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# Resource productivity analysis of apple production in Jumla district, Nepal

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**Abstract**
Apple is a major temperate fruit crop of Nepal. Apple production is an important farm enterprise of Nepalese farmers of high hills and mountains. Since the profitability of any production enterprise is largely determined by the combination of resources used, this study was conducted to investigate whether different factors of apple production are being used in an economic way. A total of 120 apple producing households were selected by random sampling technique from Patarashi Rural Municipality, Jumla and interviewed with pre-tested, semi-structured interview schedule. Jumla district, being the largest apple producing centre of the country, was selected for the study. The collected information was coded, entered and analysed by using SPSS and MS-Excel software. The data was analysed by using descriptive statistics and Cobb-Douglas production function. The production function revealed that costs on plant nutrients and labour have statistically significant effect on gross returns while other costs were found to be non-significant. The regression coefficient for nutrients and labour were estimated to be 0.54 and 0.68 respectively, both significant at 0.01P. Sum of regression coefficients also revealed that the production function shows increasing returns to scale by 1.11. Using high quality manure, providing trainings and skills to farmers, increasing value addition practices and improving market infrastructures would increase productivity and profitability of apple.

**Keywords:** resource productivity, profitability, cobb-douglas production function, regression coefficient

## Introduction
Apple belongs to the family Pomoidae (Korban & Skirvin, 1990). Apple (*Malus domestica*) is commercially the most important temperate fruit and is fourth among the most widely produced fruits in the world after banana, orange and grapes. China is the largest apple producing country in the world. Apple is the leading cash crop in Hindu Kush Himalayan region which provides employment opportunity to about 80% of people (Pratap & Pratap, 2001). Apple is a fruit of temperate origin. It was introduced to Nepal several years ago. It is best grown in Karnali region. Among the apple producingdistricts of Nepal, Jumla ranks on top in area, production and productivity. Total area, production and productivity of apple in Jumla is 700 ha, 5500 Mt and 7.86 Mt/ha respectively (MOAD, 2016). Jumla contributes around 20% of the total apple production and more than 10000 farmers are involved in apple production (SNV, 2011). However, Nepal still imports about 90% apple from china and India each years. Apple are often eaten raw, but can be found in many foods and drinks (Ewekeye, Oke, & Esan, 2016). Apple can be canned or juiced to produce apple cidar, vinegar and brandy (Korban & Skirvin, 1990). Apple has numerous health benefits due to phytochemical present in apples (Boyer & Liu, 2004). Poor transportation, poor management practices like irrigation, fertilizer application, training, pruning, harvesting and packaging are the problems related to apple production.

## Research Methodology
### Study area and sampling design
Apple production is one of the major cash crop productions in Karnali region of Nepal. Jumla is one of the leading apple producing districts (DADO, 2016). Hence, Jumla district was selected for the study. Patarashi rural municipality was randomly selected for the study. A total of 120 households were selected using simple random sampling technique. Face to face interview method was used to collect primary data using pretested semi-structured questionnaire in the month of September 2017. Data about socioeconomics and demographicinformation, variable costs incurred in production as well as income from apple production were collected during survey. Secondary data were collected from various published article, government publications, various books, web sites etc. collected data were

coded, entered and analysed in Statistical Package for Social Science (SPSS) and Microsoft Excel.

**Cost and return analysis**

The total variable costs of apple production was calculated by considering all variable inputs like sapling cost, organic manure, FYM, human labour, intercultural operation, harvesting and packaging and other costs valued at their current market price.

Total variable costs = $C_{labour} + C_{manure} + C_{bordeaux\ paste\ and\ other\ costs}$

Where, $C_{labour}$ = total cost on human labor (NRs/ha), $C_{manure}$ = total cost on organic manure (FYM) (NRs/ha), $C_{bordeaux\ paste\ and\ other\ costs}$= total costs on Bordeaux paste and other operations like harvesting and packaging (NRs/ha).

**Gross margin analysis**

Gross margin was calculated as:

Gross margin = gross returns - total variable cost

Where Gross returns = price of apple × total apple production.

**Benefit – cost analysis**

Benefits cost analysis was calculated by using the following formula:

$$\text{B/C ratio} = \frac{\textit{Gross return}}{\textit{total variable costs}}$$

**Production function analysis**

Cobb-Douglas production function is the most common and widely used technique in the field of economics to represent the technological relationship between the various inputs used and output produced (Dhakal, 2015; Mahatha, 2012 & Rahman & Lawal, 2003). The coefficients represent the elasticity of respective inputs and its summation provides the value of return to scale.

Return to scale describes the response of an output towards its overall proportionalchange from input. The summation of respective coefficients obtained from CDPF gives the value of return to scale.

$Y = aX_1^{b1} X_2^{b2} X_3^{b3} e^u$

Where, Y= Gross return (NRs/ha)

X1 = cost on human labor (NRs/ha), X2 = costs on manure (NRs/ha), X3 = costs on bordeaux paste and other costs (NRs/ha), e = Base of natural logarithm, u = Random disturbance term, a = constant, and b1, b2 and b3 are coefficient of respective variables.

**Results and Discussion**

**Cost of production**

The largest portion of the cost of apple production was found to be covered by human labor. The cost per hectare on human labor was estimated at about NRs. 114,273.94 per hawhich accounted about 60.31% of the total variable costs of production. The production activities requring human labor are planting of sapling, manure application, harvesting and paste application. The cost per hectare on manure was estimated to be NRs. 67,600 per ha which accounted about 35.67% of the total variable cost of production. The manure mostly constitute farmyard manure (FYM), goat and sheepmanure. The cost on bordeaux paste and other operations was estimated to be NRs. 7,615.72 per ha which accounted about 4.02% of the total variable costs of production. The costs on irrigation was negligible because most of the farmers depend on rain for irrigation. The entire district has been declared as organic district so the application of chemical fertilizers and chemical pesticides are prohibited in thestudy area.

**Table 1:** Total variable costs of apple production (NRs./ha)

| Inputs | Mean | Percentage |
|---|---|---|
| Human labor | 114273.94 | 60.31 |
| Manure | 67600 | 35.67 |
| Bordeaux paste and mixture | 7615.72 | 4.02 |
| Total variable costs | 189489.64 | 100 |

***Source*:** field survey 2017

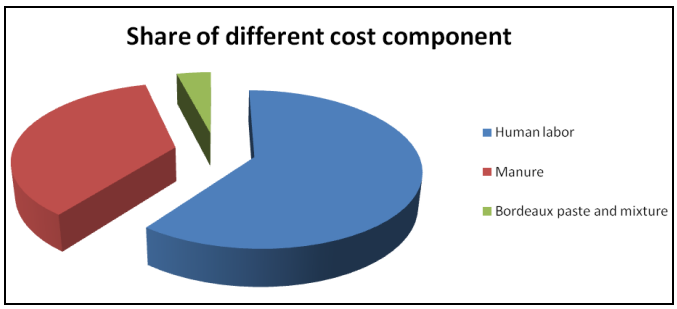


**Fig 1:** Share of different costs component of apple production

**Return from apple production**

The average farm size under apple planting in the study area was 0.15 hectare. The average productivity of apple production was estimated to be 7.06 metric ton per hectare. The average gate price of apple was NRs. 52.8 per kilogram. Per hectare gross returns and total variable costs were estimated at about NRs. 379,114.73 and NRs. 180,489.64 respectively. Per hectare gross margin of apple production was estimated at about NRs. 189,625.08. It was observed that the overall undiscounted benefit cost ratio considering total variable cost was 2.0. Thus, it can be concluded that the apple production was profitable in the study area.

**Table 2:** Economic statement of apple production in the study area

| Measuring Criteria | Average Value |
|---|---|
| Area (ha) | 0.15 |
| Productivity (t/ha) | 7.06 |
| Average Revenue (NRs./kg) | 52.8 |
| Gross Return (NRs./ha) | 379,114.73 |
| Total Variable Cost (NRs./ha) | 189,489.64 |
| Gross Margin (NRs./ha) | 189,625.08 |
| Benefit Cost Ratio | 2.0 |

***Source*:** field survey 2017

**Resource productivity analysis**

The estimated value of the coefficients and related statistics of Cobb-Douglas production function are shown in tabe 3. Out of three independent variables included in the regression analysis, the cost on human labor and plant nutrients were found significant at 1% level of siginificance while the bordeaux paste and other costs was found non-significant in apple production in the study area. The regression coefficient of nutrient cost was 0.54 which indicates that with unit increase in nutrient costs, gross return could be increased by 0.54. Similarly, unit increase in human labour cost could increase the gross return by 0.68. The sum of the regression coefficients of all the inputs taken into account in the regression function turned out to be 1.11 which indicates that the production function exhibited in an increasing return to scale. This implies that if all the inputs specified in the production function are increased byunity, the gross returns will increase by about 1.11.

**Table 3:** Estimated value of coefficient and related statistics of Cobb-Douglas production function of apple production

| Factors | Coefficient | Standard Error | t-value |
|---|---|---|---|
| Constant | -0.27 | 1.53 | -0.18 |
| Nutrient cost | 0.54*** | 0.19 | 2.80 |
| Labor cost | 0.68*** | 0.17 | 4.11 |
| Cost on Bordeaux paste | -0.11 | 0.17 | 0.63 |
| F-value | 0.000 | | |
| R square | 0.3939 | | |
| Adjusted R-square | 0.3782 | | |
| Return to scale | 1.11 | | |

***Source*:** Field survey, 2017

## Conclusion

Thus, the apple production being a profitable farm enterprise should be promoted in area having similar ecological niche. Providing trainings and skills of modern orchard management would further increase efficiency of human labour.Postharvest losses can be minimized by establishing storage facilities and postharvest centres. The production of apple can be increased by replacing unproductive orchards by high density planting of apple. Promoting value addition practices would increase market penetrability and profitability of farmers.

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