hypothesis Testing

The Cobb-Douglas production function used in this study is written as:

$$Q = b_0 L^{b1} M^{b2} F^{b3} 10^u$$

This is the non-linear form of the equation and its logarithmic form is:

$$\text{Log } Q = \log b_0 + b_1 \log L + b_2 \log M + b_3 \log F + U$$

This can be expressed algebraically as:

$$Y = b_0^* + b_1x_1 + b_2x_2\ b_3x_3 + u$$

where,

$\log q = y$

$\log b_0 = b_0^*$

$\log L = x_1$

$\log M = x_2$

$\log F = x_3$

$\log 10 = 1$

i. Hypothesis about Regression Constant

a. Null hypothesis H_0: $b_o = 0$

It means that there is not significant relationship between the output and variables not considered in the model.

b. Alternative Hypothesis H_a: $b_o > 0$

It means that there is significant relationship between output and variables not considered in the model.

Our hypothesis is that H_A: $b_o > o$

ii. Hypothesis about Regression Coefficients

a. Null hypothesis H_0: $b_1 = b_2 = b_3 = 0$

It means that there is not significant effect of inputs namely labor manure and fertilizer on the output respectively.

b. Alternative hypothesis H_A: $b_1, b_2, b_3 \neq 0$

It means that there is significant effect of inputs namely labor manure and fertilizer on the output respectively.

Hypothesis for this study is that H_A: $b_1, b_2, b_3 \neq 0$

iii. Hypothesis about Regression Equation

a. Null Hypothesis H_0: $b_o = 0$ (i = 1,2,3)

It means that there is not statistically significant relationship between the output and inputs namely labor, manure and fertilizer.

b. Alternative hypothesis H_A: $bi \neq 0$ (i = 1,2,3)

It means that there is statistically significant relationship between the output and input namely labor, manure and fertilizer.

Alternating hypothesis is that H_A: $b_i \neq 0$

3.12 Procedure of Data Processing

Local units have been used for inputs and output for the data and land in Ropani, output in Muri and Pathi, labor into Manday, manure in Doko and fertilizer in kilogram. After finishing the collection of raw data, output was converted into kilogram per hectare, labor into Manday work per hectare, manure into Dokos per hectare and fertilizer into kilogram per hectare. Data were processed by Statistical Process for Social Sciences, hand and simple calculator.

CHAPTER IV

DATA ANALYSIS

4.1 Descriptive Analysis

The raw data of inputs and output have been shown in the Appendix-A. There are four total variables taken in the production function among which one is dependent and three are independent variable. The gross output of potato is dependent variable and labor, manure and fertilizer are independent variable. All the variables measured in physical units, output in kg per hectare, manure in Dokas per hectare and fertilizer in kg per hectare.

4.2 Multiple Regression Analysis

To explain the relationship among four variables. The multiple **r**egression analysis has been used for this, usual assumptions of the multiple regression analysis are made. The regression model to explain the relationship among four variables, the multiple regression analysis has been used for this assumption of the multiple regression analysis are made. The regression model has been based upon the Cobb- Douglas production function which is expressed on the form:

$Q = b_0 L^{b1} M^{b2} F^{b3} 10^u$ …………….(1)

Above equation (1) is non-linear from of the production function and is linear in logarithmic form which can be expressed as follow:

$\text{Log } Q = \log b_0 + b_1 \log L + b_2 \log M + b_3 \log F + U$ ………….. (2)

Equation (2) can be expressed algebraically in the form:

$Y = b_o* + b_1^{x1} + b_2^{x2} + b_3^{x3}$ ……….. (3)

Since, the expected value for the disturbance term is supposed to be zero i.e. E (u) = 0, then the above equation can be written as:

$Y= b_0* + b_1^{x1} + b_2^{x2} + b_3^{x3}$ ……….. (4)

In Appendix B, the logarithmic transformation of the data has been given. The multiple regression analysis is done with the transferred data and the value for regression constant, coefficients and the production function in linear and nonlinear forms of production function which are disable.

4.2.1 MODLES

There we can see nine models of production function specified in the present analysis. The empirical results of each model are presented below:

Equation -I

In this model, there are 49 observations and here is taken only 13 observations who are using fertilizers in both lowland as well as upland. Estimated results found from this model are given below:

i. Constant of Regression

$$b_0^* = 2.6676$$

$$\text{Or, } \log b_0 = 2.6676$$

Therefore, $b_0 = 10^{2.6676} = 465.1575$ kg

ii. Coefficients of Regression

$$b_1 = 0.1721,\ b_2 = 0.2447,\ b_3 = 0.1426$$

The linear form of the production function is

$$\text{Log } Q = 2.6676 + 0.1721 \log L + 0.2447 \log M + 0.1426 \log F$$

(0.0203) (0.0251) (0.0261)

t = 8.4778*** 9.7490*** 5.4636***

N = 13

$R^2 = 13$

R= 0.9984

$\bar{R}^2 = 0.9957$

$F_9^3 = 933.3333$***

The non-linear form of production function is

$$Q = 465.1575\ L^{0.1721}\ M^{0.2447}\ F^{0.1426}$$

In this model, all the three inputs have positive coefficients which indicates that there is a positive relationship between output of potato and its inputs. All the three inputs are positively significant at 0.01 level. So, the alternative hypothesis is accepted i.e. $b_1, b_2, b_3 \neq 0$. It means that three is a significant. Statistical relationship between output of potato and inputs labor, manure and fertilizer. The values given in parenthesis are the standard errors of the coefficients. It is noted here that*** Indicates significant at 0.01 level, ** indicates significant at 0.05 level and * indicates significant at 0.10 level.

The goodness of fit of the model is measured by the coefficient by multiple determination (R^2). The value of R^2 is 0.9968 and the value of adjusted R^2 ($\bar{R}^2$) is 0.9957 expresses the percentage of the variation in output that is explained by the variation in the inputs of the model. The value of R^2 which reflects that the inputs of this model explain 99.68 % of correlation (R) is 0.9984 shows that there is positive relationship between output and inputs of potato farming. the marginal physical productivity of all the inputs is found positive. The MPP of chemical fertilizer is calculated as higher in the model. The sums of output elasticity is less than one indicates that there is decreasing returns to scale in the potato production. The F-ratio is significant at 1 % level which shows there is statistically significant relationship the output of potato and inputs considered here:

Equation -II

In this model, the production function is fitted is fitted to the data relating to the farmer who are using fertilizers in only upland (Pakho Bari). Out of 49 observation there are only 9 observations found to be using fertilizers in upland. The production model is presented below:

i. Constant of Regression

$b_0^* = 2.6703$

Or, $\log b_0 = 2.6703$

Therefore, $b_0 = 10^{2.6703} = 468.0584$ kg

ii. Coefficients of regression

$b_1 = 0.3784$, $b_2 = 0.1376$, $b_3 = 0.0564$

These regressions constant and coefficients gives the model in linear form is:

$$\text{Log } Q = 2.6703 + 0.3784 \text{ L} + 0.1376 \text{ M} + 0.0564 \text{ F}$$

(0.2209) (0.1492) (0.1477)

t = 1.7130 0.9223 0.3819

N = 9

$R^2 = 0.9218$

R = 0.9601

$\bar{R}^2 = 0.8729$

$F_5^3 = 19.4^{***}$

Hence, production function in non-linear form is:

$$Q = 468.0584 \text{ L}^{0.3784} \text{ M}^{0.1376} \text{ F}^{0.0564}$$

In this model, all the three inputs have positive coefficients which indicates that there is a direct relationship between output of potato and its inputs namely labor, manure and fertilizer. But, coefficients are insignificant even at 10 % level. Hence null hypothesis is accepted i.e. b_1, b_2, b_3 =

0 and showing that there is not significant statistical relationship between output of potato and the inputs labor, manure and fertilizer.

The coefficient of multiple determination (R^2) and adjusted $\bar{R}^2$ are 0.9218 and 0.8729 respectively which shows the variation in output is explained by inputs is only 92.18 percent. The value of multiple correlation (R) is 0.9601 shows that there is statistically significant relationship between output and input of the potato farming. The F-ratio is significant at 0.01 level. So the relation between inputs and output holds good. The marginal physical productivity of all input is found positive. The MPP_L is calculated as higher in the model. The marginal rate of technical substitution of labor for fertilizer ($MRTS_{LF}$) is found to be strong in this model. The sum of output elasticity is found as less than 1 indicates that there is decreasing returns to scale in the potato production in this model.

Equation -III:

In this model the production function is fitted to the data relating to all upland (Pakho Bari). Only 36 observations have been considered in this model out ot 49. The results have been found are given below:

i. Constant of Regression:

$b_o* = 0.7348$

Or, $\log b_o = 0.7348$

Therefore $b_o = 10^{0.7348} = 5.4300$ kg

ii. Coefficients of Regression:

$b_1 = 0.3923, b_2 = 07799, b_3 = 0.0713$

Production function linear form is:

$$\text{Log } Q = 0.7348 + 03923 \log L + 07799 \log^{M} + 0.0713 \log^{F}$$

(0.1663) (0.1780) (0.0439)

t = 20359** 4.3815** 1.6241

Production function in non-linear form is:

$$Q = 5.4300\, L^{0.3923}\, M^{0.7799}\, F^{0.0713}$$

$N = 36$

$R^2 = 0.9063$

$R = 0.9520$

$\bar{R}^2 = 0.9050$

$F^3_{32} = 112.2875^{***}$

In this model, all the coefficients of inputs are positive showing direct relationship between output of potato and inputs namely labor, significant at 0.05 level. Hence, alternative hypothesis i.e. b_1, $b_2 \neq 0$ is accepted. It shows that the effect of these inputs on output of potato production is significant. But the coefficient of the chemical fertilizer is not significant even at 0.10 level. So, we accept the null hypothesis i.e. $b_3 = 0$ which shows the effect of chemical fertilizer is not significant on output of potato. The F-ratio is significant at 0.01 level showing the statistically significant relationship between input and output. Similarly, the coefficient of multiple determination (R^2) is 0.9063 and adjusted R^2 ($\bar{R}^2$) is 0.9050. Hence, the input of the model explains 90.63 percent of variation in output of potato. The coefficient of multiple correlation ® is 0.9520 shows that there is positive correlation between inputs and output in the potato production. The marginal physical productivity of all inputs is found positive and MPP of fertilizer is calculated as higher than other model. The sums of output elasticity is found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation - IV

In this model production function is fitted to the data relating to all lowland 13 observations out of 49 is found here.

The results of multiple regression analysis are:

i. Regression constant

$b_0^* = 0.9809$

Or, $\log b_0 = 0.9809$

Therefore, $b_0 = 10^{0.9809} = 9.5697$ kg

ii. Regression coefficient

$b_1 = 0.5085, b_2 = 0.5993, b_3 = 0.0013$

Production function in linear form is:

$$\text{Log } Q = 0.9809 + 0.5085 \log L + 0.5993 \log M + 0.0013 \log F$$

(0.1766) (0.1975) (0.0237)

t = 2.8794** 3.0344** 0.0548

Production function in linear form is:

$$Q = 9.5697\ L^{0.5085}\ M^{0.5993}\ F^{0.0013}$$

$N = 13$

$R^2 = 0.9768$

$R = 0.9883$

$\bar{R}^2 = 0.9729$

$F^3_9 = 1026.44^{***}$

In this model attempts have been to examine the response of inputs to output of potato for all lowland (Khet).

All the coefficients of inputs are positive which indicates that there is a direct relationship between inputs and output. Since the inputs labor and manure are significant at 0.05 level. Hence, alternative hypothesis is accepted i.e. b_1, $b_2 \neq 0$, which is showing that the effects of these inputs on output of potato is significant. But the coefficient of chemical fertilizer is not significant even at 0.10 level. So, we accept the null hypothesis i.e. $b_3 = 0$ which means the effect chemical fertilizer is not significant on output of potato. F-ratio is significant at 0.01 level and showing the significant statistical relationship between input and output of potato. The coefficient of multiple determination (R^2) is 0.9768 and the adjusted ($\bar{R}^2$) is 0.9729 which shows the 97.68 percent of variation in output is explained by inputs of the model. The coefficient of multiple correlation (R) is 0.9883 shows that the statistically significant relationship between inputs and output. The marginal physical productivity of inputs is found positive. The MPP is higher in the model. The $MRTS_{MF}$ is found to be strong in this model. The sums of output elasticity is found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation -V

In this model, all the 49 observation have been included. Estimated results found from this model are given below:

i. Regression constant

$b_0^* = 0.8323$

Or, $\log b_0 = 0.8323$

Therefore, $b_0 = 10^{0.8323} = 6.7967$ kg

ii. Regression coefficient

$b_1 = 0.2478, b_2 = 0.8820, b_3 = 0.0256$

Production function in linear form is:

$$\text{Log } \hat{Q} = 0.8323 + 0.2478 \log L + 0.8820 \log M + 0.0256 \log F$$

(0.0899) (0.1058) (0.0207)

2.7564** 8.3365** 1.2367

Production function in linear form is:

$$\hat{Q} = 6.7967\, L^{0.2478}\, M^{0.8820}\, F^{0.0256}$$

$N = 49$

$R^2 = 0.9258$

$R = 0.9622$

$\bar{R}^2 = 0.9284$

$F^3_9 = 206.7$***

In this model attempts have been to examine the response of inputs to output of potato for all observations. All the coefficients of inputs are positive and indicating the direct relationship between inputs and output of potato. The coefficients of labor and manure are significant at 0.01 level and accepting the alternative hypothesis i.e. $b_1, b_2 \neq 0$ which means the significant effect of these inputs on the output. But the coefficient of fertilizer is not significant even at 0.10 level and accepting the null hypothesis i.e. b3= 0 which means the effect of chemical fertilizer is not significant on the output. The F-ratio is significant at 0.01 level which shows there is statistically significant relationship between inputs and outputs. The coefficient of multiple determinations (R^2) is 0.9258 and adjusted R^2 ($\bar{R}^2$) is 0.9284 which means only 92.58 percent of variation in output is explained by the inputs considered in the model. The coefficient of multiple correlation (R) is 0.9622 shows there is significant statistical relationship between inputs and output of potato farming. The marginal physical productivity of all inputs is found to be positive. The MPP_F is higher in the model. The marginal rate of technical substitution of manure for fertilizer ($MRTS_{MF}$) is found to be strong. The sums of output elasticity are found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation -VI

In this model the production function is fitted to the data relating to all lowland (Khet) as well as in upland (Pakho) both. Out of 49 observations there only 36 observations which are not using fertilizers in lowland and upland both have been considered. In this model, the third variable have been not considered. It is because this model is relating only those farmers who are not user of fertilizers in lowland and upland both. So the labor and manure have been estimated to predict the production function. The computed values of regression constant and coefficients are presented below:

i. Regression constant

$b_0^* = 0.6637$

Or, $\log b_0 = 0.6637$

Therefore, b_0 = $10^{0.6637}$ = 4.6199 kg

ii. Regression coefficient:

b_1 = 0.3251, b_2 = 0.3719

Production function in linear form is:

$$\text{Log } Q = 0.6637 + 0.3251 \log L + 0.8719 \log M$$

(0.1269) (0.1400)

t = 2.5619** 6.2279**

Production function in linear form is:

$$Q = 4.6199\, L^{0.3251}\, M^{0.9719}$$

N = 36

R^2 = 0.9514

R = 0.9756

$\bar{R}^2$ = 0.9570

F^3_9 = 387.58***

The positive coefficients of labor and manure shows the positive relationship between output and inputs labor and manure. The coefficient of the manure is significant at 0.01 level and the coefficient of labor is e significant at 0.01 level and accepting the alternative hypothesis i.e. b_1, $b_2 \neq 0$ which means the effect of labor and manure is significant on the output. The F-ratio is significant at 0.01 level which shows there is statistically significant relationship between inputs and outputs. The coefficient of multiple determinations (R^2) is 0.9514 and adjusted R^2 ($\bar{R}^2$) is 0.9570 Hence 95.14 percent of variation in output is explained by the inputs considered in the model. The coefficient of multiple correlation (R) is 0.9754. The positive R shows that there is positive correlation between inputs and input in the potato production. The marginal physical productivity of all inputs is found positive. The MPP_M is calculated higher than MPP_L in the model. The marginal rate of technical substitution of manure for labor ($MRTS_{ML}$) is found to be strong in this model. The sums of output elasticity is found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation -VII

In this model, the production function is fitted to the data relating to the farmers who are not using fertilizers in lowland (Khet). Out of 49 observations there only 9 observations of nonuser of fertilizers in lowland have been considered. The computed values of regression constant and coefficients are presented below:

i. Regression constant

b_0* = 0.9619

Or, log b_0 = 0.9619

Therefore, $b_0 = 10^{0.9619} = 9.1601$ kg

ii. Regression coefficient

$b_1 = 0.5044$, $b_2 = 0.6109$

Production function in linear form is:

$$\text{Log } Q = 0.9619 + 0.5044 \log L + 0.6109 \log M$$

(0.2247) (0.2509)

2.2448* 2.4348*

Production function in non- linear form is:

$Q = 9.1601\ L^{0.5044}\ M^{0.6109}$

N = 9

$R^2 = 0.9599$

R = 0.9797

$\bar{R}^2 = 0.9491$

$F^3_9 = 75.42$***

The positive coefficients of labor and manure shows the positive relationship between output and inputs labor and manure. The input labor is significant at 0.10 level and the coefficient of manure is significant at 0.05 level. Therefore, accepted the alternative hypothesis i.e. $b_1, b_2 \neq 0$ which means the effect of labor and manure is significant on the output. The F-ratio is significant at 0.01 level which shows that there is statistically significant relationship between inputs and outputs. The coefficient of multiple determinations (R^2) is 0.9599 and adjusted R^2 ($\bar{R}^2$) is 0.9491 Hence 95.99 percent of total variation in output is explained by the inputs considered in the model. The coefficient of multiple correlation (R) is 0.9797. So, the positive R shows that there is positive correlation between inputs an input in the potato production. The marginal physical productivity of all inputs is found positive. The MPP_L is calculated higher than MPP_M in the model. The marginal rate of technical substitution of manure for labor) is found to be strong in this model. The sums of output elasticity are found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation -VIII

In this model, the production function is fitted to the data relating to the nonuser farmers of fertilizers in Upland (Pakho/Bari). Out of 49 observations there only 27 observations is considered. The computed values of regression constant and coefficients are presented below:

i. Regression constant

$b_0* = 0.3829$

Or, $\log b_0 = 0.3829$

Therefore, $b_0 = 10^{0.3829} = 2.4149$ kg

ii. Regression coefficient

$b_1 = 0.3542$, $b_2 = 0.9398$

Production function in linear form is:

$$\text{Log } Q = 0.3829 + 0.3542 \log L + 0.9398 \log M$$

(0.1593) (0.1698)

t = 2.2235** 5.5347***

Production function in non- linear form is:

$$Q = 2.4149\, L^{0.3542}\, M^{0.9398}$$

N = 27

$R^2 = 0.9569$

R = 0.9782

$\bar{R}^2 = 0.9534$

$F^3_9 = 266.6$***

In this model, only two inputs labor and manure are considered and attempt have been made to see the response of inputs to output of potato. The positive coefficients of labor and manure are positive effects of these inputs on the output. The coefficient of manure is significant at 0.01 level and the coefficient of labor is significant at 0.05 level. Hence alternative hypothesis is accepted i.e. $b_1, b_2 \neq 0$ which means there significant statistical relationship between output and the inputs labor and manure. The F-ratio is significant at 0.01 level which shows there is statistically significant relationship between inputs and outputs. The coefficient of multiple determinations (R^2) is 0.9569 and adjusted R^2 (R^2) is 0.9534. Hence 95.69 percent of the total variation on output is explained by the inputs considered in the model. The coefficient of multiple correlation (R) is 0.9782. Therefore, the positive R shows that there is positive correlation between input and output in the potato production. The marginal physical productivity of all inputs is found to be positive. The MPP_F is higher in the model. The marginal physical productivity of input labor and manure found positive. The MPP_M is calculated as higher in the model. The marginal rate of technical substitution of manure for labor ($MRTS_{MF}$) is found to be strong. The sums of output elasticity is found as greater than one indicates that there is increasing returns to scale in the potato production in this model.

Equation -IX

In this model, the production function is fitted to the data relating to the farmers of fertilizers in both Upland and lowland. Out of 49 observations there only 13 observations which are using fertilizers in the both upland and lowland. In this model, the first variable labor has not taken. Thus, the production function has been estimated with two inputs manure and chemical fertilizer. Hence b_2 and b_3 represent the regression coefficients of manure respectively. The computed values of regression constant and coefficients are presented below:

i. Regression constant

$b_o^* = 3.0146$

Or, $\log b_o = 3.0146$

Therefore, $b_o = 10.^{3.0146} = 1034.1892$ kg.

ii. Regression coefficient

$b_2 = 0.1717$, $b_3 = 0.2924$

Production function in linear form is:

$$\text{Log } Q = 3.0146 + \underset{(0.1062)}{0.1717} \log M + \underset{(0.0663)}{0.2924} \log F$$

t = 1.6168 4.4103***

Production function in non-linear form is:

$$Q = 1034.1892\, M^{0.1717}\, F^{0.2924}$$

$N = 13$

$R^2 = 0.9224$

$R = 0.9604$

$\bar{R}^2 = 0.9077$

$F^2_{10} = 60.00^{**}$

The positive coefficients of manure and fertilizer shows the positive relationship between output and the inputs manure and fertilizer. The coefficient of fertilizer is significant at 0.01 level. Hence, alternative hypothesis is accepted i.e. $b_3 \neq 0$ which means there is significant statistical relationship between output and chemical fertilizer. But the coefficient of manure is insignificant even at 0.10 level. Hence, null hypothesis is accepted i.e. $b_2 = 0$ which shows there is not significant statistical relationship between output and holds good in the model. The coefficient of multiple determination (R^2) is 0.9224 and adjusted $\bar{R}^2$ is 0.9077. Hence 92.24 percent of the total variation in output is explained by the variation of inputs considered in the model. The coefficient of multiple correlation (R) is 0.9604. Therefore, the positive R shows that there is positive correlation between inputs and output in the potato production. The marginal physical productivity of inputs manure and fertilizer is found positive. The MPP is calculated as higher in the model. The marginal rate of technical substitution of fertilizer for manure ($MRTS_{FM}$) is found to be stronger in this model. The sum of output elasticity is found as less than one indicates that there is decreasing return of scale in the potato production in this model.

4.3 Product Isoquants, Marginal Rate of Technical Substitution and Isoclines

Production Isoquants, MRTS between inputs manure and fertilizer and isoclines are estimated here. These equations are estimated on the basis of the production function is:

$$Q = 1034.1892\ M^{0.1717}\ F^{0.2924} \qquad \text{………………. (4.1)}$$

There, as the output of potato is fixed, the above production function can be written as:

$$Q_0 = 1034.1892\ M^{0.1717}\ F^{0.2924}$$

where, Q_0 is the constant level of output.

Therefore,

$$F = \left(\frac{Q0}{1034.1892 M^{0.1717}}\right)^{\frac{1}{0.2924}} = \left(\frac{Q0}{1034.1892 M^{0.1717}}\right)^{3.4201}$$

$$\text{Or, } M = \left(\frac{Q0}{1034.1892 F^{0.2924}}\right)^{\frac{1}{0.1717}} = \left(\frac{Q0}{1034.1892 F^{0.2924}}\right)^{5.8241}$$

MARGINAL RATE OF TECHNICAL SUBSTITUTION EQUATION

Taking the partial derivatives of the given production function (4.1) with respect to manure and fertilizer respectively. The marginal physical productivities of manure and fertilizer are derived.

$$\frac{\partial Q}{\partial M} = 177.5703\ M^{-0.8283}\ F^{0.2924} \qquad \text{…………….. (4.2)}$$

$$\text{And, } \frac{\partial Q}{\partial F} = 302.3963\ M^{0.1717}\ F^{-0.7076} \qquad \text{……………. (4.3)}$$

Dividing the equation (4.2) by (4.3) by (4.2) MRTS equation are derived i.e.

$$\frac{\partial Q}{\partial M} = 0.5872\ \frac{F}{M} \qquad \text{……………….. } MRTS_{MF}$$

$$\text{Or, } \frac{\partial Q}{\partial F} = 1.7030\ \frac{M}{F} \qquad \text{……………. } MRTS_{FM}$$

The marginal rate of technical substitute (MRTS) between the inputs manure on fertilizer and fertilizer on manure of the above production functions are presented in the table below:

Table 4.1

Marginal Rate of Technical Substitution between

Manure on Fertilizer and Fertilizer on Manure

Models	$MRTS_{LM}$	$MRTS_{LF}$	$MRTS_{MF}$	$MRTS_{ML}$	$MRTS_{FL}$	$MRTS_{FM}$
I:	0.8537	0.9387	1.0995	1.1713	1.0654	0.9095
II:	3.5055	5.2309	1.4922	0.2853	0.1912	0.6702
III:	0.2280	0.3932	0.7243	6.9166	2.5435	0.5799
IV:	0.9403	114.9286	122.2286	1.0635	0.008	0.008
V:	0.3143	1.9399	6.1714	3.1813	0.5155	0.1620
VI:	0.4049	-	-	2.4701	-	-
VII:	0.9189	-	-	1.0882	-	-
VIII:	0.4062	-	-	2.4616	-	-
IX:	-	-	0.3763	-	-	2.6573

Source: Empirical Analysis.

The above table shows the different rates of substitution between the inputs manure and fertilizer in different models.

a. In model I, the marginal rate of technical substitution of manure for fertilizer is 1.0995 which implies that 1.0995 units of manure should be sacrificed for an additional unit of fertilizer. The marginal rate of technical substitution of fertilizer for manure is 0.9095 which implies that 0.9095 units of fertilizer should be sacrificed for an additional unit of manure.

b. In model II, the marginal rate of technical substitution of manure for fertilizer is 1.4922 and of fertilizer for manure is 0.6702 which shows that 1.4922 units of manure should be sacrificed for an additional unit of fertilizer and 0.6702 units of fertilizer should be sacrificed for an additional unit of manure.

c. In model III, the marginal rate of technical substitution of manure for fertilizer is 1.7243 and of fertilizer for manure is 0.5799. Which shows that 1.7243 units of manure should be sacrificed for additional unit of fertilizer and 0.5799 units of fertilizer should be sacrificed for an additional unit of manure.

d. In model IV the marginal rate of technical substitution of manure for fertilizer is 122.2286 and of fertilizer for manure is 0.0080. The MRTS of manure for fertilizer is highest than the other model which is 122.2286. It shows that manure can be replaced for the fertilizer by 122.2286 units. But fertilizer can be replaced by 0.0080 units which is very lowest than the other model.

e. In the model V, the marginal rate of technical substitution of manure for fertilizer is 6.1714 and of fertilizer for manure is 0.1620. Which shows that 6.1714 units of manure should be sacrificed for additional units of fertilizer and 0.1620 units of fertilizer should be sacrificed for an additional unit of manure.

f. In the model IX, the marginal rate of technical substitution of manure for fertilizer is 0.3963 and of fertilizer for manure is 2.6573. Which shows that 0.3763 units of manure should be sacrificed for an additional unit of fertilizer and 2.6573 units of fertilizer should be sacrificed for an additional unit of manure.

Other models are not using fertilizer so there is no chance to substitution between manure and fertilizer. From the above analysis, it can be said that it is preferable to the potato producer of Pokhara-27, Hemja to substitute manure for fertilizer to maximum production for potato.

¶ Isocline

By setting MRTS of model V is equal to a constant k, then the equation for isoclines is:

$$F = \frac{K}{34.4325} M$$

$$M = \frac{K}{0.0290} M$$

4.4 Least Cost Combination of Inputs

The particular combination of inputs labor and manure and $MRTS_{MF} \left(\frac{dM}{dF}\right)$ are predicted from the estimated production function of model ninth of potato isoquants of 3000, 3500 and 4000 kgs. Per hectare. The MRTS of the data has been calculated on the basis of the equation:

$$M = \left(\frac{Q}{1034.1892F^{2924}}\right)^{5.8241}$$

are given in the table below. It gives the required information for finding out the inputs combination which will give lowest cost for a given level of output.

Input combination and marginal rate of technical substitution $\left(\frac{dM}{dF}\right)$ have been predicted form the estimated production function of model nine for potato isoquant 3000, 35000 and 4000 kg per hectare.

Table 4.2

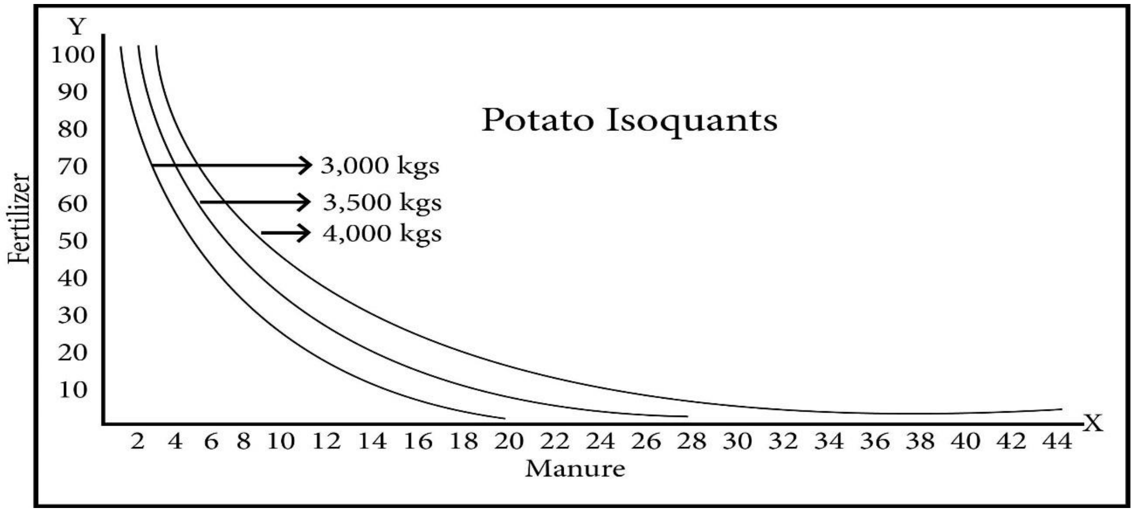
Least Cost Combination of Inputs

3000kgs.			35000 kg.			4000 kgs.		
F	M	$\frac{dM}{dF}$	F	M	$\frac{dM}{dF}$	F	M	$\frac{dM}{dF}$
10	9.79	-	10	24.03	-	10	52.29	-
20	3.01	0.678	20	7.38	1.665	20	16.06	3.623
30	1.51	0.150	30	3.71	0.367	30	8.05	0.801
40	0.92	0.059	40	2.27	0.144	40	4.93	0.312
50	0.63	0.029	50	1.55	0.072	50	3.37	0.156
60	0.46	0.017	60	1.14	0.041	60	2.47	0.090
70	0.36	0.010	70	0.87	0.027	70	1.90	0.057
80	0.28	0.008	80	0.71	0.016	80	1.52	0.038
90	0.23	0.005	90	0.57	0.014	90	1.24	0.028
100	0.19	0.004	100	0.48	0.009	100	1.04	0.020

From the above table No. 5.2, it is clearly seen that the rate of substitution falling continuously. It can be shown with the help of the following figure.

Figure 4.1

Potato Isoquants



4.5 Output Elasticity and Returns to Scale

The output elasticity and returns to scale which are found in the above analysis are presented in the following table.

Table 4.3

Output Elasticity and Returns to Scale

Models	Labor	Manure	Fertilizer	Sums	Returns to scale
I	0.1721	0.2447	0.1426	0.5594	Decreasing
II	0.3784	0.1376	0.0564	0.5724	Decreasing
III	0.3923	0.7799	0.0713	1.2435	Increasing
IV	0.5085	0.5993	0.0013	1.1091	Increasing
V	0.2478	0.8820	0.0256	1.1554	Increasing
VI	0.3251	0.8719	-	1.1970	Increasing
VII	0.5044	0.6109	-	1.1153	Increasing
VIII	0.3542	0.9398	-	1.2940	Increasing
IX		0.1717	0.2924	0.4641	Decreasing

Source: Empirical Analysis

The above table shows that the output elasticity of labor, manure and fertilizer are positive in all models. The sums of regression coefficients of production elasticity show the degree of homogeneity of Pokhara-27, Hemja of Kaski district. Since the highest sum is 1.2940 for model VIII, and the lowest sum is 0.4641 for model IX, all mode is except the models I, II and IX are shown the sum is greater than one so they show increasing returns to scale operating in the Pokhara-27, Hemja of Kaski district for potato cultivation. But the sum of models I, II and IX is lowest than one that indicates the decreasing returns to scale in model I, II and IX of the study areas.

4.6 Average Inputs and Output

In the present analysis the average inputs and output for the various models are found as below.

Table 4. 4

Average Inputs and Output

(Physical Units per Hectare)

Models	$\overline{Q}$ (In kg)	$\overline{L}$ (In Mandays)	$\overline{M}$ (In Dokos)	$\overline{F}$ in kg
I	11558.4607	254.4486	832.1469	74.2164
II	10697.9361	187.7587	791.0428	59.2379
III	8735.7460	319.3743	647.4407	2.7746
IV	6207.2609	249.7468	453.5237	4.3985
V	7978.1096	299.2265	589.1194	3.1347
VI	6979.1093	317.2488	519.9960	-
VII	4357.1248	182.7679	329.1547	-
VIII	8165.8237	381.2414	605.7592	-
IX	11558.4607	-	832.14469	74.2164

Source: Empirical Analysis.

The above table shows that the average inputs and output of potato. The average output of potato as 7978. 1096 kg. per ha. and average used of labor, manure and fertilizer as 299.2265 Mandays per hectare, 589.1140 Dokos per ha. and 3. 1347 kg per ha respectively. But the average inputs and output differ from model to model. The average output of potato ranges in between the maximum of 11558.4607 kg per ha. in model I for those farmers who are using fertilizers in lowland (Khet). Similarly, the average used of labor ranges in between the maximum of 381.2414

Manday per ha. in model VIII for those farmers who are not using fertilizer in upland (Pakho Bari) and minimum of 182.7679 Manday per ha in model VII for those farmers who are not using fertilizer in lowland (Khet). As like, the average used of manure ranges in between the maximum of 832.1469 Dokos per ha. in model I for those farmers who are using fertilizers in both lowland and upland and minimum of 329.1557 Dokos per ha. in model VII for those farmers who are not using fertilizers in lowland. Such as the averages used of fertilizer ranges in between the maximum of 74.2164 kg per ha. in model I for those farmers who are using fertilizers in both lowland ad upland and minimum of 2.7746 kg per ha. in model III for all upland.

4.7. Marginal Physical Productivity

In the present analysis, the marginal physical products (MPR) of different inputs for the values models are found as below;

Table 4.5

Marginal Physical Productivity

(In kgs)

Modes	MPP_L	MPP_M	MPP_F
I	7.8177	3.3980	22.2074
II	21.5601	1.8609	10.1851
III	10.7306	10.5230	224.0509
IV	12.6382	8.2025	1.8340
V	6.6070	11.9445	65.1544
VI	7.1518	11.7022	-
VII	12.0247	8.0867	-
VIII	7.5866	12.6688	-
IX	-	2.3849	45.5362

Source: Empirical Analysis.

The above table shows that in all the models, the marginal physical productivity of input fertilizer is positive and very high in comparison to other inputs labor and manure. These higher marginal products for fertilizer indicate that there have been used less of fertilizer in the production process. Therefore, it is better to increase the use of fertilizer in all the models except the model IV. It is lower than the MPP of labor and manure. The largest marginal physical productivity of fertilizer for all upland (Pakho Bari) in model III suggest to use more doses of fertilizer than in other models.

The marginal physical productivity of labor is also positive in all models and it is very small as more or less equal to the marginal physical productivity of manure.

The marginal physical productivity of manure is also positive in all models. But these higher marginal physical productivities indicate generally the lesser pressure of labor force and lesser use of manure and fertilizer in the production process. The use of fertilizer is too low than what is required. Therefore, it is better to use more fertilizer, manure and labor in all the models generally.

Table 4.6

Comparison of Elasticity Coefficients,

Marginal Physical Productivities and

Marginal Rate of Technical Substitution and

Average Output between all Upland and Lowland

Model	Land type	$\overline{Q}$	Coefficients			MPP_L	MPP_M	MPP_F	$MRTS_{MF}$
			L	M	F				
III:	All up	8735.75	0.39	0.78	0.071	10.73	10.52	224.1	1.72
IV:	All low	6107.26	0.51	0.60	0.013	12.64	8.20	1.834	122.23

Source: Empirical Analysis.

The above table shows that the elasticity coefficients of labor, manure and fertilizers are positive in both all upland and lowland. It shows that there is positive impact of inputs labor, manure and fertilizer on output. Similarly, the marginal physical productivities of labor, manure and fertilizers are positive in both all upland and lowland. Both of these indicate than manure and fertilizers' response is greater than labor. The marginal physical productivity of fertilizers in all upland is very much greater than all lowland it shows that the fertilizer is required more for all upland than all lowland. The marginal rate of technical substitution of manure for fertilizer also shows that it is more preferable to substitute more of fertilizer for manure in all lowland as like more or less same in all upland. The marginal rate of technical substitution for all lowland is found as higher. The average output for all upland is calculated as higher than all lowland. Thus, from the above analysis we can say that in case of all upland the production is found as higher. So, farmers must be cultivation potato in all upland but fertilizer should be use more in all of cases.

Table 4.7

Comparison of Elasticity Coefficients, Marginal Physical Productivities and Marginal Rate of Technical Substitution, and Average Output between Those Farmers Who are Using Fertilizers in Both Low & Upland & Those Farmers Who are Not Using Fertilizers in Both Low & Upland

Model	Fertilizers	$\overline{Q}$	Coefficients			MPP_L	MPP_M	MPP_F	$MRTS_{MF}$
			L	M	F				
I:	Using up & lowland	11558.46	0.17	0.25	0.143	7.82	3.40	22.21	1.11
VI:	Not using low & upland	6979.11	0.33	0.88	-	7.15	11.70	-	-

Source: Empirical Analysis.

It is obvious from the above table that, in both models all the coefficients are positive. The manure coefficient is greater in case of those farmers who are not using fertilizers in both lowland and upland. The marginal physical productivity of labor is more or less equal in both model. The marginal physical productivity of manure is higher in model VI and less in model I or higher in those farmers who are not using fertilizer is both low and upland and less in those farmers who are using fertilizer in both low and upland. The marginal physical productivity of Fertilizer for those farmers who are using fertilizers in both low and upland is very higher than the marginal physical productivity of labor and manure. The average output for those farmers who are using fertilizers is calculated higher than the farmers who are not using fertilizers in both low and upland. It is more or less double than the farmers who are not using fertilizers. Thus, form the above analysis we can say that farmers should use more fertilizer to increase their potato production.

CHAPTER V

SUMMARY AND CONCLUSIONS

5.1 Summary

Nepal is an agrarian country. Agriculture is the backbone of our Nation. Potato is the main cash-crops and vegetable of Nepal. The production of potato still plays a significant role in total cash-crops of Nepal. Potato is the major cash-crops and vegetable of Nepal.

The present study is a micro level study, which tries to analyze the input output relationship of potato production of Pokhara-27, Hemja, Kaski district through the Cobb-Douglas type of production model. Nine types of models have been estimated in the analysis and relative productivity, marginal rate of technical substitution between inputs, returns to scale, average inputs and output, are identified for the different models considered in the analysis is that we have performed.

The main aim of this study is not to generalize the input-output analysis of potato production for the national level as a whole. But this study may represent the regions having similar geographical conditions alone with the same technique of farming. So, the findings may be applied only for such regions.

The entire study can be summarized in the following table, whereas marginal rate of technical substitution, output elasticity and returns to scale, average inputs and outputs and marginal physical productivity are given in table no (5.1), (5.3), (5.4) and (5.5) respectively. It is well remarked here that *** indicates significant at 0.01 level.

Table 5.1

Regression Constants and Coefficients

Models	Regression constants (b_o)	Regression coefficients		
		b_1	b_2	b_3
I:	2.6675	0.1721	0.2447	0.1426
II:	2.6703	0.3784	0.1376	0.0564
III:	0.7348	0.3923	0.7799	0.0713
IV:	0.9809	0.5085	0.5993	0.0013
V:	0.8323	0.2478	0.8820	0.0256
VI:	0.6637	0.3251	0.8719	-
VII:	0.9619	0.5044	0.6109	
VIII:	0.3829	0.3542	0.9398	-
IX:	3.0146	-	0.1717	0.2924

Table 5.2

Multiple Coefficient of Correlation (R), Coefficient of Determination (R^2) and F- Values

Models	R^2	R	$\overline{R}^2$	F- Values	Sample size
I:	0.9968	0.9984	0.9957	933.3333***	13
II:	0.9218	0.9601	0.8729	19.4***	9
III:	0.9063	0.9520	0.9059	112.2875***	36
IV:	0.9768	0.9883	0.9729	1026.44***	13

V:	0.9258	0.9622	0.9884	206.7***	49
VI:	0.9514	0.9754	0.9570	387.58***	36
VII:	0.9599	0.9797	0.9491	75.42***	9
VIII:	0.9569	0.9782	0.9534	266.6***	27
IX:	0.9224	0.9604	0.9077	60.00***	13

Table 5.3

Production Functions

Models	Production functions	Sample Size
I:	$Q= 2.6676\ L^{0.1721}\ M^{0.2447}\ F^{0.1426}$	13
II:	$Q= 2.6703\ L^{0.3784}\ M^{0.1376}\ F^{0.0564}$	9
III:	$Q= 0.7348\ L^{0.3923}\ M^{0.7799}\ F^{0.0713}$	36
IV:	$Q= 0.9809\ L^{0.5085}\ M^{0.5993}\ F^{0.0013}$	13
V:	$Q= 0.8323\ L^{0.2478\ M0.8820}\ F^{0.0256}$	49
VI:	$Q= 0.6637\ L^{0.3251}\ M^{0.8719}$	36
VII:	$Q= 0.6919\ L^{0.5044}\ M^{0.6109}$	9
VIII:	$Q= 0.3829\ L^{0.3542}\ M^{0.9398}$	27
IX:	$Q= 3.0146\ M^{0.1717}\ F^{0.2924}$	13

5.2 Conclusion

Form the earlier analysis it is found that except model II the output labor has positive coefficient and significant in all the models, So form the analysis, it can be said that there is less use of labor for potato production. Model II shows that there is excess supply of labor for potato cultivation which caused disguised unemployment.

The input manure coefficient is also positive and significant in all the models shows that there is less use of manure for potato production. But model II is insignificant. It is insignificant in the case of those farmers who are using fertilizer in upland. This indicates that there is no any response of manure input in the production of potato. This may be happened due to the certain reasons as:

a. Most of the sampled farmer use large amount of manure. Cattle farming is the second major occupation of the farmers. Therefore, the amount of manure per hectare needed is already maintained.

b. Most of the farmers are not aware of scientific farming-due to the lack of proper knowledge. The raw manure also does not work as perfect compost. Therefore, the response of this input is found to be insignificant.

Thus, from the all foregoing analysis of these studies. It is concluded that there is close relationship between input and output of potato. All of the models except model second labor and manure are positive and significant. Hence the alternative hypothesis (H_A): is accepted i.e. b_1, b_2, $\neq 0$, and in case of model 1st the input fertilizer is also positive and significant effect upon the output. So the fertilizer is hypothesis (H_A): is accepted i.e. b_1, b_2, $b_3 \neq 0$. But in case of model II all the inputs labor, manure and fertilizers are insignificant so the null hypothesis is accepted i.e. b_1, b_2, $b_3 = 0$, so that there is no significant relationship between inputs and output of potato. The input fertilizer is insignificant in all of the model except first model. Hence, the null hypothesis is accepted i.e. $b_3 = 0$ shows that there is no significant relationship between input fertilizer and output of potato due to the certain reason that there is negligible use of fertilizer or the actual use of fertilizer is too low which indicates that there is no any response of fertilizer input in the cultivation of potato.

5.3 Recommendations

After having our study, following suggestions can be put forward so that the problems as the related field could be solved.

i. The amount of manure needs to increase to increase the potato production in Pokhara-27, Hemja. MOA need to teach the scientific method of preparing compost through JTA and other technical assistance need to provide for the better management of ***"AALOO MAHOTSAB OF HEMJA".*** If there is more doze of manure somewhere that should be reduced.

ii. The labors should be shifted from potato to another factor of find production. Some labor-intensive method for another development works can be adopted.

iii. Another input fertilizer is also positive but insignificant except model first with positively less elasticity which says that the actual doze of fertilizer is low. Therefore, modern technique of using desirable fertilizer should be taught and fertilizer should be given free of cost to the farmers to increase potato production. Loan facility at reasonable interest rate can be given to the farmers.The farmers who use more fertilizer have more positively significant lowland (Khet) and upland (Bari/Pakha) should be provided more fertilizers.

iv. The average production who are using fertilizer in upland in higher than the general model and after not using fertilizer (or using manure only). The proper training should be given to manage the fertilizer form ADO (Agriculture Development Office).The average output in all model in upland is higher than the average output in all lowland. It is clear that those who used more fertilizer get more output. So, it is better to cultivate potato in upland (Bari) of Hemja.

v. The harvesting procedure should be taught to the farmers. The higher use of fertilizer has grown higher production of potato. So, training should be given to all farmers of Hemja area from the Pokhara metropolis. Farmer need to understand the idea of preparing compost manure by using their local resources also. Government at local level can donate them the tools that are necessary to prepare compost manure. People and local government can have interaction program to mitigate the existing problem for the potato production in Pokhara-27, Hemja.

APPENDIX-A

INPUTS AND OUTPUT OF POTATO PRODUCTION

S. No	Labor in Manday/ha. (L)	Manure in Doka/ ha. (M)	Fertilizer in Kg/ ha (F)	Patato (output) in Kg/ ha (Q)
1.	240	800	80	12,000
2.	160	700	50	10,000
3.	320	1,000	130	14,286
4.	240	1,400	120	14,000
5.	180	1,200	60	10,667
6.	120	500	40	8,000
7.	280	1,400	100	14,000
8.	125	400	30	8,000
9.	130	460	20	8,000
10.	360	700	80	10,000
11.	650	1,000	150	16,000
12.	575	1,200	160	16,000
13.	480	900	120	14,000
14.	60	100	-	1,200
15.	200	500	-	4,800
16.	175	300	-	3,200
17.	210	400	-	5,000
18.	400	700	-	12,000
19.	80	160	-	2,000
20.	320	500	-	8,000

S.No	Labor in Manday/ ha. (L)	Manure in Doka/ ha. (M)	Fertilizer in Kg/ ha (F)	Patato (output) in Kg/ ha (Q)
21.	120	300	-	4,000
22.	420	450	-	8,000
23.	600	1000	-	16,000
24.	240	450	-	8,000
25.	980	1,500	-	24,000
26.	260	350	-	4,000
27.	660	800	-	16,000
28.	760	1,100	-	18,667
29.	280	500	-	5,000
30.	160	200	-	2,667
31.	280	600	-	6,667
32.	560	1,200	-	16,000
33.	100	180	-	1,280
34.	520	700	-	10,000
35.	580	625	-	10,000
36.	860	1,300	-	20,000
37.	240	550	-	8,000
38.	850	1,250	-	20,000
39.	380	675	-	8,667
40.	300	500	-	8,000
41.	480	825	-	12,000
42.	540	900	-	12,000
43.	650	960	-	16,000
44.	280	400	-	4,000
45.	600	600	-	12,000
46.	260	450	-	4,000
47.	275	600	-	8,000
48.	120	200	-	2,000
49.	260	400	-	4,000

APPENDIX -B

Interview Schedule

1. General introduction:

   Ward No.:

   Name of the Village/ Tole:

   Date of interview:

2. Name of the respondent:

   Age Sex:

   Academic qualification:

   Main occupation:

3. Family composition: (General information)

S.N	Name	Age	Sex	Education	Occupation

4. Information or, landholding:

Total area owned (in ropani)	Irrigated	Non-irrigated	Rented in
Khet			
Bari			
Pakho			

5. Production of food grains:

S. N	Cereals Crop	Annual Production	Total cost of Production	Self-Consumption	Profits
a.	Rice				
b.	Maize				
c.	Wheat				
d.	Millet				
e.	Coffee				
f.	Potato				

6. Starting of Potato farming (in years) ………………………………..
7. Give the production amount of potato (in kg) form 1 kg of seeds.
8. What is your purpose of Potato farming?
9. Please provide information about the total quality and input cost for potato production within one year?

S.N	Items	Quantity	Cost/Price
1.	Land		
2.	Labors		
3.	Fertilizers		
4.	Insecticides and Pesticides		
5.	Tools and instruments		
6.	Others		

10. Used for potato production per Ropani:
    a. Compost (Dokos)
    b. Chemical fertilizers (kgs.)
        i. Complexal

ii. Uria

iii. Murate of Potash

iv. Fosphoras

11. Do you use insecticide?

    Yes/ No

12. How much price of potato per Kg?

    Rs. ……………..

13. For what purpose do you need to have the cultivation of potato?

    a. For own self use:

    b. For Sale:

14. Use of seed per Ropani kg.

15. What are the problems faced by you in potato cultivation?

    a. b. c.

16. Do you get govt. incentive in potato cultivation?

    Yes/ No

17. Any aid get form JOCV in potato cultivation?

    Yes/ No

18. What are your suggestions to receive aid for potato cultivation?

19. Do you sustain your family from the production of potato?

    a. Yes b. No

20. If no, how do you manage?

21. Did you get any training for this farming?

    a. Yes b. No

22. Have you got any type of help form Government or NGOs?

    a. Yes b. No

23. If yes, what type of help did you get?

a. Technical c. Farming management

b. Irrigation d. Others

24. Have you taken loan for potato farming?

a. Yes b. No

25. If Yes,

Source of Loan	Amount	Interest Rate (in %)
a. Banking and financial institutions		
b. Co-operative society		
c. Money lenders		
d. Others		

26. Where do you sell your product?

S.N	Market	Distance form Field	Means of Transportation	Time	Quantity of Selling	Total Amount (in Rs.)

27. Can you sell your production in time?

a. Yes b. No

28. If no, why?

29. Are you getting satisfactory price of your production?

a. Yes b. No

30. If not, what are the causes?

a. Lack of suitable market d. Middle man agent

b. High transportation cost e. Others

c. Lack of storage

31. What are the difficulties of market of potato?

a. Transportation c. Lack of storage

b. Unsatisfactory price d. Other

32. How much income did you have from selling the potato in the following three years?

S.N	Years	Income (in Rs.)
1	2072	
2	2073	
3	2074	

33. Did you spend this income entirely on potato farming?

a. Yes b. No

34. Is it more profitable than cereal crop farming?

a. Yes b. No

35. What do you think about the future of Potato farming?

a. Good b. Normal c. Bad

36. What are the problems and prospects of potato farming in your view?

37. Do you have any suggestion about the potato farming to increase its' production and to make more profitable?

Thank You for your co-operation.

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