Research Article

A Comprehensive Value Chain Analysis of Mango Production and Distribution in Saptari District, Nepal

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Article Information	Abstract
   	Mango is an important fruit crop grown widely in the Saptari district of Nepal. A study was conducted in March and June 2022 under PMAMP-PIU (Prime Minister Agriculture Modernization Project-Project Implementation Unit), Saptari (PMAMP-PIU, 2074/75) to analyze the value chain of Mango in Saptari, which explored the functional and economic linkage among the actors. A total of 60 producers, 10 traders, 5 retailers and 2 key informants were interviewed. Data regarding production, post-harvest handling and marketing were analyzed by using descriptive and analytical methods with SPSS (version 26) and MS Excel 2021. Qualitative and quantitative analysis was undertaken in this study to generate insights into the limitations and opportunities of the mango value chain which can be used to establish the critical control points. The study identified key actors of Mango VC as input suppliers, producers, contract farmers, village-level collectors, wholesalers, retailers and consumers. Likewise, 4 marketing channels were identified in the study area. Economic analysis shows the cost of production per hectare was $1,453.71. Benefit cost analysis showed mango sub-sector is profitable business with BC ratio of 2.02. The average return was $2942.88/ha. The producers' share was 55.28% in the proximal market and 32.25% in the distant market. Infestation of disease, insect and pest and lack of processing and post-harvest technology was major production problem. .

Introduction

Mango (*Mangifera indica* L.) is one of the world's most important tropical and subtropical fruits belonging to the family of Anacardiaceae available in both fresh and processed forms. (Gupta, 2017; Lahutiya and Yadav, 2023). It serves as a crucial source of carbohydrates and proteins and is abundant in nutrients, including vitamins, minerals, and fibers (Lebaka *et al*., 2021). Furthermore, it is renowned for its distinct and delightful flavor that appeals to consumers. Mango is believed to have originated in Asia

around 4000 years ago, with the tropical and subtropical environments favoring its growth (Yadav & Paudel, 2022). Fruit culture is acknowledged as one of Nepalese key economic subsectors. 35.1 percent of the Gross Domestic Product (GDP) is contributed by the agricultural sector, and 13.49 percent of the Agricultural GDP (AGDP) is made up of fruit and spices. Mango contributes 0.99% in AGDP (Devkota, 2017). Mango alone accounted for 56.06 percent of the total summer fruit productive area and 46.33 percent of total summer fruit (Regmi, 2020). Mango is

commercially produced in almost all districts of Terai of Nepal like Sarlahi, Siraha, Saptari, Rautahat, Mahottari, Sunsari, etc. with Saptari being the hub for its production. The total area of mango cultivation in the country is about 14,000 ha, and the annual production exceeds 100,000 tons mainly in Terai and Low hill regions (Subedi *et al.*, 2008). The annual production of Mango is 366,144 metric tons covering 49,588 ha area. Madhesh province is the major mango-producing area of Nepal with an annual production of 258,509 metric tons. Saptari is one of the leading mangoes producing districts with an annual production of 68,101 metric tons (MOALD, 2020, 2016). Therefore, there exists substantial potential for mango production in Nepal, with a few commercial mango plantations in operation, yet the current productivity levels could be elevated (Yadav *et al.*, 2022).

Value Chain Analysis is a valuable instrument to figure out how the greatest possible value of a product can be created to its final consumers (Sah *et al.*, 2022; Chaudhary *et al.*, 2023). The analysis answers to a set of questions such as how the process of production is carried out; who the actors at various steps are; where the actors interact and for what benefits, etc (Magar *et al.*, 2022). Such information gathered is very pivotal to explore intervention for the enhancement of economic wellbeing of all the actors (Kattel *et al.*, 2009).

An agricultural value chain is defined as the people and activities that bring a basic agricultural product from obtaining inputs and production in the field to the consumer, through stages such as processing, packaging and distribution (Chapota, 2013). Value addition refers to the transformation of a product from its original state to one of enhanced worth. This enables small-scale farmers to reduce post-harvest losses for perishable fruits and thereby offering them opportunities to maximize returns (Tobin *et al.*, 2016; Aujla *et al.*, 2007). Mango fruits have been utilized at all stages of development for a long time. Some of the value-added products made from mango fruits at the farm-level include; mango juices, dessert, sliced and packed, dried mango, etc. Moreover, value addition also signifies changing a raw product into something new through storage, packaging, processing, and drying (Devkota, 2017).

Rationale of Study

This research was carried out as Saptari has a great deal of potential in terms of rectifying economic weaknesses and developing effective plans for mango production and marketing to increase income and contribute more to the household economy. This study aims to identify the players of mango subsector participating in each value chain segment, as well as their interrelationships with other actors, the value they provide to the product, and the opportunities and constraints they confront. The mango value chain analysis is a useful technique for determining

the efficiency and competitiveness of mango business as well as the activities that enable a competitive market environment. It aids in the provision of information on competitive advantage in terms of cost, value addition, product segmentation, and the upgrading of important success factors for the market. Several problems exist from production to marketing and distribution to ultimate consumers. One of them is the sharing of profit along the value chain. In this context, the research attempts to examine the profitability at each step of the mango value chain.

Objectives of Study

General objective
The overall objective of this research is to study mango value chain in Saptari district of Nepal.

Specific objectives
1. To identify mango value chain actors and their respective functions in the study area.
2. To study the cost of production, marketing cost, and value addition at each level.

Hypothesis

Null hypothesis: All the actors involved in value chain of mango share equal profit margin.

Alternate hypothesis: All the actors involved in value chain of mango do not share equal profit margin.

Methodology

Study Area
The research was conducted in Saptari district of Madhesh Province for the in-depth study of value chain of Mango as it is the major mango growing hub of the country. Saptari is an outer terai district lying between 26°25' to 26°47' N latitude to 86°28' to 87°7' E longitude. Saptari is renowned for its agricultural output and is bordered on the east by Saptakoshi river. The research was conducted in Surunga municipality, Shambhunath municipality, Rupani rural municipality, Kanchanrup municipality, Rajbiraj Municipality, Khadak Municipality and Agnisaira Krishnasavaran rural municipality. These were the command area of Mango zone under PMAMP-PIU, Saptari (PMAMP-PIU, 2074/75).

Selection of Respondents and Sample Size
A list of 15 mango farmers' cooperatives was provided by PMAMP-PIU Saptari. Then, proportionate random sampling was done to select mango 4 farmers from each cooperatives making sample size of the producers 60 for the household survey. 10 contract farmers/traders were randomly selected from different areas. Similarly, 5 retailers were selected randomly for the survey. Furthermore, 2 key informants were selected to get more information regarding value chain.

Data Collection

The research used both primary and secondary data. Primary data were collected through questionnaire survey, key informant interview and field observation. These data were collected by face-to-face interviews with mango farmers, and key market actors including contract farmers, traders and retailers. Secondary data were obtained by reviewing various governmental and non-governmental articles, reports, journals, books, internet materials and other publications produced by FAO (Food and Agriculture Organization), MoALD (Ministry of Agriculture and Livestock Development), NARC (Nepal Agricultural Research Council), PMAMP, AKC (Agriculture Knowledge Centre) and other relevant organizations.

Data Analysis

Data collected from survey was coded and directly entered in Statistical Package for Social Science (SPSS Version 26). Detection and removal of errors and inconsistencies were done to improve the data quality. Moreover, various graphs and charts were made by using relevant tools of MS Excel 2021. The quantitative data obtained from survey was analyzed quantitatively by using both descriptive and analytical statistics. Qualitative analysis uses non-quantifiable tools to understand or judge a process or system. In our study, basically, value chain analysis of qualitative mango data was done by using various analytical tools of value chain approach and relevant economic & marketing research tools. Simple statistics like sum, mean, relative frequency, maxima & minima and standard deviation was used for descriptive analysis of farm characteristics of the respondents like production, price, cost, margin, etc.

Cost of Production

Establishment and Maintenance cost of Mango orchard:

The main cost for orchard establishment were determined to be saplings, manure and fertilizers, irrigation, labor and equipment. Labor cost includes digging pit and other field preparation operations. Similarly, manure and fertilizers, irrigation, plant protection chemicals and labor constitute the maintenance cost. Hence, the total cost of establishment during per hectare (ha) is calculated as:

Establishment cost (A) = Sapling cost + Labor cost + Manure and fertilizer cost + Irrigation + Equipment cost + Miscellaneous cost   (Eqn. 1)

Maintenance cost (B) = Manure and fertilizers cost + Irrigation cost + Labor cost + Plant protection chemicals cost   (Eqn. 2)

Cost incurred during post-harvest management and marketing. For the estimation of cost incurred for post-harvest handling and marketing both fixed cost and variable cost were considered. Total fixed cost (TFC) included depreciation cost of equipment. For our study depreciation rate of 10% was used. Total variable cost (TVC) included sum of transportation cost, labor cost, packaging cost and cost of other raw materials.

TVC = Transportation cost + Labor cost + Packaging cost + Input cost   (Eqn. 3)

Gross Margin

A gross margin is a simple and quick method to analyze the performance of a farm business. It is calculated by deducting the total variable cost from gross return or gross income.

Gross margin = Gross return – Total cost of Production   (Eqn. 4)

Gross Return = Total production × Price of product   (Eqn. 5)

Market Margin

Marketing margin is the difference between the cost to the seller and to the cost to the consumers. It was calculated as:

Market margin = Retail price (P_r) – Farmgate price (P_f)   (Eqn. 6)

Producer's Share

Producers' share is the ratio of farm gate price to retail price expressed in percentage. It is calculated as:

Producer's share (P_s) = (P_f / P_r) × 100%   (Eqn. 7)

Profit Analysis

The net profit is the difference between gross income and total cost incurred. Thus, the net profit for any farm business can be written as:

Profit = Gross income – Total cost (Eqn. 8)

Benefit Cost Analysis

Benefit cost analysis is the benefit of the farm business relative to its cost, expressed in monetary value. The Benefit cost ratio is calculated by taking the ratio of total revenue and total cost. It is calculated as:

B/C ratio = Gross income/ Total cost   (Eqn. 9)

Payback Period

Payback period is defined as the number of years required to recover the original cash investment. It is calculated as:

Payback period = No. of years preceding the final recovery + (Balance still to be

recovered)/ (Cash flow during the final year of recovery) (Eqn. 10)

Indexing

Indexing is a tool to analyze respondents' perception by using scaling technique. Farmers' perception on production and marketing problem was analyzed by using indexing technique. Same technique was used to rank the reason for

adopting mango farming. The index of severity or importance can be computed by using following equation:

$$I = (\sum Si/fi)/N \qquad \text{(Eqn. 11)}$$

where,

I = Index of importance/ Severity

$\sum$ = Summation

Si = Scale value at i^{th} importance/severity

fi = Frequency of importance/severity given by the respondents

N = Total number of respondents

Value Chain Mapping
Value chain map is a graphical representation showing the major actors and their relationship along with the sequence of activities involved in the value chain. It applies both qualitative as well as quantitative methods in order to show the linkage and operation of the chain from input supply to processing and marketing. In order to understand the traits of the value chain players and the interrelationships among them a value chain map of mango sub-sector was prepared with all attempts to make the maps easily comprehendible.

SWOT Analysis
SWOT (Strength, Weakness, Opportunity and Threat) analysis of farmers and traders was done through key informant interview and face-to face interviews with producers and traders.

Results and Discussion

Mango Plantation Status
The plantation status of mango in initial plantation period as compared to current status is presented in Table 1. The respondent in the study area have been into mango farming varying from 7 years to 100 years. In Saptari, among the respondents the average initial area of mango plantation per

HH (Household) was 0.2ha which increased to an average of 0.31 ha. This shows an increment of about 55% in terms of area. Similarly, the average number of trees per HH has increased from 40.62 to 71.85. the number of trees among respondents varied from 25 to 350 and the average number of productive and unproductive trees was 70.35 and 1.77 respectively.

Production Status
Mango is an alternate bearing fruit, and this characteristic can be seen in its production behavior. Few farmers perform different management practices like flower induction, fertilizer application, irrigation etc. to overcome this problem. Similarly, some farmers use regular bearing varieties like Amrapali, Bangalora etc. However, most of commercially grown varieties like Maldaha, Dussheri are alternate bearings. Due to its alternate bearing feature, the production is likely to increase in one year and decreases in the following year which can be seen in Table 2.

Value Chain Analysis of Mango in The Study Area
Value chain analysis is concerned with the contribution of value adding functions of each actor along the commodity chain (Kaplinsky, 2001). Value chain analysis requires value chain mapping, identifying the actors and the institutions that provide an enabling environment. It also identifies the opportunities and constraints in each level of the value chain thereby recommending possible interventions to upgrade the value chain (Mcgee, 2015).

Value Chain Mapping:
Value chain mapping is the process of developing a visual depiction of the basic structure of the value chain (Zamora, 2016). The map illustrates the way the product flows from raw materials to end markets and presents how the industry functions. Fig. 1 shows the overall process of the mango value chain in the study area.

Table 1: Initial and Current Mango Plantation status in study area

Farm Characteristics	Mean
Initial area of mango plantation per HH (ha)	0.2±0.16
Current area of mango plantation per HH (ha)	0.31±0.27
Initial number of plants per HH	40.02±31.61
Current number of plants per HH	71.85±59.09
Number of productive trees	70.35±56.7
Number of unproductive trees	1.77

Source: Field survey (2022)

Table 2. Production status over years

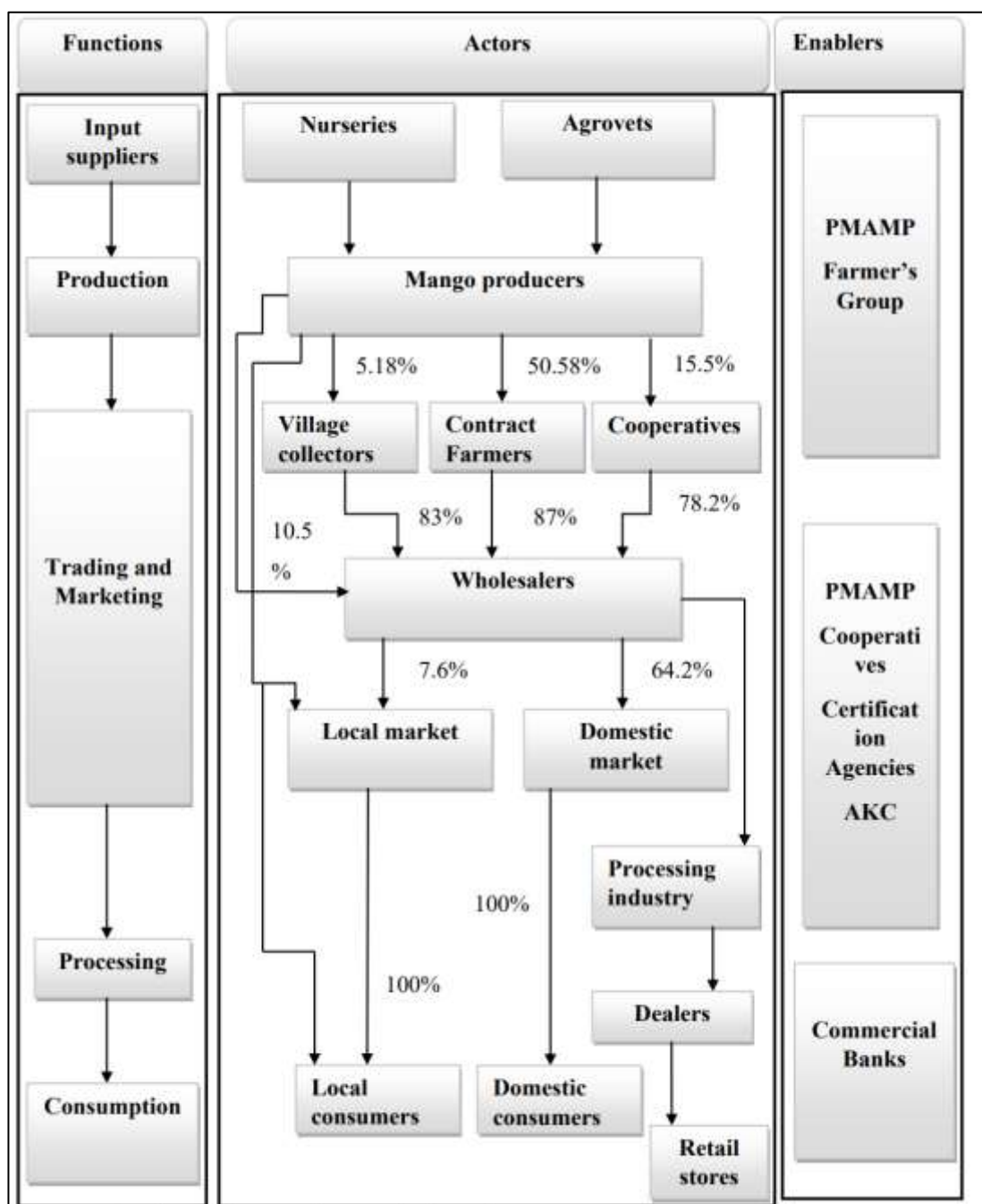| Year	Mean (N=60) (kg)	Minimum (kg)	Maximum (kg)
2019	6801.23±9779.323	65	43000
2020	15613.25±13141.7	500	53000
2021	7144.42±9318.533	100	42000

Source: Field survey (2022)

Fig. 1. Value chain map of Mango in the study area
[Source: Field survey (2022)]

Function of Actors:
Input suppliers
These are actors (nurseries and agrovets) engaged in supply and provision of raw materials for mango production in the area. The major input supplies used in mango farming are saplings, manure and fertilizers, plant protection chemicals and tools & equipment. The source of these inputs is shown in Fig. 2.

Mango producers
These are the farmers who produce mango using their own resources. From the production aspects, the main value chain functions performed by the farmers are planting, tree management, pruning, and harvesting by using different

planting materials. The main value adding activities performed by farmers prior to marketing are the post-harvest handling activities such as grading and sorting, drying, cleaning and packaging. Producers sell 5.18% of their produce to village collectors, 50.58% to contract farmers and 10.55% to wholesalers.

Contract Farmers or Pre-harvest contractors
Contract farming is the most widely practiced trading system in the study area. Contract farming involves agricultural production being carried out on the basis of an agreement between the buyers and farm producers Shyama, 2020). In the survey area, contract farming is an eminent form of business between farmers and traders of mango.
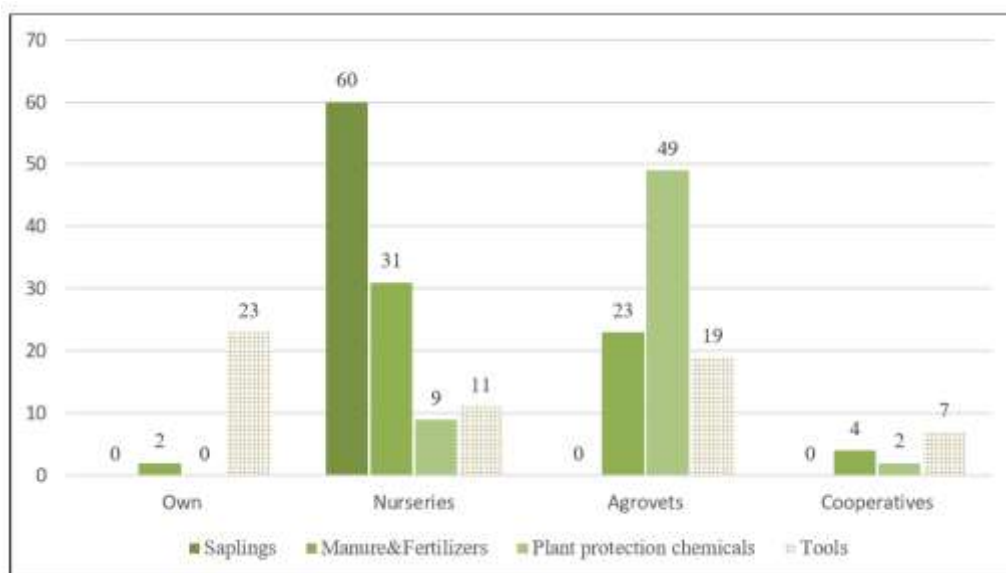
Fig. 2: Source of input supplies in mango farm. [Source: Field survey (2022)]

The following activities and agreements are included in contract farming:

1. Traders were responsible for the security of orchards from trespassers, insects and pests etc.
2. Harvesting and sales of produce were carried out by traders.
3. Some traders were involved in orchard management like spraying of pesticides, fertilizer application etc.
4. In case the production exceeded, farmers were not allowed to reevaluate their produce.

Wholesalers

Wholesalers purchase mango directly from farmers, village collectors and pre-harvest contractors. They usually purchase mangoes in bulk with better financial and marketing strategies and sell to retailers, processors and consumers in terminal markets. They also sell mango to retailers outside the study area. They procure and consign large amounts of mango to the regional markets and to terminal markets.

Retailers

Retailers purchase and handle products in small quantity. Local retailers purchase mangoes from farmers directly or through village collector or pre-harvest contractors. Domestic retailers acquire mangoes from wholesalers.

Consumers

These are final users of mango emerging from study area. Consumers for this particular study mean those households who bought and consume mango. They buy mango either in fresh or processed form from farmers, retailers and processors. Consumers prefer physically undamaged, not bruised and less fibrous for their immediate consumption.

Enablers

Enablers provide regular support, services and represent the common interest of the value chain actors. They were in the form of general investment and preparatory activities benefitting all or at least several value chain simultaneously. Government and private agencies have been promoting mango by policy formulation, extension, research and development.PMAMP (Prime Minister Agriculture Modernization Project) is largest existing agricultural project of Nepal under Ministry of Agriculture and Livestock Development formulated by Government of Nepal. PMAMP, PIU, Saptari provides grants in saplings and fertilizers in mango zone. Similarly, Agriculture Knowledge Centre (AKC) are working to increase and commercialize the production throughout the country. Cooperatives (Sagarmatha, Kuntamai) and Farmers' group (Shree Rupnagar) are providing financial, marketing and technical aid to the producers.

Marketing Channel

Four marketing channels were identified in the study area as illustrated in Fig. 3. İn first marketing channel, majority of them (50.58%) had pre-harvest contracts with traders who then sold to wholesalers. Likewise, in second channel about 10.55% sold directly to wholesalers while in third channel 15.5% of them were associated with cooperatives to reach the wholesalers. 3.6% of the produce was directly sold to retailers. The flow of mango from production point to the end market indicated that about more than 80% of mango marketed during production season was consumed by the domestic consumers.

Price Trend of Mango

Mango is an alternate bearing fruit, so its price changes based on its bearing season. During the high production season, the price falls and increases when the production is limited. The price trend of mango from 2018 to 2022 at wholesale level is illustrated in Fig. 4. As shown in the figure, the price seem to be higher in 2019 as compared to 2018 was due to less production in 2019 and the same trend can be observed in subsequent years.
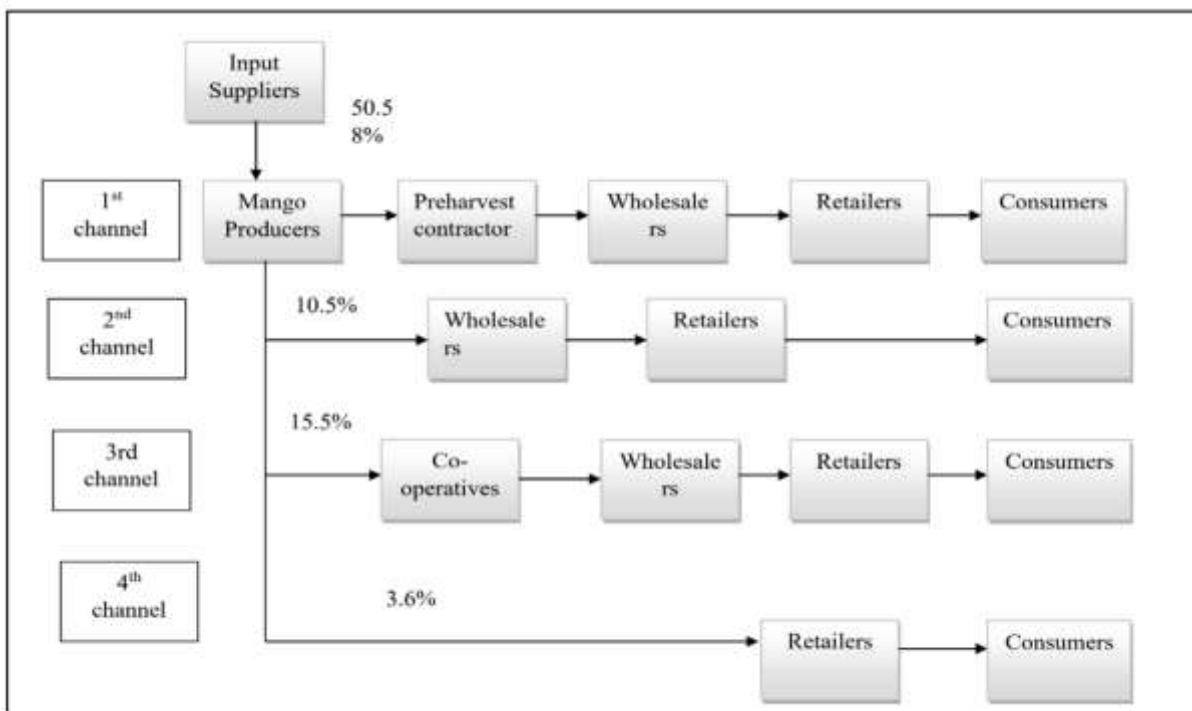
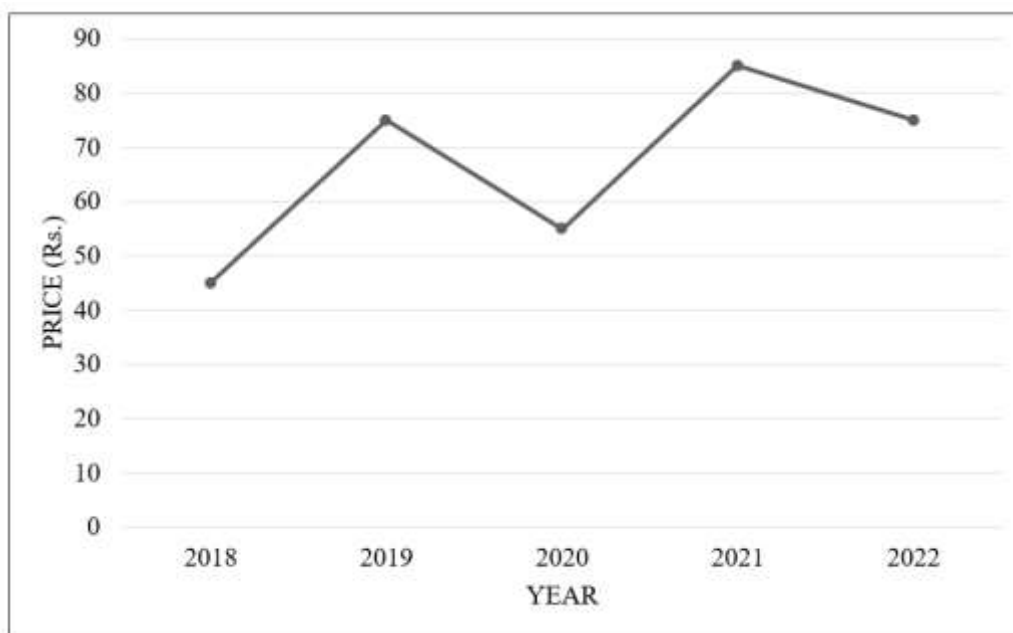**Fig. 3:** Marketing channel in the study area. [Source: Field survey (2022)]

Fig. 4: Price trend of Mango at wholesale level
[Source: Field survey (2022)]

Economic Analysis

This section deals with the economic analysis at three major levels of the value chain: namely, mango producer, traders and processor. Cost of production, gross margin, benefit cost ratio and profitability index were estimated in each level.

Cost of Production

Establishment and Maintenance cost of Mango orchard

Mango is a perennial crop and typically live past 80 years and can produce fruit until the late stage of their life cycle (Kancharla, 2022). Mango trees planted from seeds will take roughly 8 years to produce fruit, while mango trees planted from saplings will take up to 5 years for economic yield. The total cost incurred up to 5th year constitutes establishment cost. The establishment and maintenance cost incurred during gestation period were distributed over natural lifespan of Mango. Since, the orchard was established significant nymber of years ago inj long term fixed cost is spread into variable cost. The establishment cost of Mango orchard in 1 hectare land was estimated as $1453.71. The maintenance cost i.e. $1059.6 from sixth to

tenth year and $849.75 in later years indicates that the cost is generally higher in initial years but decreases gradually. Labor cost comprises the maximum cost during mango farming. This can be reduced by implementing new technologies and increasing the efficiency of available labours. Table 3 and Table 4 shows the establishment and maintenance cost of Mango plantation per hectare respectively.

Cost incurred during Postharvest management and Marketing
Post-harvest management of Mango usually includes cleaning, sorting & grading and packaging. Similarly, marketing cost includes transportation and communication cost. Transportation cost varies according to the distance. Proximal market like Lahan, Rajbiraj, Biratnagar, Itahari have relatively low transportation cost than distant market i.e., Chitwan, Kathmandu. It cost around $48.89 for

shipping Mangoes to proximal market (Biratnagar) and about $82.73 for distant market. These activities are mainly performed by pre-harvest contractor /traders. However, these are also carried out by farmers while selling the mangoes directly to wholesalers or retailers. Traders deal with more than 500 quintals of Mango in a season. Hence, depending on the quantity of Mango traders expend more than $3760.63 in a season depending on the quantity of Mango (Table 5).

Return from Mango orchard
Since first 5 years is gestation period, commercial return is obtained from sixth year. Then, the production is obtained till the last stage of mango tree. The average yield from 1 ha land initial years is around 230 kg generating $77.85 in revenue. Likewise, the yield increases tremendously in 11th-20th year with an average yield of 12500 kg and revenue of $4230.71 (Table 6).

Table 3. Establishment cost of Mango orchard

Particulars	Total cost (USD/ha)
Sapling cost	406.15
Labor cost	804.77
Manure and Fertilizer cost	69.8
Irrigation cost	116.58
Equipment cost	30.09
Miscellaneous cost	26.32
Total cost	**1,453.71**

Source: Field survey (2022)

Table 4. Maintenance cost of Mango orchard

Particulars	Cost (USD/ha)				
	2nd year	3rd-5th year	6th-10th year	11th-20th year	21st-32nd year
Manure Fertilizer cost	72.2	75.21	65.28	43.17	34.45
Irrigation cost	63.93	97.78	54.15	43.62	33.09
Labor cost	644.57	653.6	895.03	895.03	737.08
Plant protection	41.37	41.37	45.13	45.13	45.13
Total cost	822.07	867.95	1,059.6	1,026.95	849.75

Source: Field survey (2022)

Table 5. Cost incurred during postharvest management and marketing

Particulars		Cost (USD/kg) [Mean (N =10)]
Transportation cost	Proximal market	0.019
	Distant market	0.034
Labor cost		0.060
Packaging cost		0.019
Other raw materials		0.030
Total cost		0.13 (Proximal market)
		0.14 (Distant market)

Source: Field survey (2022)

Table 6: Return on Mango orchard in different aged orchards

Particulars	1st year	2nd-5th year	6th-10th year	11th-20th year	21st-32nd year
Yield (kg/ha)	0	230	10500	12500	11550
Cost (USD/ha)	1,453.71	845.01	1,059.60	1,026.95	849.75
Returns (USD/ha)	-	77.85	3,553.8	4,230.71	3,909.17

Source: Field survey (2022)

Profitability Analysis

In order to appraises a business if it is worthwhile or not, profitability analysis is generally conducted. Estimation of gross margin, net profit and Benefit Cost analysis was done to evaluate the profitability of farmers and traders.

Profitability analysis of Mango Producers

Table 7 shows the profitability analysis of producing mango per hectare. As discussed earlier, the total cost of production was $1,453.71/ha. The gross return per hectare was $2,942.88 and gross margin was $1,489.17. After deducting total variable cost of $ 945.33 from gross return, the net profit was $1,997.55. Then, the Benefit cost ratio was 2.02 which shows mango farming is a profitable business. An estimation done by (MoAD, 2016) indicates the BC ratio of Mango production to be 2.1. The average BC ratio of Mango farm was found to be 2.02 which is in consistency with the research done by (Shrestha *et al*., 2020) which indicated the BC ratio was 2.06.

Marketing margin and Producer's share

The retail price of mango in proximal market was $0.53/kg and $0.9/kg in distant market. The average farm gate price was $0.29/kg. Moreover, producers' share in proximal market is 64.28% and distant market is 35.5% (Table 8).

Value Addition at Different Level

For the purpose of estimating value addition in different level of mango value chain, the average price of mango at different level is shown in Table 9. The average cost of production of 1kg mango was $0.16. Packaging and transportation cost was about $0.049/kg making total cost $0.34/kg for contract farmers which is then sold at $0.45/kg to wholesalers. Wholesalers purchase in bulk and $0.029/kg is incurred during shipping and distribution. Finally, the produce reaches retailers who deals in small quantity. The operational cost was $8.47/kg which includes store rent, electricity cost etc. The selling price of mango was $0.9/kg at retailers' level.

Table 7: Profitability analysis of Mango Producers

Particulars	Cost USD/ha)
Total cost of production (CoP)	1,453.71
Total Variable cost (TVC)	945.33
Marketing cost	208.23
Gross Return (GR)	2,942.88
Gross margin (GM = GR-CoP)	1,489.17
Net profit (GR – TVC)	1,997.47
Payback Period	11.17 years
BC Ratio	2.02

Source: Field survey (2022)

Table 8. Marketing margin and Producer's share

Particulars	Cost (USD/kg)	
	Proximal market	Distant market
Retail price	0.53	0.98
Farmgate price	0.29	0.27
Market margin	0.24	0.61
Producers' share	55.28%	32.25%

Source: Field survey (2022)

Table 9. Value addition in different level at mango value chain

Particulars	Buying price (USD/kg)	Production cost (USD/kg)	Total cost (USD/kg)	Selling price (USD/kg)	Value addition (USD/kg)
Producer	-	0.16	0.16	0.29	-
Contract Farmers	0.29	0.049	0.34	0.45	0.11
Wholesalers	0.45	0.029	0.48	0.56	0.084
Retailers	0.56	0.064	0.63	0.75	0.12

Source: Field survey (2022)

Problems and Constraints

Despite huge scopes and opportunities, mango sub-sector isn't expanding as anticipated. There are problems and constraint in production and marketing part which are discussed below. In order to rank the severity of problems, respondents were given production and marketing problems each and asked to rate its severity in 4-point scale as severe, moderate, slight and no problem (Table 10).

Major Production Problem

The survey has revealed infestation of disease, insects and pest, post-harvest loss and low technical knowledge as major production problems with index of 3.8, 2.9 and 2.62 respectively.

Major Marketing Problem

During the survey period, different constraints related with the mango marketing in the study area were identified in participatory manner with farmers and traders.

Producer's level

The marketing problems faced by producers are shown in Table 11. It was found that lack of processing technology, insufficient market information and low farm gate price were major marketing problems with ranking I, II and III respectively with index value 3.73, 3.47 and 2.57. It was followed by other marketing problems like interference of middlemen (IV) and lack of post-harvest technology (V).

Trader's level

Marketing problems faced by traders are ranked in Table 12. The major marketing problem at trader's level were insufficient processing facilities (I), marketing inefficiency (II), insufficient storage facilities (III) and transportation problem (IV) with index value 3.6, 3.2, 3.1 and 1.3 respectively. Mango has high potential for processing and value addition, since storage period of mangoes is less. But lack of processing facilities has highly affected its marketing system at both producers' and traders' level leading to 25-35% post-harvest loss.

SWOT Analysis

SWOT analysis was done regarding production and marketing. The major strength lied in suitable agro-climatic condition, superior taste and easily accessible market. Similarly, alternate bearing, weak market synchronization were weaknesses in mango subsector. The scope lied in post-harvest handling, export etc. and price fluctuation, low-shelf life were threats in mango farming. Based on key informant interview upgrading strategies were presented at production, post-harvest and market level (Table 13).

Table 10. Major Production Problem

Particulars	Severe (4)	Moderate (3)	slight (2)	No problem (1)	Index	Rank
Infestation of Disease, Insect and Pest	51	6	3	0	3.8	I
Lack of Irrigation facilities	15	18	16	11	2.62	III
Insufficient labor	2	13	15	30	1.78	V
Low technical knowledge	22	15	18	5	2.9	II
Limited fertilizers and other inputs	3	24	27	6	2.4	IV

Source: Field survey (2022)

Table 11. Producer's level marketing problem

Particulars	Severe (4)	Moderate (3)	slight (2)	No problem (1)	Index	Rank
Interference of middlemen	6	26	19	7	2.57	IV
Lack of processing technology	47	10	3	0	3.73	I
Low farm gate price	6	22	32	0	2.57	III
Insufficient market information	33	22	5	0	3.47	II
Lack of post-harvest technology	6	25	23	7	2.47	V

Source: Field survey (2022)

Table 12. Trader's level marketing problem

Particulars	Severe (4)	Moderate (3)	Slight (2)	No problem (1)	Index	Rank
Lack of processing facilities	6	4	0	0	3.6	I
Insufficient storage facilities	4	3	3	0	3.1	III
Transportation Problem	0	0	3	7	1.3	IV
Marketing inefficiency	4	4	2	0	3.2	II

Source: Field survey (2022)

Table 13: SWOT analysis at Producers' level

Strength	Weakness
Production - Suitable agro-climatic condition for mango production. - Mangoes produced in Saptari are regarded superior in quality, taste and flavor. - Being a long-term crop, it can provide revenue for long period. - Higher return than cereals and other vegetables. - Production of mango in Saptari can serve industrial level of demand. **Marketing** - Easily accessible market. - High scope for value added products.	**Production** - Alternate bearing causes production and financial problem. - Traditional practices of cultivation. - Gestation period of 5-6 years restrain farmers to adopt mango production. - Lack of processing industry in the production area. **Marketing** - Weak market information system. - No synchronization among mango traders.
Opportunity	**Threats**
Production - Greater scope for increasing production and productivity. - Several public and non-governmental institutions working for the capacity building of mango producers. - Establishment of post-harvest center. **Marketing** - Easy to sell. - Export potential. - Road access to major markets.	**Production** - Low shelf-life of mango. - Infestation of diseases (Anthracnose, Powdery mildew, scab) and pest (Mango hopper, mealy bug) **Marketing** - Price fluctuation due to alternate bearing. - Interference of middlemen. - Export limitation.

Source: Field survey (2022)

Conclusion

Mango production is an important agricultural activity in Saptari and has huge potentiality for export and value addition due to its quality, taste and flavour. The study reveals that the production function was highly efficient despite limited input supply and use of traditional practices. With use of quality inputs, new technologies and proper agronomic practices the production can be increased tremendously. Value chain analysis have indicated input suppliers, producers, contract traders, wholesalers and retailers as main actors of value chain. Contract farming is eminent in the study area which has limited the market intelligence among farmers. Most farmers sell their produce to middlemen who buy the whole orchard and they manage the marketing thereafter. Economic analysis was carried out at producer's level. The total establishment cost is Rs. 193280/ha while the maintenance cost is Rs. 114,000/ha. The average revenue is about Rs. 350,000 per ha. Similarly, total cost of production is Rs. 20.75/kg. Gross return of Rs. 391275/ha and net profit of Rs. 265587/ha was acquired by producers. The Benefit cost ratio was 2.02 which shows mango farming is a profitable business. The retail price of mango in proximal market was Rs. 70/kg and Rs. 120/kg in distant market. The average farm gate price was Rs. 38.7/kg. Moreover, producers' share in proximal market is 64.28% and distant market is 35.5%. Proper harvesting, sorting, grading and packaging of Nepalese fruit is generally poor compared to the imported fruits in domestic market. However, marketing and processing of mango have not picked up commensurate with the level of production. Also, post-harvest loss is one of the major problems of mango farming and processing of mango to produce value added products could be the possible solution. Lack of processing technology in the study area has limited the growth in mango sub-sector. Hence, there is great potential for other chain actors like large scale processors and exporters to participate in the value chain.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contribution

Both authors contributed equally at all stages of research work, data analysis and the manuscript preparation. Final form of manuscript was approved by both authors.

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