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## Economic analysis of commercial banana cultivation and supply chain analysis in Chitwan, Nepal

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### Abstract

This survey was conducted to assess the economics of commercial banana cultivation and to study the supply chain in the eastern Chitwan in 2018. The study was conducted in Ratnanagar and Khaireni municipalities. A household survey of 100 banana growers which includes 50 from each municipality and of total 20 traders were interviewed for collection of primary data. Data obtained from semi-structured questionnaire were subjected to descriptive analysis. The result showed that, the cost of banana cultivation per hectare was NRs 455857.80 and average profit to be NRs 197853.23 per hectare. The average benefit cross ratio was 1.50. Cobb-Douglas production function analysis showed that labor cost, machinery expenses, contributed significantly to gross income of banana at 1% level of significance. Organic manures and fertilizers costs contributed significantly to gross income of banana at 5% level of significance. Producers-Collectors-Wholesalers-Retailers-Vendors-Consumers supply chain was the prevailing supply chain in the study area. Most of the respondents perceived that the disease and pest infestation and fluctuation in price were major problems.

**Keywords:** Benefit-cost ratio, cobb-Douglas production function, gross return, producer's share, supply chain

### 1. Introduction

Banana (*Musa paradisiaca* L.) of the family Muscaceae is herbaceous tropical and sub-tropical fruit growing in clusters, usually elongated and curved, with soft flesh rich in starch covered with a rind which may be yellow or green when ripe. The complex domestication of wild bananas in the genus *Musa* occurred over thousands of years (Langhe, 2009) [8]. Bananas are excellent sources of Vitamin B6, soluble fibers and contain moderate amounts of vitamins, manganese and potassium. Consumption of banana may be associated with a reduced risk of breast cancer and renal cell carcinoma (Bose, 1990) [3].

In Nepal, banana is being grown since time immemorial for home consumption (Gautam, 1994) [6]. Before recent years, Nepalese subsistence farmers grew their banana crops in kitchen garden and homestead land (Ahamad, 2008) [1]. It ranks the fifth in area and third in production among fruit crops grown in Nepal (ASD, 1996/1997) [2]. Banana being a prioritized high-value agricultural product and a major fruit in Nepal in terms of the potential growing area, production and domestic consumption, is currently grown in 68 districts with total productive area of 14311 hectares and production of 234319 tones and productivity 13.2 tones per hectare. Nepal imports 27878 tones of banana annually from India to meet the domestic demand, particularly in urban and peri-urban areas (TEPC, 2016) [11].

Chitwan is the largest producer of bananas after Saptari, Jhapa, Morang and Rupandehi districts. The cultivation of banana initiated in Chitwan in 1940 (Shrestha, 1994) [10]. According to Banana Farms Promotion and Development Center, Chitwan district is the leading banana producing district earning NRs 150 million before 2010/11. Banana production in the district increased by a whopping 566 percent over the past decade (Ghimire, 2016) [7]. Banana is cultivated in Chitwan in 690 hectares and accounts for 12256 tones of the country's total production (DADO, 2016) [4, 5]. In Chitwan, banana is widely commercialized and the number of commercial plantation is rising and current plantations are expanding in the area. Most of the region of district is climatically suitable for growing banana, and hence the production potential is high. Farmers have adopted crop rotation that helps to minimize insect-

pest and disease infestation. Banana is grown for 5 to 6 years and cleared for rice, maize and mustard for one to two years. This study was targeted at central question of economic assessment of commercial banana cultivation in Chitwan district. The primary objective was to study socio-economic analysis, economics of production, marketing channel, gross return, identify problems and suggest appropriate policies and measures for improving commercialization of banana production.

## 1.1 Research Methodology

### 1.2 Study area and sample size

The survey was conducted in Prime Minister Agriculture Modernization Project (PMAMP) Banana zone of Chitwan district. Ratnanagar and Khaireni municipalities were purposively selected as study site. Sampling frame was prepared from the member's directory of Banana Zone Implementation Unit. Out of the sampling frame, 25% of the respondents were taken as study sample for this study. Simple random sampling method was used to select the required number of sample. Thus, selected respondents (100 banana growing farmers along with 20 traders comprising 50 growers and 10 traders) from each municipalities were interviewed by using pre-tested semi-structured interview schedule. Secondary information was obtained through reviewing different publications of different institutions (DADO Chitwan, Banana Producers Association, Banana Zone Profile, NGOs and INGOs), informal group discussions, participatory observations and key-informant survey.

The field survey was conducted in November, 2018. The respondents were interviewed with two interview schedules, one for producers and next for the traders. The collected information were first tabulated, coded and entered in to the computer. All the local measurements were converted to standard units and final analysis was done by using computer software packages: Microsoft Excel and Statistical Package for Social Sciences (SPSS).

## 2. Methods of data analysis

### 2.1 Cost of production

The total cost of production includes Total Variable Cost (TVC) and Total Fixed Cost (TFC). The cost of production encompasses cost of planting material, manure, fertilizer, micro nutrients, pesticides, labor, machines, marketing/transport and rent/ contract of orchard.

### 2.2 Benefit cost ratio

Benefit cost ratio simply gives an idea about recovery of cost incurred during the production by return from products. This analysis was done after calculating the total cost and gross return from banana production. B: C ratio was calculated using the formula:

$$B: C \text{ ratio} = \frac{\text{Gross return}}{\text{Total cost}}$$

### 2.3 Profit analysis

The difference between the total revenue and total cost incurred is the profit. The net profit can be determined as:

$$\Pi = TR - TC$$

Where,  $\Pi$  = Net profit, TR = Total Revenue, TC = Total Cost

### 2.4 Marketing margin and producers share

Marketing margin (MM) is used synonymously with the term

“Price Spread” and is the difference between the price paid by the consumers and the price received by the farmer was determined as frequency of importance given by the respondents. This was calculated by subtracting farm gate price from retailer price.

Marketing margin = Retailer price – Farm gate price

$$MM = P_r - P_f$$

Similarly, producers share is the price received by the farmer expressed as a percentage of the retail price, which is the price paid by the consumer. Considering  $P_r$  is the retail price and  $P_f$  is the producer's price (farm gate price), the producers share ( $P_s$ ) is calculated as:

$$P_s = \left( \frac{P_f}{P_r} \right) * 100$$

## 2.5 Indexing

So as to know the importance of different production and marketing problem five point scale was used based on farmer's perception about them. It includes very high importance, high importance, normal importance, less importance and the least importance to the different problems using numeric values 1, 2, 3, 4, and 5 respectively. The index of importance was carried out using the following formula:

$$I_{imp} = \frac{\sum (S_i F_i)}{N}$$

### Where

$I_{imp}$  = Index of importance

$\sum$  = Summation

$S_i$  =  $i^{\text{th}}$  Scale value (1, 2, 3, 4 and 5)

$F_i$  = Frequency of  $i^{\text{th}}$  importance given by the respondents

$N$  = Total number of respondents

## 2.6 Factors affecting banana production

Cob-Douglas production function was chosen to estimate the banana production function of banana producers. The choice of the functional form was based on its theoretical fitness to agriculture and its computational manageability. Further, most production studies in agriculture sector have used this function ((Sahota & S. Geain, 1968); Dhawan and Bansal 1977; Barman 1993; Barman and Chaudhary, 2000). The model specified and used was represented by  $Y = \alpha X_1^{b_1} X_2^{b_2} X_3^{b_3} \dots X_n^{b_n}$ , where  $Y$  was dependent variable and  $X_1$  through  $X_n$  were factors of production, respectively. The production function was converted to logarithmic form so that it could be solved by least square method i.e.  $\text{Log } Y = \text{Log } \alpha + b_1 \text{Log } X_1 + \dots + b_n \text{Log } X_n$ . Mathematically, the Cobb-Douglas production function can be expressed as;

$$Y = \alpha X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} X_8^{b_8} X_9^{b_9}$$

In log linear form the above model can be expressed as follows

$$\text{Log } Y = \text{Log } \alpha + b_1 \text{Log } X_1 + b_2 \text{Log } X_2 + b_3 \text{Log } X_3 + b_4 \text{Log } X_4 + b_5 \text{Log } X_5 + b_6 \text{Log } X_6 + b_7 \text{Log } X_7 + b_8 \text{Log } X_8 + b_9 \text{Log } X_9$$

### Where,

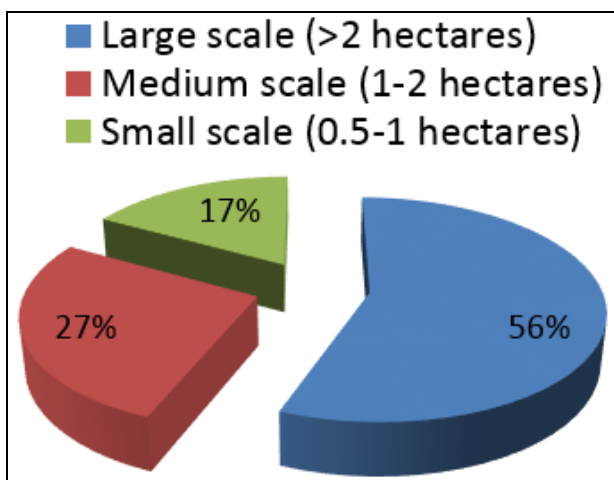
$Y$  = Gross return (Rs/hectare)

- $X_1$  = Planting material cost (Rs/hectare)  
 $X_2$  = Manure cost (Rs/hectare)  
 $X_3$  = Fertilizer cost (Rs/hectare)  
 $X_4$  = Micronutrient cost (Rs/hectare)  
 $X_5$  = Pesticide cost (Rs/hectare)  
 $X_6$  = Labor cost (Rs/hectare)  
 $X_7$  = Area (hectare)  
 $X_8$  = Rent/Contract of orchard (Rs/hectare)  
 $\alpha$  = Coefficient

### 3. Results and Discussions

#### 3.1 Farm size and scale of production

The scale of production of banana in the study areas appeared in three categories. Those farm sizes were small, medium and large. Among the total production, 56 percent banana production was large scale followed by 27 percent medium scale and 17 percent small scale of production as illustrated in figure 1.



**Fig 1:** Farm size and scale of production of banana

#### 3.2 Cost of production

Cost of production refers to the outlay of funds for the procurement of necessary inputs and labor employed. As banana cultivation needs higher amounts of inputs as

**Table 3:** Distribution of area under banana cultivation by municipality

Municipality	Average (Mean $\pm$ SE)	Minimum	Maximum	Total	Standard Deviation
Ratnanagar (n=50)	1.96 $\pm$ 0.23	0.33	5.33	176.88	1.12
Khaireni (n=50)	1.89 $\pm$ 0.26	0.36	4.59	179.23	1.45
Total (n=100)	1.92 $\pm$ 0.24	0.35	4.96	178.05	1.28

#### 3.5 Average area, production and productivity of banana

Different varieties of banana *viz* Malbogh, Grand Nain, Robestra, Mirchman, Jhapali, Battisa, William hybrid, Basarai dwarf, Harichhal and Chini champa were grown across the study sites. The average area, production and productivity of banana were observed 1.005 hectares, 14.31 tones, 14.25 tones per hectare throughout the study area. The average

compared to other field crops, it is a capital intensive enterprise. The total cost of banana cultivation per hectare was NRs. 455857.80. Rent/ contract of orchard contributed to highest share (23.14%) of total production cost. Details of cost and share of different factors of banana production are given in Table 1.

**Table 1:** Cost of commercial banana production per hectare

Particulars	Cost (NRs)	Share %
Planting material (suckers)	45398.99	9.95
Manure (FYM)	48569.02	10.65
Fertilizer (Urea, DAP, SOP)	59117.63	12.96
Micro-nutrients	9289.485	2.03
Pesticides	37778.99	8.28
Labor	69851.99	15.32
Machine	68941.49	15.12
Marketing/Transport	7174.463	1.57
Rent/Contract of orchard	97313.02	21.34
Others	12422.77	2.72
Total	455857.8	100

#### 3.3 Net return and profit

The average return of commercial banana cultivation was found to be NRs. 555324.14 per hectare with average profit of NRs. 197853.23 per hectare. The details of cost, return and profit of banana cultivation is illustrated in Table 2.

**Table 2:** Net return and profit of banana production (NRs per hectare)

Description	Minimum	Maximum	Average
Return	342000	765000	555324.20
Cost	250500	462750	455857.80
Profit	22500	302250	197853.23

#### 3.4 Area under banana cultivation

It was found that banana was mainly cultivated in the upland of both municipalities of Chitwan district. The total land under commercial banana cultivation was higher in Khaireni (179.23 hectares) than Ratnanagar (176.88 hectares). The maximum land under banana in Ratnanagar (5.33 hectares) was greater than Khaireni (4.59 hectares) while minimum were 0.33 hectares and 0.36 hectares respectively.

productivity of banana was observed higher in Khaireni municipality (14.54 tones/hectare) and lower in Ratnanagar municipality (13.96 tones per hectare). The average productivity of these municipalities were found higher than district average (13.57 tones per hectare) (DADO, 2016) [4, 5] and national average productivity. (13.2 tones per hectare) (DOA, 2016/17).

**Table 4:** Average area, production and productivity of banana in study area

Municipality	Area (hectare)	Production (tones)	Productivity (tones/hectare)
Ratnanagar (n=50)	1.02	14.23	13.96
Khaireni (n=50)	0.99	14.39	14.54
Total (n=100)	1.005	14.31	14.25

### 3.6 Benefit cost ratio

The study showed the average cost of production and return per hectare were NRs 365244.81±1850.67 and NRs 549719.77±1830.18 respectively and benefit cost ratio was 1.50, indicating that banana cultivation was profitable enterprise in Chitwan district. The benefit cost ratio analysis showed that the banana cultivation was profitable enterprise

in both the municipalities as the benefit cost ratio was greater than one i.e. 1.54 and 1.47 for Ratnanagar and Khaireni municipalities respectively. The higher return in Ratnanagar municipality might be due to higher density of bananas trees per hectare and hybrid varieties cultivation as compared to Khaireni municipality.

**Table 5:** Benefit cost ratio (NRs/hectare) of banana production

Municipality	Cost	Return	B:C ratio
	Mean ± SE	Mean ± SE	
Ratnanagar (n=50)	355507.50±1245.02	547983.22±2415.06	1.54
Khaireni (n=50)	374982.12±2456.32	551456.32±1245.30	1.47
Total (n=100)	365244.81±1850.67	549719.77±1830.18	1.50

### 3.7 Marketing margin and producers share

From the study, it was found that average farm gate price (NRs/Dozen) of banana was NRs. 34.32 in Ratnanagar and NRs. 36.78 in Khaireni while NRs. 35.55 was the average of two municipalities. Average retail price was found NRs 79.14 per dozen of banana. So overall marketing margin of the

study area was found NRs 43.59 per dozen whereas the producer's share was 44.90 percent. The marketing margin per dozen was almost similar in both municipalities (NRs. 43). The higher marketing margin might be due to lack of market information. The details are illustrated in Table 6.

**Table 6:** Marketing margin and producer's share of banana production in study area

	Municipality		
	Ratnanagar (n=50)	Khaireni (n=50)	Total
Average farm gate price (NRs per bunch)	34.32	36.78	35.55
Average retail price (NRs per bunch)	78.05	80.23	79.14
Market margin (NRs per bunch)	43.73	43.45	43.59
Producer's share %	43.97	45.84	44.90

### 3.8 Selling practice of banana in study area

Generally, two types of selling were practiced in the surveyed area i.e. selling to the wholesaler/collector and pre-harvest contractors were followed by the farmers of respective municipalities (Table 7). The non-contract system was the most commonly preferred system of selling. Majority of the respondents (83%) practiced the non-contract system of selling compared to pre-harvest contract system of selling (17%). Traders preferred non-contract system because of the low risk associated with market demand and storage.

**Table 7:** Selling practice of banana in study area

Municipality	Contract system	Non-contract system	Total
Ratnanagar (n=50)	5	45	50
Khaireni (n=50)	12	38	50
Total (n=100)	17	83	100

### 3.9 Income share from banana cultivation

The results in Table 8 showed that the percentage of cash income obtained from selling banana contributed considerably to household economy. Out of total farm income banana alone contributed about 42.14 percent to the total household economy, which showed the importance of banana enterprises in the farming economy. The contribution of banana to the total household income was observed higher in Ratnanagar as compared to Khaireni.

**Table 8:** Contribution of banana production to household income

Municipality	Average annual income (%)
Ratnanagar (n=50)	45.23
Khaireni (n=50)	39.56
Total (n=100)	42.14

### 3.10 Factors affecting commercial banana cultivation

**Table 9:** Parameters estimates of regression models for gross return of banana production with different explanatory variables

Independent variables	Unstandardized coefficients		Standardized coefficients	t-value	Significance error
	B	SE	Beta		
Constant	1.08	0.402		6.023	0.000
Log planting materials cost (Rs/hectare)	0.225	0.078	0.023	1.256	0.197
Log manure cost (Rs/hectare)	0.265	0.112	0.237	2.356	0.036*
Log fertilizer cost (Rs/hectare)	0.290	0.245	0.254	1.956	0.145*
Log micronutrient cost (Rs/hectare)	-0.137	-0.064	-0.214	-0.222	0.335
Log pesticides cost (Rs/hectare)	0.312	0.014	0.045	0.451	0.256
Log labor cost (Rs/hectare)	0.625	0.245	0.654	4.325	0.215**
Log machinery cost (Rs/hectare)	0.419	0.241	0.745	3.956	0.256**
Log area (hectare)	0.856	0.045	0.520	1.254	0.652
Log rent/contract of orchard (Rs/hectare)	0.877	0.024	0.627	1.562	0.567

Dependent variable: Gross return SE=Standard error

R=0.845, R<sup>2</sup>=0.650, Adjusted R<sup>2</sup>=0.742 and standard error of estimate 0.06547, Durbin-Watson test=2.314 and F statistics= 61.235\*\*

Note: \*\* and \* refers to the significant at 0.01 level and 0.05 level of significance, respectively.

Regression analysis was done for the whole sample with the specified functional model i.e. Cob-Douglas production function. The coefficients and estimated values of different parameters in the model are as illustrated in Table 9. The coefficient of multiple determination ( $R^2$ ) of the model was 0.650.  $R^2$  value indicates that 65 percent of the variation in gross return from banana was explained by the independent variables which were included in the model.

The F value of the equation was observed to be 61.235 and highly significant at 1 percent level implying a good fit of the model. It was clear from the table that the coefficient of fertilizer cost, expenses on manure and pesticides, area under banana cultivation and expense on labor showed positive and significant relation whereas micronutrient showed negative but non-significant relation with the production.

The value indicates that keeping all factors constant 1 percent increase in manure cost will increase the gross return by 0.26 percent, which is significant at 5 percent level. The value indicates that the one percent extra expense on fertilizers, other things remaining constant increase the gross return by 0.30 percent significant at 5 percent level. The coefficient indicates that the one percent more expense on labor and machinery increase the gross return by 0.63 percent and 0.42 percent which is significant at 5% level.

### 3.11 Intensity of problems of banana production and marketing

#### Faced by growers in study area

From the study it was revealed that the disease and insect pest infestation was the major production problem where as second most important problem was labor. Lack of chemical fertilizers was in third rank. It was followed by wind and irrigation. The intensity of problems of banana production faced by farmers in the study area is illustrated in the Table 10.

**Table 10:** Intensity of problems of banana production faced by growers in study area

Problems	Index	Ranking
Disease and pest	0.66	I
Lack of chemicals	0.60	III
Lack of labor	0.62	II
Wind	0.41	V
Irrigation	0.57	IV

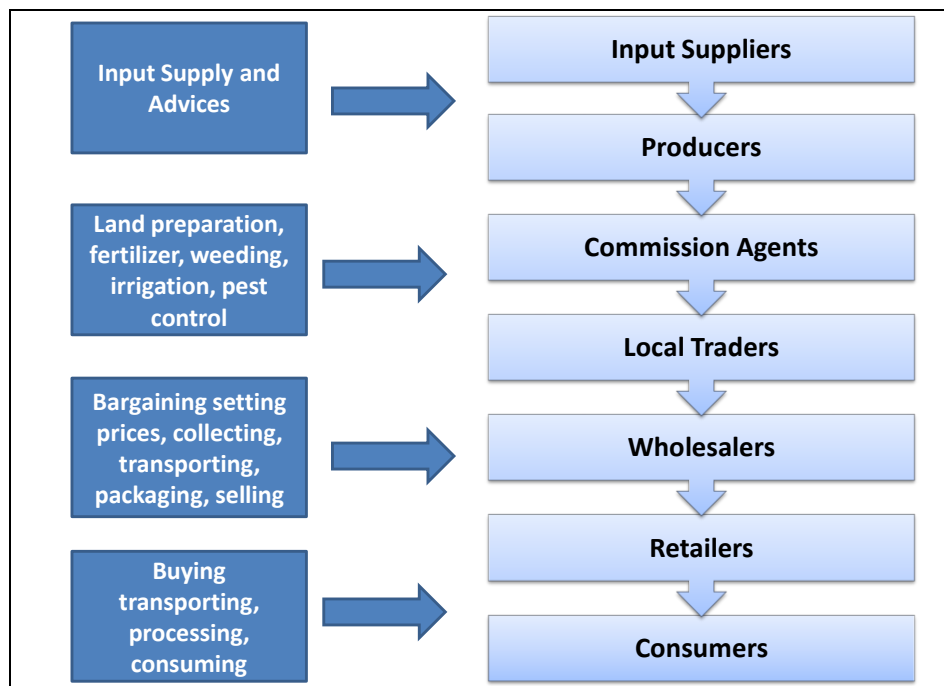
Marketing plays important role for the easy disposal of the product from producer ultimately to the consumer. Due to low storage life in ordinary condition, easy and safe disposal of the commodity after harvesting is imperative.

The intensity of marketing problems faced by wholesalers and retailers is shown in the Table 11. Various problems were mentioned and assigned cores by the banana traders. Problems of seasonal supply, Lack of storage facility, lack of production, transportation, lack of market information were ranked hierarchically by the wholesalers of the study area. Similarly, the retailers ranking of problems from very high importance to least importance is as follows: Seasonal supply, lack of storage facility, lack of market information, transportation and lack of production.

**Table 11:** Intensity of problems faced by wholesalers and retailers in the study area

Problems	Wholesalers		Retailers	
	Index	Rank	Index	Rank
Seasonal supply	0.65	I	0.68	I
Lack of market information	0.53	V	0.65	III
Lack of storage facility	0.62	II	0.61	II
Transportation	0.56	IV	0.59	IV
Lack of production	0.58	III	0.54	V

### 3.12 Marketing channel and supply chain map of banana



**Fig 2:** Marketing channel and supply chain of banana

The banana producers and the local collectors were the main person involved in marketing. Mainly buying, assembling, transportation etc are done by the collectors, while producers

involved in selling activities only. The marketing channel and supply chain that had been operating in the study area for banana marketing is illustrated in the Figure 2.

#### 4. Conclusion

Banana is identified as the potential sub-tropical fruit in Chitwan due to favorable climatic and edaphic conditions as well as easy access to regional and national markets. Ratnanagar and Khaireni municipalities are potential production area of banana which is indicated by profitable and lucrative farming due to high Benefit cost ratio in both municipalities. The average cost of production was NRs 455857.80 and average return was NRs 555324.20 per hectare. Banana farming was considerably contributing to the household income and shared 42.14 percent to total household economy, which showed the importance of banana enterprise for strengthening socio-economic conditions of farmers. Although farmers are getting good price for their production recently, marketing system is still fledging. There is still larger market margin and farmers are away from reasonable price of their produces due to lack of market information. The DADO in collaboration with PMAMP zone implementation unit, Banana Producers Association, cooperatives need to work to solve various production and marketing problems such as storage, grading, processing, orchard management, disease and pest management procedures to increase farm efficiency of commercial production of banana in eastern region of Chitwan district.

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