

# Assessment of Production and Market Potentiality of Nepali Walnut

Rishi Ram Kattel

Agriculture and Forestry University, Rampur, Chitwan, Nepal

Email address: rrkattel@afu.edu.np

**Abstract-** Walnut production has provided benefits economically to poor Nepalese rural farmers. The majority of poor farmers live on the hillsides and mountains mainly in Karnali and Sudurpachim Provinces of Nepal. This means that the income generation from walnuts could be a great benefit to hillside farmers. Walnuts are one of the uncultivated foods of Nepal that have shown to be profitable, although not wider-spread for low-income individuals. Albeit, having huge production and market potential of Nepali walnut in national and international markets, market penetration with value added products (like walnut oil from hard shell nuts and kernel in small packet) has not been practiced yet in Nepal. So, this study gauged the potentiality of Nepali walnuts and their value-added potential products to national and international market.

**Keywords-** Market, Walnut, Value Chain, Nepal.

## I. INTRODUCTION

The walnut, also referred to as the Persian Walnut is a softwood tree plant grown and used throughout the world (Taha and Al-wadaan, 2011). It is used for medicinal purposes, for its timber, and most importantly for its fruit known by the same name (Molnar et al., 2011). There are many different species of Walnut which all fall under the genus *Juglans*. A species found in the Himalayan region, including Nepal, is *Juglans Regia* (FAO, 2004). It is also important to note that in Nepal, the local common name for the walnut tree is Okhar (Acharya, 2006). In Nepal, one of the primary uses of the Walnut (Okhar) tree is the harvesting of its fruit (Aryal, Berg and Ogle, 2009), which holds significant export potential.

In terms of the Walnut specifically it is grown in the High Mountains region of Nepal with an elevation of 1000- 4000 m (Devkota, 1999). Although this is true, Walnut trees can be found spread across the country in temperate regions of the country (Dhakal et al., 2003). It is important to note that the Walnut tree does exist in naturally grown forests in the country.

Walnut production has provided benefits economically to poor Nepalese rural farmers (Aryal, Berg and Ogle, 2009). The majority of poor farmers live on the hillsides and mountains mainly in Karnali Province and Sudurpachim Province in Nepal. This means that income from walnuts can be of great benefit to farmers on hillsides (Bhattarai and Tomar, 2009). Walnuts are one of the uncultivated foods of Nepal that have shown to be profitable, although not wider-spread for low-income individuals (Aryal, Berg and Ogle, 2009).

By geographic area Karnali is the largest province comprised of 27,984 square kilometers, whereas from size of population it is the smallest among the seven provinces. Agriculture, including crops and livestock, is the main occupation and major source of livelihood of the people in Karnali. As most parts of the province comprise of hills/mountains, only about six percent (165910 ha) of the physical land area is used for agricultural purpose. This is equivalent to 3.3 percent of agricultural land in Nepal. 15.25 percent of agricultural land of the province is irrigated, which represents about one percent of the country's irrigated land. Karnali province contributes only about 4 percent to the national production from agriculture including livestock sector. Karnali province contributes to about 5.6 percent of cereal, 2.97 percent of fruits and 2.67 percent of vegetables production in the country. Major producing fruit is apple and other important commercial fruits include walnut in the mountains, citrus in the mid-hills and banana in foothills and valleys. Five of the ten districts of the province, namely; Dolpa, Mugu, Humla, Jumla and Kalikot have been food deficit.

Globally 4.5 million tons of walnut is produced and China ranks highest with 56% of total production followed by United States, Iran and Turkey (FAOSTAT, 2019). The top exporters of walnut are US (\$762M) followed by Chile, Ukraine, Germany and China while the major importers were Germany (\$270M) followed by Japan, Spain, Netherland and South Korea (OEC, 2019). Nepal has 2184 ha area under walnut cultivation with 10051 tons production and has imported 2225 tons of shelled and non-shelled walnut (FAOSTAT, 2020). Persian walnut is one of the important nut crops traded along the silk road route between Asia and the Middle East. A large part of walnut orchards in the world located in the silk road countries, producing more than 71% of the world walnuts production (Vahdati, 2014). In hilly region of Karnali region of Nepal, thin hard shell to thick hard shell wild walnut trees are found abundantly. Cultivation of walnut is famous in districts like Jumla, Kalikot, Humla, Mugu, Jajarkot, Baitadi, Bajhang, Bajura, Darchula, Morang, Saptari, Udaypur etc in Nepal. Commercial walnut cultivation in Nepal has begun from the Marpha and Tukuche regions of Mustang district. Improved varieties of walnut are believed to be brought as English and Persian cultivar having thin hard covering dante walnut four decades before and distributed all over Nepal. The far-western region of Nepal is more popular for walnut cultivation.

Walnut production also provides benefits economically to poor rural farmers (Aryal, 2009). Nepal is still very much a rural country with an urban population of only 17 %. The majority of poor farmers live on the hillsides and mountains. This means that the income generation from Walnuts could be a great benefit to hillside farmers (Bhattarai and Tomar, 2009). Walnuts are one of the uncultivated food crops in Nepal that have proven to be profitable, although not common for poor people (Aryal, Berg, & Ogle, 2009).

Despite the widespread natural and cultivated nut forests along the Silk Road, which are intensively used and significantly affect local livelihoods, it has been noted that current socio-economic research is still relatively limited and unevenly distributed in the Silk Road countries, especially in Asia. and the region. Iran (Shigaeva and Darr, 2020).

Different studies were done regarding the value chain of walnut over the world. The walnut and kernel value chain in Kyrgyz Republic is found both large and complex, engaging many actors including collectors, traders, walnut crackers, processors, exporters, retailers, and a limited number of manufacturers for cakes and confectionery (Willie, 2012). The modernized value chain analysis of walnut done in Jammu and Kashmir of India found that in modernized channel processors were able to pay better prices to the producers. Value addition of walnut in processing units were earmarked for export markets and needs a huge investment also (Qammer and Baba, 2018).

This paper examines the walnut value chain and identify the problems and contribute to better implementation of future program for development of walnut enterprise with assessment of national and international market potentiality of Nepalese walnut.

## II. MATERIALS AND METHODS

This study was conducted in October to November, 2018 to visit Jumla production area and potential market outlet in Jumla and Kathmandu. Both quantitative and qualitative data from primary and secondary sources were used in this study. National and international data of walnuts demand and supply as well as potentiality of Nepali walnut/its products to market segments from local, regional, national to global were assessed and analyzed. A variety of primary and secondary sources of information were used for collecting recent data and information using different means (including literature review, web research, interview, focused group discussion, key informant interview, rapid market appraisal, etc.). To identify market potential of both walnut oil and kernel including whole nut in national and international markets, value chain map and analysis at production level (mainly in Jumla district), supply capacity and quality products, benefit-cost assessment, market penetration and diversification approach, price spread and share were gauged from following research instruments: (1) two focus group discussion (FGD) were conducted in Jumla district in Tatopani Rural Municipality ward number 4 (Gidi Khola) and Patarasi Rural Municipality ward number 6 (Urthu Chautara). Total 21 walnuts producers were participated; (2) Key Informant Interview (KII) with leader walnut producers, technical

experts and traders were conducted in Jumla and Kathmandu; (3) Rapid Market Appraisal (RMA) with retailers and gift shop (*Kosheli Ghar*) in Jumla as well as market outlets in Kathmandu were conducted to estimate demand and price spread of walnuts, (4) Multi-stakeholders Assessment (MSA) was conducted during two days training in Jumla district and (5) Trend analysis of area, production, import and export was done from secondary longitudinal time series data.

In all applied research instruments, the participatory learning and action (PLA) and participatory market system development (PMSD) approaches were used. Further, supply side and demand side factors were collected and analyzed using desk review, primary survey with case study, trend analysis and forecasting the future projection using longitudinal time series data. Secondary data were collected from district, MOALD, MOFE, DOC, NTPC data-based profile as well as internet search for export import data of walnut. Benefit cost analysis, value chain mapping of both type walnut and their products including oil were analyzed in this study.

## III. RESULTS AND DISCUSSION

### *Socio demographic characteristics of walnut producing households*

Total two FGD were conducted with walnut producers/wild hard shell nut collectors' household members from Patarasi (Urthu Chautara) and Tatopani (Gidi Khola) Rural Municipality of Jumla district as well as one multi-stakeholders' assessment (MSA) was conducted in Chandan Nath Municipality during training session. Total 21 walnut producers/hard shell collectors from forest were participated in two FGD in Jumla district, namely, 10 HH members from Patarasi RM-6, Urthu Chautara and 11 HH members from Tatopani RM-4, Gidi Khola. Average age of FGD participants is 46.5 years which is found higher in Tatopani (46.8 years) as compared to Patarasi (46.3 years). The average family size is 7 members and average education of participants is found 6.5 years of schooling.

TABLE 1. Socio-demographic characteristics of FGD participants in Jumla district

Variables	Patarasi RM-6, Urthu Chautara	Tatopani RM-4, Gidi Khola	Total Average
Age (in years)	46.3	46.8	46.5
Family size	7.1	7.0	7.01
Education (year of schooling)	6.5	6.4	6.47
Gender of the respondents			
Male	10 (100.0)	8 (72.7)	18 (85.7)
Female	0 (0.0)	3 (27.3)	3 (14.3)
Ethnicity of the respondents			
Chhetri	10 (100.0)	9 (81.9)	19 (90.5)
Dalit	0 (0.0)	2 (18.2)	2 (9.5)
Migration status of HH members to abroad			
Yes	2 (20.0)	0 (0.0)	2 (9.5)
No	8 (80.0)	11 (100.0)	19 (90.5)

Note: Figures in parentheses indicate percent.

Source: Field Survey in Jumla, 20-25 September, 2018

Out of total 21 participants, 85.7% are male and remaining 14.3% are female. All participants from Patarasi Rural Municipality, Urthu Chautara are male. In case of the ethnicity composition, 90.5% are Chhetri and 9.5% are found Dalit. All of the participants from Patarasi are only Chhetri. About 9.5% household members are migrated to abroad for better job opportunity (refer Table 1).

*Land Holding, walnuts production and marketing*

Total land holding per household is 24.9 ropani<sup>1</sup> which is slightly higher in Tatopani (25.45 ropani) as compared to Patarasi rural municipality (24.3 ropani). About 71.4% respondent HHs have produced soft shell walnut. In case of hard shell nut production, 57.1% are producing at own farm which is found higher in Tatopani (90.9%) as compared to Patarasi (only 20%). About 13 soft shell walnut trees are found at farm level in each household in the study area which is found higher in Patarasi (15 trees) than Tatopani (11 trees). The average number of hard shell walnut trees per household are about 10 which is found higher in Tatopani (16 trees) as compared to Patarasi (about 4 trees) at own farm.

TABLE 2. Land holding, number of walnut trees, production, HH surplus and market place in Jumla district

Variables	Patarasi RM-6, Urthu Chautara	Tatopani RM-4, Gidi Khola	Total Average
Total land holding (in Ropani)	24.30	25.45	24.90
Soft shell walnut produce at farm (Yes)	8 (80.0%)	7 (63.6%)	15 (71.4%)
Hard shell walnut produce at farm (Yes)	2 (20.0%)	10 (90.9%)	12 (57.1%)
Number of walnut tree at farm			
Soft- shell walnuts	15.5	11.3	13.3
Hard-shell walnut	3.7	16.6	10.5
Production of walnut/HH from farm			
Soft-shell nuts (Number)	2162	3932	3089
Soft-shell nuts (in Kg)	24.0	43.7	34.3
Hard-shell nuts (Number)	795	22363	12092
Hard-shell nuts (in Kg)	13.3	372.7	201.5
Surplus of walnuts after HH consumption			
Yes	8 (80.0)	6 (54.5)	14 (66.7)
No	2 (20.0)	5 (45.5)	7 (33.3)
Market place/whom to sell of soft shell walnuts			
Village level collectors	4 (66.7)	6 (100.0)	10 (83.3)
Local market place in Jumla	2 (33.3)	0 (0.0)	2 (16.7)

Note: Figures in parentheses indicate percent.

Source: Field Survey in Jumla, 20-25 September, 2018

The household level soft shell walnut production is 34.3 kg (i.e. 3089 number of nuts)<sup>2</sup> which is found higher in Tatopani (43.7 kg, i.e. 3932 number of nuts) than Patarasi (24 kg, i.e. 2162 number of nuts). The average household level hard shell walnut production at own farm is 201.5 kg (i.e. 12092 number of hard shell nuts)<sup>3</sup> which is found higher in Tatopani (372.7 kg, i.e. 22363 number of nuts) as compared to Patarasi (13.3 kg, i.e. 795 number of nuts). About 67% households have had

<sup>1</sup> 19.65 ropani= 1 hectare

<sup>2</sup> 1 kg soft shell walnuts = 90 number of soft shell nuts (Based on weightage done in field in September, 2018 in Jumla).

<sup>3</sup> 1 kg hard shell walnuts = 60 number of hard shell nuts (Based on weightage done in field in September, 2018 in Jumla).

a surplus of soft shell walnuts for market after home consumption which is found higher in Patarasi (80%) than Tatopani (54.5%).

In case of marketing, about 83% surveyed households sell to the village level soft shell nuts collectors which is hundred percent from Tatopani and 67% from Patarasi. About 17% households sell their soft shell nuts to the local market place of Jumla which is only from Patarasi area. Table 2 presents the land holding, number of walnut trees, production of different type of nuts, surplus and marketing places in Jumla district.

*Marketing of walnuts*

About 29.3 kg soft shell walnut (2633 numbers of nuts) are sold last year from each household which is found higher in Tatopani (36.5 kg) than Patarasi (21.3 kg). Average selling price is about NRs. 5/soft sell nut (NRs. 450-500/kg) from farm level. The annual household income is NRs. 83,333 on an average which is higher in Tatopani (NRs. 85,454/HH) than Patarasi (NRs. 81,000/HH). On an average NRs. 13509 is earned from soft shell nuts sale from household level which is higher in Tatopani (NRs. 17,882/HH) as compared to Patarasi (NRs. 8,700/HH). On an average, walnut shares 16.2% annual household income which is found higher in Tatopani (20.9%) than Patarasi (10.7%). It indicates that walnut sub-sector is potential business in the study areas (refer Table 3).

TABLE 3. Marketing volume, price and HH income from walnut sub-sector in Jumla district

Variables	Patarasi RM-6, Urthu Chautara	Tatopani RM-4, Gidi Khola	Total Average
Marketed volume of walnuts from HH level (Number)	1920	3281	2633
Marketed volume of walnuts from HH level (kg)	21.3	36.5	29.3
Selling price of soft-shell nut (NRs./kg)	4.7	5.1	4.9
Annual HH income from walnut sub-sector (in NRs.)	8700	17882	13509
Total Annual HH income (in NRs.)	81000	85454	83333
Share of walnut sub-sector in annual HH income (%)	10.7	20.9	16.2

Source: Field Survey in Jumla, 20-25 September, 2018

*Training, walnut oil processing, own walnut nursery, forest walnut collection*

Table 4 shows the training received, walnut oil processing, own walnut nursery and forest walnut collection in the study areas of Jumla district. About 14.3% participants have received walnut production and marketing training which is only from Tatopani area. On an average 57% surveyed households have done hard shell walnuts processing at HH level for oil making in traditional way which is found very high in Tatopani (90.9%) as compared to Patarasi (20%). The volume of walnut oil processed per household is about 6.8 liters per year which is 10.7 liters in Tatopani and 2.5 liters from Patarasi<sup>4</sup>. About 43% participant households have had their own walnut nursery at their farm. On an average 57%

<sup>4</sup> The oil processing efficiency from farm producing hard shell nuts is 5-7% which is only 3% from hard shell walnuts collected from forest areas.

households in study area have collected hard shell walnuts from forest which is found higher in Tatopani (81.8%) than Patarasi (30%). The average volume of hard shell nuts collection from forest per surveyed household is 126 kg annually.

TABLE 4. Training, walnut oil processing, own walnut nursery, forest walnut collection in Jumla district

Variables	Patarasi RM-6, Urthu Chautara	Tatopani RM-4, Gidi Khola	Total Average
Training received on walnut production and marketing (Yes)	0 (0.0)	3 (27.3)	3 (14.3)
Hard shell walnut processing at HH level for oil (Yes)	2 (20.0)	10 (90.9)	12 (57.1)
Volume of walnut oil processed per HH from traditional way (in liter)	2.5	10.7	6.8
Own walnut nursery at farm (Yes)	4 (40.0)	5 (45.5)	9 (42.9)
Collection of hard-shell walnuts from forest (Yes)	3 (30.0)	9 (81.8)	12 (57.1)
Volume of hard-shell walnut collected from forest per HH (in kg)	127	123	126

Note: Figures in parentheses indicate percent.

Source: Field Survey in Jumla, 20-25 September, 2018

Cost benefit analysis of soft shell walnut production in Jumla

It is estimated that 12 saplings of walnut (grafted) is needed in 4 ropani dry land. Normally, plantation cost (labour), pit digging, irrigation cost, farm yard manure (FYM) application, harvesting cost are major cost required for soft-shell walnut cultivation including fixed cost of land in Jumla district. There is on any chemical fertilizers and pesticides applied for walnut cultivation in Jumla while Jumla district has already declared as an “Organic District” since 2007. This study estimated 15 years cost- and revenue from cultivation of walnut in 4 ropani land in Jumla. Major variable costs are FYM application and harvesting for walnut farming (refer Table 5).

Walnut is first harvested after 4 years of plantation and at the beginning low walnuts are harvested @ 200 nuts per tree in 4 years and full potential harvesting will achieve after 14 years (3000 nuts per tree).

Table 5 presents discounted summary of financial analysis of soft-shell walnut production in Jumla district. After 15 years, total walnut harvested will be 36000 nuts or 400 kg<sup>5</sup> (@3000 nuts/tree) and total cumulative walnut harvesting within 15 years will be 228,000 nuts. The average harvested soft nuts damage/loss will be 22,800 (10% of total harvest). Total nuts sale will be 205200 nuts /22.8 quintal after 15 years. The average farm gate price per soft nut is NRs. 5. Total cost required (FC+VC) within 15 years will be NRs. 197,609 and total revenue generation from walnut sale will be NRs.102,6000. Farmer will receive NRs. 828,391 net profit within 15 years having payback period (PBP) will be 6 years. The cost for production per nut after 15 years will be NRs. 1.54 only. Net Present Value (NPV) at low (10%) and high (15%) discount rate is found positive with 3.55 Benefit Cost (B/C) ratio and 30.45% Internal Rate of Return (IRR). Thus, soft shell walnuts producing in Jumla is found financially

viable with high economic gain including environment and health benefits.

TABLE 5. Discounted financial analysis of soft-shell walnut production in Jumla

Variables	Parameters
Total cost within 15 years	197609
Production of nuts (Number from 12 trees) within 15 years	228000
Harvesting damage/loss (10%)	22800
Total nut for sale (No.)	205200
Total Revenue (NRs.) @ NRs. 5/nut	1026000
Profit (NRs.)	828391
Pay Back Period (PBP), Years	6.0
Cost for production per nut after 15 years	1.54
Discounted Benefit (at 10%)	341987
Discounted Cost (at 10%)	96378
Discounted Benefit (at 15%)	209196
Discounted Cost (at 15%)	23648
NPV at 10% (NRs.)	245609
NPV at 15% (NRs.)	185548
B/C ratio	3.55
Internal Rate of Return (IRR, %)	30.45

Source: Jumla field assessment in September, 2018.

Cost benefit analysis of oil processing of hard shell walnut in Jumla

It is estimated that 70 MT hard shell nuts will be collected from forest in Gidi Khola (40 MT) and Urthu Chautara (30 MT) in a year. In addition, 26.25 MT hard shell nuts are producing at farm from Gidi Khola (20 MT) and Urthu Chautara (6.25 MT) in a year. So, potential hard shell nuts collected from forest and farm will be 60 MT in Gidi Khola that can produce 3000 liter oil (5% oil production efficiency) whereas 36.25 MT hard shell will collected from forest and farm in Urthu Chautara that can produce about 1812.5 liter walnut oil. Before project intervention (like Helvetas Nepal International), very few hard shell nuts have been collected and few household have involved for oil processing in traditional method that increased women drudgery in walnuts collection and oil processing. Helvetas project has introduced walnuts processing scheme at community level through nut crusher and oil processing machine. This scheme has found potential for oil processing in large scale with income generation and reducing drudgery among marginalized HHs in Jumla.

Table 6 presents fixed and variable cost items for oil processing from hard shell walnuts in Jumla through nuts crusher and processing machine support to the community at 80% subsidy scheme. For oil processing, nut crusher cum oil processing machine cost will be NRs. 400,000 (including transportation cost of NRs. 50,000), storage house construction cost will be NRs. 600,000, tripal and mates cost will be NRs. 20,000, drum cost will be NRs. 10,000 and weighing machine cost will be NRs. 20,000. So, total fixed cost for oil processing from hard shell nuts is NRs. 105,0000 estimated.

Total estimated variable cost per year is NRs. 106,7600 including hard shell nuts purchasing (NRs. 720,000 @ NRs. 12/kg of hard shell nuts), staff cost for 6 months (NRs. 132,000), wage labor cost for processing (NRs. 131,600 @

<sup>5</sup> 90 soft nuts =1 kg

NRs. 700/day for 188 man days in a year), packing/labelling cost (NRs. 60,000) and electricity cost (NRs. 24,000) in Ridi Khola (Tatopani Rural Municipality-4).

Table 7 also presents discounted financial analysis of oil production from hard shell nuts in Ridi Khola, Jumla. Within 10 years, total 30,000 liters walnut oil can be processed (@ 3000 liter per year). The production cost of 1 liter oil will be NRs. 369 whereas the cost will be NRs. 443 per liter after adding 30% business profit margin. Total cost required within 10 years will be NRs. 13288838 whereas total revenue generated will be NRs. 17275489. The net profit gain from the business will be 398,6651 within 10 years of business period. The NPV at low and high discount rate will be positive. Benefit Cost (B/C) ratio will be 1.3 and IRR will be 36%. Thus, oil processing business at community level in Jumla from hard shell walnut is found highly profitable.

TABLE 7. Financial analysis, fixed and variable cost item for oil processing from hard shell walnut in Jumla

Fixed Cost		Unit	Cost/unit (NRs.)	Total (NRs.)
Nut Crasher machine and oil processing (350000+50000 machine cost +transport)		1	400000	400000
Storage Home		1		600000
tripal and mates				20000
Drum		1		10000
Weighing machine		1		20000
Total fixed cost in first year (NRs.)				1050000
<b>Annual variable Costs</b>				
Collection of hard shell Walnut from forest/farm (NRs., @NRs.12/kg)		60000	12	720000
Labour for oil processing (staff/proponent)	month	6	22000	132000
Wage labour for processing	man day	188	700	131600
Packing and label (oil processed from 60 MT hard nut= 3000 liter (@5% oil efficiency)	Per liter	20	3000	60000
Electricity (for 6 months)	month	6	4000	24000
<b>Annual total variable cost (NRs.)</b>				<b>1067600</b>
NPV at 10% (NRs.)				2398279
NPV at 15% (NRs.)				1940461
B/C ratio				1.3
IRR				36

Source: FGD in Jumla with walnuts producing and collecting HHs, September, 2018

#### Value chain analysis of walnut

Value chain map of walnuts (both soft- and hard-shell nuts) in study area of Jumla district is prepared based on function, actors and enablers/supporters. Value chain map of walnut is presented in Figure 1.

In walnut value chain, input supply (mainly sapling and irrigation materials), production of both soft- and hard-shell nuts at farm, collection of hard-shell nuts from community forest areas, collection and distribution of soft shell nuts through village level collectors and local market hub in district headquarter and supply to end market mainly at district level, Nepalgunj and Kathmandu niche traders are major function in walnut value chain in Jumla.

**Input supply:** Main actors are walnut nursery in Jumla. About 5 walnut nurseries are found in Jumla and they are selling grafted walnut sapling to the producer at price of NRs. 500-1000/sapling. However, government rate is only NRs. 250/sapling in district. Due to low productivity and poor quality of Jumli apple in present context (because of climate change, disease outbreak and poor orchard management), most of the apple producers in Jumla have been sifted to walnut farming from apple and the price of good quality walnut sapling is found higher in district. For sapling preparation for grafting, it takes around 2 to 3 years. Leader farmers, GO/INGOs (mainly Krishi Gyan Kendra, Helvetas Nepal and other organizations) are major input/service supply actors in walnut sub-sector in Jumla district.

**Production:** In Patarasi Rural Municipality ward number 6 and 7 (Urthu Chautara), about 125 households are producing soft shell nuts at farm (@ 24 kg/HH). The total production of soft shell nut per year from Urthu Chautara is 30 quintal whereas 65.5 quintal hard shell nuts are produced at farm level and 300 quintal (30 MT) can be collected from community forest in Urthu Chautara. Thus, Urthu Chautara can produce 1827.5 liters of oil from hard shell walnut processing at community level annually from 36.55 MT hard shell nuts collection from farm and forest areas.

In Tatopani Rural Municipality ward number 4 (Gidi Khola), about 400 households are producing soft shell nuts at farm (@ 44 kg/HH). The total production of soft shell nut per year from Gidi Khola is 176 quintal whereas 200 quintal hard shell nuts are produced at farm level and 400 quintal (40 MT) can be collected from community forest in Gidi Khola. Thus, Gidi Khola can produce 3000 liters of oil from hard shell walnut processing at community level annually from 60 MT hard shell nuts collection from farm and forest areas.

**Collection, distribution and trading:** From Urthu Chautara and Gidi Khola villages, 82% hard shell nuts go to village level collectors, 16% goes to local market hub in Jumla (Kosheli Ghar, Airport site grocery shops) and remaining 2% soft shell nuts goes to individual visitors. The farm gate price of soft shell nut is NRs. 5 per nut (NRs. 450/kg) ranging from NRs. 4 to 7 per nut depend on size. Whereas grocery shop and village level collectors sell soft shell nut at NRs. 7 per nut (@ NRs. 630/kg) ranging from NRs. 6 to NRs. 10 per nut (@NRs. 540 to 900/kg). From Jumla very few volume of hard shell nuts sell to Kathmandu niche market (i.e. Rationpani Private Limited, Retail outlets) and Nepalgunj. The price of walnut in Kathmandu market hub is NRs. 12-15 per nut (@ NRs. 1080 to 1350/kg).

Walnut oil processed from hard shell nut is only consumed at home and few households are exchanged with mustard/soybean oil at same rate. Till now, very few households in study area are processed walnut oil from hard shell traditionally and that has been increasing women drudgery for crashing hard shell nut and making oil. In general calculation of leisure time of household members opportunity cost of wage, it is required 20 days wage labour (NRs.700 per day \*20 = NRs. 14000) to collect and process of 100 kg hard shell nuts and from 100 kg walnuts can processed 5-liter oil in traditional way. So, cost of hard-shell nut oil is about NRs.

2800/liter. So, introducing nut crusher and processing machine and business establishment at community level, the farm gate price of walnut oil will be NRs. 450/liter (see Annex 5 in detail).

The potential traders of walnut oil from Jumla are Himalayan Bio Trade, Everest Aroma Pvt. and Aeron International Nepal in Kathmandu. They are willing to purchase Jumli walnut oil in relevant price with sufficient profit margin to the processors (refer Annex 3 in detail of potential traders in Kathmandu).

**Enablers/Supporters:** Helvetas Nepal, Agriculture Food Security Project (AFSP), Plan Nepal and Krishi Gyan Kendra are major business enabling environment supporters in walnut sub-sector production in Jumla district. Jumla Chamber of Commerce and Industry (JCCI), Karanli Province (6), Ministry of Land management Agriculture and Cooperative (MOLMAC) in Province 6, Ministry of Agriculture and Livestock Development (MOALD), Ministry of Industry, Commerce and Supply (MOICS), FNCCI/Agriculture Enterprise Center (AEC) in Kathmandu are major enablers for trade facilitating of Jumli walnut (shell) and walnut oil.

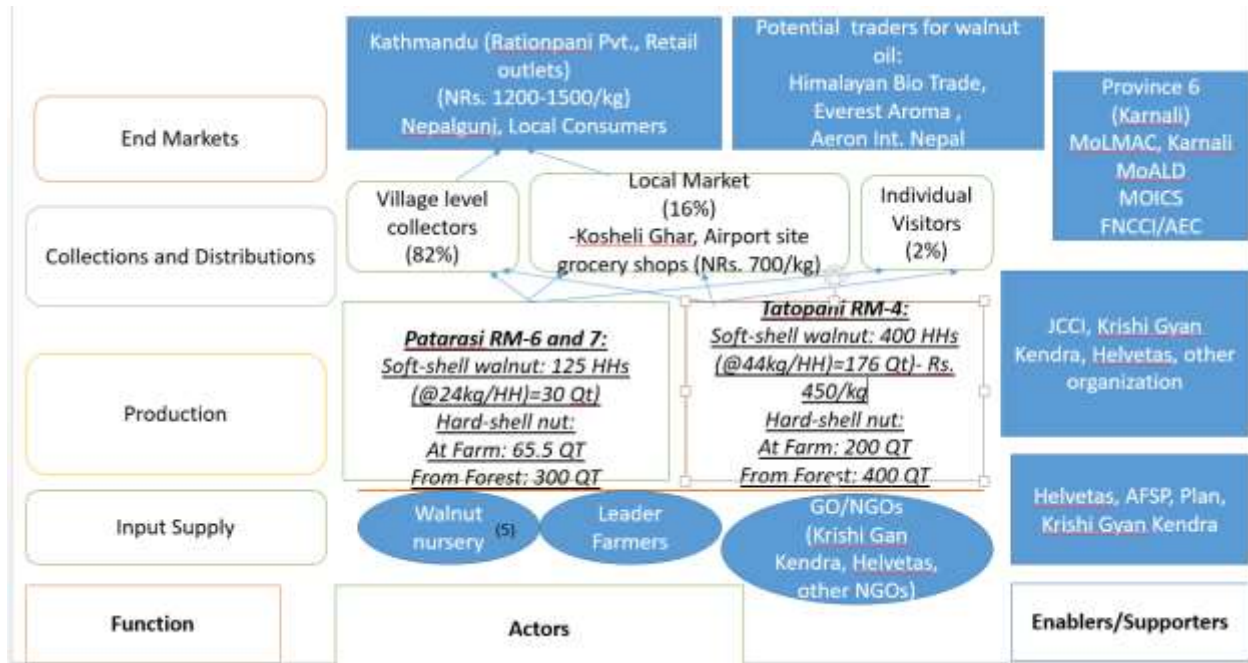


Fig. 1. Value chain map of walnut in Jumla, Nepal

#### IV. CONCLUSION

Walnut production has provided benefits economically to poor Nepalese rural farmers. The NPV of both walnut production and oil processing were found positive, B/C ratio is greater than 1 and IRR is greater than required rate of return (RRR). This means that the income generation from walnuts could be a great benefit to hillside farmers. Walnuts are one of the uncultivated foods of Nepal that have shown to be profitable, although not wider-spread for low-income individuals. There are two types of walnuts found in Jumla (1) soft shell nut- sale whole nut or shelled (kernel) and (2) hard shell nut-potential for oil processing (forest collected hard nut- 3% efficiency and farm product hard nut-5-7% oil efficiency).

Value chain map of walnuts (both soft and hard shell nuts) in study area of Jumla district is prepared based on function, actors and enablers/supporters. In walnut value chain, input supply (mainly sapling and irrigation materials), production of both soft and hard shell nuts at farm, collection of hard shell nuts from community forest areas, collection and distribution of soft shell nuts through

village level collectors and local market hub in district headquarter and supply to end market mainly at district level, Nepalgunj and Kathmandu niche traders are major function in walnut value chain in Jumla.

The study concluded that, walnut production and oil processing from hard shell nut in Nepal are found highly economically, socially, financially, environmentally and market penetration in both national and international market. So, Government of Nepal and concerned stakeholders should invest in walnut sub-sector production promotion and oil processing enterprises development with market linkages.

#### ACKNOWLEDGMENT

The Author acknowledge to the Helvetas International Nepal for financial support and walnut producers for technical supports of this study.

#### REFERENCES

- [1] B. P. Bhattarai and C. S. Tomar. "Effect of integrated nutrient management on leaf nutrient status of walnut (*Juglans regia* L.)," *Nepal Journal of Science and Technology*, vol. 10, pp. 63-67, 2009.

- [2] B. Willie. *Analysis of the Walnut Value Chain in the Kyrgyz Republic*, Working Paper. Washington D.C: PROFOR, 2012
- [3] FAO. *Inventory of walnut research, germplasm and references*. E. Germain (Eds.). Rome: FAO Technical Series 66, 2004.
- [4] FAO. *World Food and Agriculture - Statistical Yearbook 2019*. Food and Agriculture Organization of the United Nations, Rome, 2019.
- [5] FAO. *World Food and Agriculture - Statistical Yearbook 2020*, Food and Agriculture Organization of the United Nations, Rome, 2020.
- [6] J. Shigaeva, and D. Darr. "On the socio-economic importance of natural and planted walnut (*Juglans regia* L.) forests in the Silk Road countries: A systematic review," *Forest Policy and Economics*, vol. 118, p. 102233, 2020.
- [7] K. P. Acharya. "Linking trees on farms with biodiversity conservation in subsistence farming systems in Nepal," *Biodiversity and Conservation*, vol. 15, pp. 631-646, 2006.
- [8] K. P. Aryal, A. Berg and B. Ogle. "Uncultivated plants and livelihood support—a case study from the Chepang people of Nepal," *Journal of Ethnobotany Research & Applications*, vol. 7, pp. 409-422, 2009.
- [9] K. Vahdati, "Traditions and folks for walnut growing around the silk road." *Acta Horticulturae* 1032(1032), pp. 19-24, 2014.
- [10] L. N. Devkota. *Deciduous fruit production in Nepal*, In Papademetriou, M. K., Herath, E. M. (Eds.) *Deciduous Fruit Production in Asia and the Pacific*. Rome: FAO, 1999.
- [11] L. P. Dhakal, K. R. Shrestha and J-P. B. Lilleso. "Tree planting zones for the benefits to the small holders in Nepal." *World Agroforestry Centre*, (1-18), 2003.
- [12] M. K. Qammer and S. H. Baba, "Analysis of Modernized Value Chain of Walnut in Jammu & Kashmir," *Economic Affairs*, vol. 63, number 1, pp. 165-174, 2018.
- [13] N. A. Taha, and M. A. Al-wadaan. "Utility and importance of walnut, *Juglans regia* Linn: A review," *African Journal of Microbiology Research*, vol. 5, pp. 5796-5805, 2011.
- [14] OEC, <https://oec.world/en/profile/hs/shelled-walnuts>, 2019.