FINAL DRAFT REPORT (WCP GRANT 2023)

SUMMARY

Research title	Value chain dynamics and trade performance of lentil (*Lens culinaris*) in Nepal
Researcher	Binod Ghimire
Name of the institution	Agriculture and Forestry University (AFU), Faculty of Agriculture
Department	Department of Agricultural Economics and Agribusiness Management
Study sites/districts	Rautahat, Dang, Bardiya, Kailali and value chain streams across the country
Accepted Proposal ID	WCP 2313
Research proposal submitted to	Kathmandu University School of Management under the WTO Chairs Programme.
Approved Research grant	NRs. 1,85,000.0

APRIL 30, 2024

ACKNOWLEDGMENT

It is quite difficult to acknowledge the people and organizations in words who helped me to pursue shape and complete this work in the form of valuable report. As this study is a part of a PhD research, I would like to express my special gratitude and thanks to my advisor Associate Professor Dr. Shiva Chandra Dhakal (Director of Planning, AFU) my inspiring personality as a supervisor, untiring guidance, insight and advice right from the beginning to complete this research work. I would also like to thank my committee members, Associate Prof. Dr. Santosh Marahatta, Dr. Ram Chandra Bastakoti for their guidance as my committee members in spite of busy schedule and even at hardship.

My notable and special thanks to WTO Chairs Programme, Kathmandu University School of Management for partial grant support for the research work. I am very thankful to Lumbini Provincial Government, the Ministry of Agriculture and Land Management who trusted and facilitated me to achieve this success.

I am also grateful to Dean Prof. Arjun Kumar Shrestha Faculty of Agriculture, Dean Prof. Dr. Bhumi Nandan Devkota Post Graduate Center, Director DOREX Dr. Rishi Ram Kattel, Department head Agricultural Economics and Agribusiness Management Dr. Ujjwal Tiwari, Assistant Prof. Pankaj Raj Dhital, Asst. Prof. Suryamani Dhungana who guided to keep me on the right track and accomplishment of the study.

I am thankful to lentil producer farmers and related stakeholders of Kailali, Bardiya, Dang and Rautahat districts. Also, heartfelt appreciation to lentil traders of major markets for their valuable information to complete this research. I am thankful to lentil sector business enablers SQCC, Provincial seed testing laboratories, TEPC, NARC, GLRP, Custom offices, AKCs, Local levels etc. for providing various data regarding lentil research and development in Nepal. My heartfelt appreciation to all those people and enumerators those facilitated in data collection process.

Last but most importantly, I am greatly thankful to my family for their love, care, encouragement, blessing and sacrifices throughout the entire period. This work would not have completed without their immense support.

Thank you all!!

BINOD GHIMIRE

ABSTRACT

Based on primary data of 473 lentil farmers and 155 lentil traders selected randomly, the study was designed to analyze lentils farm profitability, efficiency, commodity value chain, market structure and marketing efficiency. Also, secondary data pertaining for 30 years was used to analyze lentil export performance and competitiveness. On average lentils farmers were earning about 40% profit as of gross return with benefit-cost ratio 1.78. Resources allocated in lentil production were found inefficient and to achieve maximum return, expenses on land preparation, seed, nutrient, plant protection cum irrigation should be increased by 27.6%, 80.8%, 33.1% and 97.9% respectively whereas; expenses on labor and harvest and post harvest activities should be decreased by 30.1% and 23.6%. The model estimated the mean technical efficiency percentage estimated by the model for the pooled sample is 61.5% with range between 23.0% and to the maximum of 89.9%. Most frequently and largest volume transacted marketing channel for lentil was via producer-local collector-processor-wholesaler-retailer-consumer accounting 44.56%. The highest profit share (36.02%) was obtained by processors followed by producers (30.85%). Highest proportion of value addition was done by processors (37.59%) followed by producers (32.36%), large collectors (10.92%), local collectors (10.87%), retailers (10.25%) and wholesalers (5.80%). The price spread of overall lentil value chain was 42.13% (67.11 NRs./kg) with 57.87% of farmers share with marketing efficiency 2.60. the study resulted product unavailability and capital shortage were the major barrier to entry. Whereas, price fluctuation and unavailability of quality lentil were the major marketing constraints. The result further revealed that the export growth of lentil from Nepal during 30 years is very poor and nominal (1.44) whereas; growth in import is very high with higher instability showing high economic risks and deficit situation in the country. Reveled comparative advantage, reveled symmetric comparative advantage and export performance ratio results indicates higher competitiveness of Nepal in the export of lentil and can be benefited with higher comparative advantage. Trade specialization index value suggest that even though the country's performance fluctuated over the years, it remains in the stage of import substitution declining from growth stage and have witnessed positive direction to revive and regain the lentil export performance from Nepal.

Keywords: Nepal, Lentil, Profitability, Value chain, Competitiveness

1. INTRODUCTION

1.1 Background

Nepal is among the least developed country having 17.4 percent of population multidimensional poor (0.074 multidimensional poverty index MPI), 25 percent living below the poverty line and 4.6 million people are food-insecure (NPC, 2019). Agriculture remains Nepal's principal economic activity, employing over 69% of the population and providing about 27% of GDP where, only about 25% of the total area is cultivable; 40% is forested; rest is mountainous (MoF, 2018). Rice wheat and maize are the main staple food crops and vegetable, oilseed, fruits, livestock and pulses are the major source of income.

Lentil (*Lens culinaris L.*) is an economically important pulse crop and plays an important role in human, animal and soil health improvement occupying a unique position in cereal-based cropping systems (Erskine et al., 2009) and also represent a primary component of farming system in Nepal (Ghimire et al., 2022). In Nepal lentil is a prioritized pulse and among the total pulses in Nepal, it alone covers 62% in area and 64% in production (Dhakal, 2021) with a total production of 2,49,491 MT in a total area of 1,98,605 ha. (MoAD, 2018). With 212876 ha. Area and 262835 tons of production (MoALD, 2021), Nepalese lentil accounts 4.35 percent of area and production globally being world's fifth largest producer (Ghimire et al., 2022). Among the lentil producing countries, Canada ranks first followed by India, USA, Turkey, Kazakhstan and Nepal. Nepal accounts for 4.35 per cent of global lentil area (208766 ha), 4.38 per cent of global lentil production (251185 tons) and is the fifth largest producer after Canada, India, Australia and Turkey (FAOSTAT, 2019). USAID, (2011) reported South Asia as the leading producer of lentil with 50% share in total area and 40% share in total production globally. Among the South Asian nations, Nepal is one of the major lentils producing countries. Nepal exports both whole and split lentils. It is also the largest exported item among agricultural commodities from Nepal with a share of about 3.1 percent of the total world export (USAID, 2011). Percentage share of Lentil in the total export of Nepal was 1.3% and Bangladesh, Singapore, Sri Lanka, Germany, Korea, UK, Indonesia are its major export markets (TEPC, 2018). Nepal was listed among the top 10 exporters and was 5th in 2009/10 and 6th in 2017/18 in terms of quantity and value in US dollar exported. Bangladesh is Nepal's biggest trading partner for lentil, accounting for over 80% of export from Nepal (ANSAB, 2011).

Economically representing main component of farming system (Ghimire et al., 2022), Nepalese lentils are rich in iron, zinc and other micronutrients supporting nutritional security to low-income

people (Darai et al., 2017). Lentils are locally grown in inadequate nutrient and rainfed farms following traditional farming. Based on soil type, irrigation availability and farm size, lentils generally for grain and seed purposes using local home saved seed or improved seed are grown with methods like tillage, relay, sole and mixed. In the mixed cropping method lentil is generally mixed with rapeseed, mustard, wheat and other winter grain legumes (Adhikari et al., 2018). Considering the diverse benefit of the Nepalese lentil, this sector should be the most prioritizing ones to address the food and nutrition security as well as the livelihood improvement of rural smallholder farmers (Gautam et al., 2022) if produced at optimum efficiency. The production efficiency of small holder farms has been reported to have an important implication for the development strategies in the most developing countries (Ogundari et al., 2006). Achieving a given amount of the product should use the least of resources available (Ajoma et al., 2016) and the resource efficiency is much concerned in the developing nations where production is low, small scale, traditionality and high climatic risks. Thus, the examining the farm production level, economics, resource used and their efficiency in lentil production needs detailed investigation to derive productivity and profitability.

Export orientation of various sectors is very important to drive the economy to export-led growth and reach out to the rural population for sharing the benefits of trade. Export diversification has been a goal of national development strategy of Nepal since the implementation of the Third Five Year Plan (1965-70). Besides this, various other government plans and policies such as Agricultural Perspective Plan, Agriculture Development Strategy, Industrial and Trade Policies have also recognized export diversification as a major strategy to achieve high economic growth. Nepal with its integrated into the global market through WTO and other bilateral agreements could benefit substantially from international trade in exportable agricultural commodities like lentil.

1.2 Statement of Problem

Lentil is important subsector prioritized under Agriculture Development Strategy (ADS) value chain development program and focused to promote this crop as export promotion (ADS, 2015). There is a challenge to increase production and productivity of lentil to meet increasing demand and balance trade deficit. But the Government prioritization for the development of this sector is found as relatively weak as reflected by only 10.6 percent of expenditure on agricultural total outlays and allocation of below 3 percent of total budget in consecutive fiscal years for central federal agriculture ministry (MoF, 2018).

In Nepal processing and industrialization of agriculture sector is still in infant stage and the phase is creeping. The produced commodities are unable to meet the domestic demand and exported goods are unable to compete with international markets because of low quantity, adequate value addition and distorted market chain. There is a problem of trade diversification in terms of both commodity wise and destination wise. There are large gaps between imports and exports and their growth rates, leading to escalating trade deficits (Sharma et al., 2017). Nepal's economy still remains the least competitive of all the major South Asian economies (Adams & Adhikari, 2005). Other concerns from the point of product development in Nepal includes poor performance in value addition to primary products for exports, and weak backward and forward linkages with rest of the economy in the case of manufactured products exported (Sharma et al., 2017). Also, due to the lack of market information, Nepali producers are unable to capture the opportunity provided by the overseas markets (NPC 2014). On the other hand, the agricultural sector has suffered persistently from insufficient investment in technology transfer, research and extension services, infrastructure development, value chain upgrading and marketing (IFAD, 2017). Lack of coordination between the actors of value chains and inefficient marketing channels and marketing infrastructures has led to the high price gap between the consumers and the farmers. In this regard, lentil value chain analysis from the perspective of farm efficiency to trade performance is an interesting area of study that has not been investigated.

Despite a high production potential, there are many constraints that are limiting the yield and availability of lentils in the market. In Nepal 700,000 lentil farmers are smallholders who do not use modern production and postharvest practices, resulting in low productivity, post-harvest losses that can top 20 percent, and low profitability (USAID, 2011). More importantly, small farmers have been forced to sell to local traders who enjoy significant market power, implying a low share in value for the farmers (Kumar et al., 2016). Weak technology transfer, low rate of variety and technology adoption and inefficient use of inputs and skills by farmers in lentil production systems in Nepal is increasing their cost of production leading to lower net farm income and shifting from business. Lentil farmers of Nepal are traditionally using different inputs without considering their efficient use levels (Gautam et al., 2022). Several biotic and a-biotic factors affect the production and yield of lentil (Sehgal et al., 2021). Although, development efforts in Nepal have prioritized pulse intensification, result confirm that lentil remain risky enterprise highlighting the prevalence

of crop failure (16%), modest yields (352 kg/ha), and low levels of profitability (US$ 33 ha-1) in wet winter (Paudel et al., 2020).

Till 2011, lentil alone was contributing about 2.3 percent of total national exports and shares about 3.1 percent of the total lentil export in the world (USAID, 2011) but reaching to 2018 the percentage share of lentil in the total export of Nepal was dramatically reduced to 1.3% and only 3 percent of total world market of lentil is covered by Nepal (ITC, 2017). Lentil sub-sector in Nepal is facing problems in both production side and marketing side due to lack of attention and inadequate research (GLRP, 2017). Lentil exports have been falling continuously for the last five years while imports are soaring. This shows that there is a huge research gap regarding potentialities of lentil in terms of value chain dynamics from farm production to export market. There is growing competition from Canadian and Australian exports in South Asian markets. Nepal lacks clear, well-coordinated, and institutionalized value-chains to maximize value addition in potential export sectors (NTIS 2016). In this context, this study investigated some of the unanswered questions regarding the lentil production and marketing which are provided below:

a. What is the export performance level of the Nepalese lentil? Do the trade performance of Nepalese lentil is competitive?

b. The demand of Nepalese lentil is increasing in domestic as well as global market. Do the farms are productive, profitable and efficient?

c. What is the market structure, performance and efficiency along the lentil value chain?

d. What are the key strength, weakness, opportunities and threats for lentil sub-sector?

1.3 Rationale of the study

The agricultural sector is considered as one of the major driving forces for economic growth and the heart for improving of social wellbeing (World Bank, 2018). In the recent past, Government of Nepal has made significant efforts to better integrate the economy with regional and global trading systems. Nepal joined the multilateral trading system – the World Trade Organization (WTO) – in 2004 and entered into two regional trade agreements – Agreement on South Asian Free Trade Area (SAFTA) and Bay of Bengal Initiative for Multispectral Technical and Economic Cooperation (BIMSTEC) Free Trade Agreement. While these global and regional trading systems offer Nepal an opportunity to diversify export products and markets, they are not without risks. With the recent policies put forth by the government in order to increase the economic activity, it is important for research activities of this kind to be intensified towards such a domain so as to provide feedbacks

and recommendations regarding export potentialities of exportable commodities. In Nepal lentil is recognized as one of the major agricultural produces among 12 goods with high export potential and medium socio-economic impacts by Nepal Trade Integration Strategy (MoCS, 2010). Nepal has a great potential to produce different grain legume species including lentil because of her diverse agro-ecological environments. She still holds about 0.24 million hectares of rice-fallows having a great opportunity to incorporate grain legumes in the rice-based cropping system (Gharti et al., 2014). Further, Agriculture Development Strategy (2015-2035 A.D.) mentioned Nepal having comparative advantages in export markets in resource- and labor-intensive low technology agriculture products and the prioritized value chains include: dairy, lentil, maize, tea, and vegetables. Agricultural trade of Nepal is mainly dominated by export of lentils, tea, cardamom, fruit, ginger, and medicinal and aromatic plant products (MAPs). There are enormous opportunities to boost yield of lentil through simple technology (NTIS, 2010) and supply higher volume to huge neighboring markets in Bangladesh, Pakistan, and Sri Lanka.

Lentil commodity in Nepal recognizes as a cultural, nutrition sensitive, income source, rural employment generative and industrial product. Lentil-based cropping system is profitable and also have comparatively higher productivity, as it is suitable for mostly un-exploited rice-fallows under water deficit conditions (Ghimire et al., 2022). Currently lentil crop is mostly curbed to terai districts accounting almost 90% of the total production (CRS, 2018) showing immense potentiality of expansion to the virgin hills and producing organically creating huge space in domestic and overseas market.

This study will add to knowledge building on some issues of production economics of lentil and also address certain problems plaguing the value chains and exportation in foreign markets. Attempts will be made to create knowledge linkages from past trends, growth, production sites to export aligning the dynamics of lentil value chain. Also, this work may expedite comparative and competitive advantage with export potentialities suggesting priority actions and determinants in lentil value chain dynamics. This will enable the government to know where to divert expenditure and also to come up with measures aimed at attaining a favorable economic growth from the export of lentil.

The first part of this study has focused on analysis of growth trend of production and export of Nepalese lentil along with its competitiveness and trade performance. The second part of this study covers the overall lentil value chain dynamics including profitability, production efficiency,

market performance and market efficiency. The third part of the study analyzed strength, weakness, opportunities and threats for sustainability of the lentil value chain.

1.4 Objectives of the study

1.4.1. General objective

The general objective of this study was to assess the value chain dynamics and trade performance of lentil in Nepal.

1.4.2. Specific objectives

The specific objectives of this study were as follows:

a) To measure the export growth trend, instability, competitiveness and performance of Nepalese Lentil,
b) To estimate productivity, profitability and efficiency of lentil production in the study area,
c) To evaluate performance and efficiency of lentil market along the value chain,
d) To illustrate strength, weakness, opportunities and threats of lentil value chain in Nepal.

1.5. Significance of the study

Study covers lentil value chain dynamics from production to market and trade performance. This study covered the time span of 30 years for analyzing growth and export-import performance analysis of lentil. Lentil productivity, profitability and efficiency in the study area and overall value chain mapping and analyzing performance and efficiency was the vital scope of this research. Likewise, lentil export performance and competitiveness analysis were also done to enrich the research content. To fulfill the proposed objectives of the research, apart from primary survey data study used secondary data collected online and from different agencies and government organizations. The findings of the study will provide great insight for lentil producers, traders, exporters and business enablers.

2 LITERATURE REVIEW

2.1. Conceptual framework of the study

Value chain activities derive economic environment based on market structure, governance and profit sharing which is multi-dimensional in nature. To derive economic benefits, each commodity follows specific core value chain possessing governance structure, an enabling environment and support factors. These elements include socio-cultural factors (labor condition, gender, income and education level), economic factors (productivity, profit, efficiency), institutional factors (actor

roles, rules, laws, policies, programs), infrastructure factors (road, transportation, storage, processing unit) etc. creating governance of the chain. The commodity core value chain always faces some sort of limiting factors of risks and constraints. In this study, the assessment from farm production efficiency, core value chain governance, market and export performance with SWOT analysis was done for the lentil value chain in Nepal based on the designed theoretical framework for this study as illustrated in Figure 1.

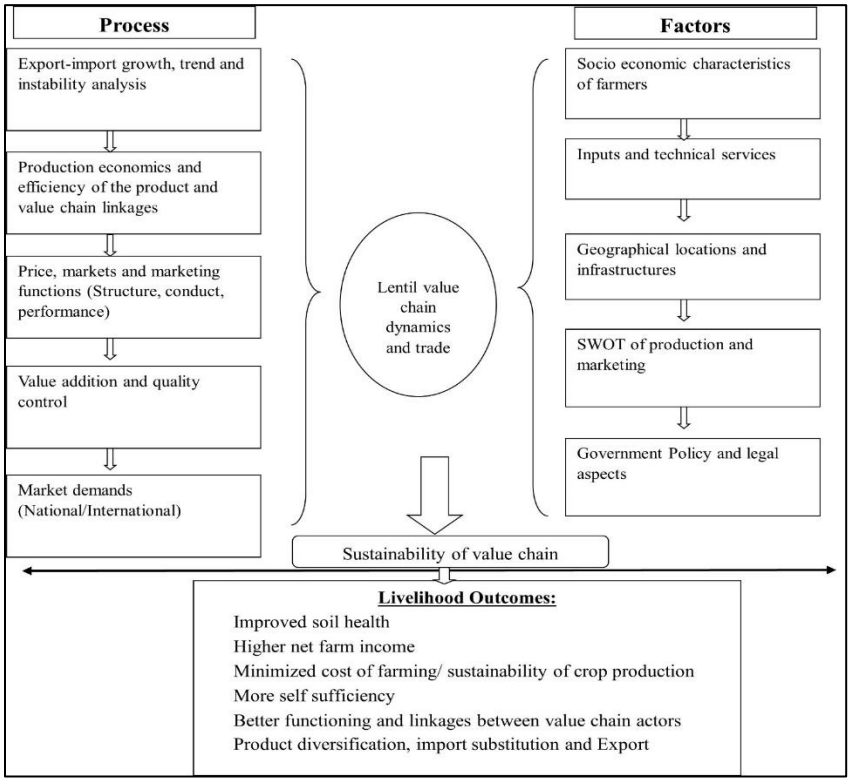

Figure 1. Conceptual framework of the study (Authors' illustration)

2.2. Farming and agriculture system of Nepal

Nepal is adorned with three major agro ecological conditions namely tropical Terai in the south, subtropical in mid hills and temperate to alpine in high mountains in north within narrow patch of the geography. The Terai region with mostly fertile flat land, hot climatic condition comprises 23% of area and considered as national food granary (MoALD, 2021). Terai and inner Terai together are home to 48.4 percent of the population and cover 56 percent of the total cultivated land. The mostly grown crops in the region are paddy, wheat, maize, sugarcane, pulses predominately lentil and oilseed.

Half of the small-scale farming is dependent on natural rainfall and critically affected by rainfall variability. Rainfall and other climatic factors are critical to crop yields, as shown by annual

variations in production and growth rates due to these interactions. The draught is the silent disaster leading to major reductions in production. Empirical studies in recent years indicate that 70% of the performance of crop production can be explained by the climatic variability linked with the temporal weather conditions (Sherchand et al., 2007).

Agriculture in Nepal represents an extremely powerful economic force, still the largest sector of economy, produces only one-third of total value added, although remains the largest employer, accounting for 67 percent of total employment (MoALD, 2022). The large agricultural sector is performing poorly, absorbing 66 percent of labor force but accounting for only 1.3 percent points of growth and contributing 13 percent of total foreign trade. Therefore, growth in this sector's productivity is critical to enhancing aggregate productivity (World Bank, 2018). The share of agriculture sector to employment, income, food security and poverty reduction, especially in rural areas, is quite considerable. Agriculture is also an important sector for poverty reduction and shared prosperity as agriculture is still the single most important productive sector in terms of its share in GDP and also in terms of the number of people it employs. Most of the poverty reduction between 2003-04 and 2010-11 occurred in rural areas and was driven by rising agriculture incomes (ADB, 2017). The average land holding of 0.6 ha per household limits the possibility of agricultural mechanization and thus commercial farming (MoALD, 2021).

2.3. Lentil in global scenario

Globally, there was a period of stagnation in pulses production between 1997 and 2003 when the production has not exceeded 60 million tons and varied from 55.8 (1997) to 59.2 (2003) million tons and at that period average annual growth rate was 0.1 percent. In 2017, production reached 96 million tons, so since 2003 it increased by 62 percent with average annual growth rate of 3 percent. The largest annual increase was recorded in 2017, as the harvests were 15 percent higher than in 2016. When analyzing by regions, each year Asia represents the highest level of production with over 43 percent share in global production in 2017, followed by Africa with 20 percent contribution and American regions with a very similar share. Europe's contribution in the global pulses production equals 12 percent, and the share of 4 percent ranked Oceania on fifth place. The observed global increase in production was reached mainly due to the growth in Asia (Joshi & Rao, 2016). In global scenario area under legume crop is increasing but total production seems to be decreasing. During the year 2017 area under pulse crops and total production was found as 93.75 million hectare and 93.59 million tons respectively while in 2018 area under pulse crops and

total production was found as 95.72 million hectare and 92.27 million tons respectively (FAOSTAT, 2019). India was the biggest pulses producer, in 2017 followed by Canada, Myanmar, China and Nigeria. Total pulses production in India reached over 23 million tons in 2017, which constituted almost one fourth of the global production of this food (Agata et al., 2019). The biggest driver of production in developed countries was, however, area, which grew by 6.4 percent per annum compared to only 0.5 percent in developing countries (Agata et al., 2019). Total lentil cultivated area during the year 2017 was found as 5.8 million hectares while in 2018 it was 6.10 million hectare showing increasing trend while total production of lentil in 2017 was found as 6.39 million tons and in 2018 it was 6.33 million tones showing decreasing trend (FAOSTAT, 2018).

2.4. Lentil in Nepalese scenario

Lentil is the most important pulse and important cash crop in Nepal. It is one of the significant pulses in terms of area, production and trade. It can be grown in all provinces of Nepal and Terai is the most favorable agro-ecological zone for the lentil production. During the period of 1980 to 2013, globally, Nepal ranked first in terms of share of lentil area compared with total legume area of the country which constituted 37.2 percent during 1980-82, 44.1 percent during 1990-92 and 70 percent during 2011-13. During the period of 2011-13, Nepal ranked fourth in terms of area harvested having total area harvested of 2,07,000 hectare (4.8 percent of global lentil harvested area) and ranked sixth in terms of total production having production of 2,14,000 tonnes (4.6 percent of global production) and at the same period India was the top country in terms of total area harvest and Canada was the top country in terms of total production (Joshi & Rao, 2016). At that period Lentils contributed 66 percent of the total protein intake from pulses in Nepal. During the period of 1990-92, Nepal had shared 4.6 percent of global export but export had decreased during the period of 2009-11 sharing only 2.03 percent of global export. The contribution of lentil to the agricultural value of production also has risen marginally from 2.4 percent in 1981 to 2.9 percent in 2013. Further, lentil emerged as the most valuable export commodity of Nepal with its 11.4 percent share in agricultural exports in 2013. Between 1981 and 2013, there was a significant increase in the area, yield, and production of lentil in Nepal. A more than two fold increase in the area as well as the yield of lentil has resulted in a rise in production by more than four times, from 48.7 tons to 214.0 tons (ANSAB, 2011).

Area, production and productivity of lentil have been increased by 111 percent, 257 percent and 69 percent, respectively in between 1985/86 and 2012/13. During the period of 2012/13, Lentil

was the major grain legume and accounted for 62 percent of area and 65 percent production of total grain legumes in Nepal and has emerged as an important agricultural export commodity. During that time lentil was recognized as one of the major agricultural product among 12 goods with high export potential and medium socioeconomic impacts by Nepal Trade Integration Strategy (Gharti et al., 2014). From the year 2015/16 to 2017/18, area under lentil cultivation decreased resulting decrease in total production while productivity increased. During the period of 2014/15, lentil has shared almost 62 percent of total legume area, 64 percent of total legume production but in 2017-18, it has shared almost 64 percent of total legume area and 68 percent of total legume production. Among the newly formed seven provincial region, Koshi Province shares 6.37 percent of total lentil area, 6.29 percent of total lentil production and yield remains almost at par with national yield, Madhesh Province shares 36.68 percent of total lentil area, 35.48 percent of total lentil production and yield is slightly lower than national yield, Province 3 shares 3.17 percent of total lentil area, 2.97 percent of total lentil production and yield is slightly lower than national yield, Gandaki province shares 2.58 percent of total lentil area, 2.39 percent of total lentil production and yield is slightly lower than national yield, Lumbini Province shares 35.83 percent of total lentil area, 37.15 percent of total lentil production and yield is slightly higher than national yield, Karnali province shares 1.8 percent of total lentil area, 1.34 percent of total lentil production and yield is almost 25 percent lower than national yield and Sudurpaschim Province shares 13.56 percent of total lentil area, 14.34 percent of total lentil production and yield is slightly higher than national yield (MoAD, 2018).

2.5. Economics of lentil cultivation

Pulses like chickpea, lentil, black gram and pigeon pea are less labor-intensive crops; and cheap comparatively to other competitive winter crops like wheat, etc. (Pande et al., 2003). Due to the difference in agronomic practices, input used and climatic condition, cost of lentil cultivation and income varies from one region to another. Lentil cultivation requires comparatively low number of inputs in comparison with other crops and due to low use of inputs, production seems to be low. Lentil and pigeon pea were profitable legumes, while chickpea and black gram were showing negative monetary returns. The net profit was only Rs. 3,787 per hectare in lentil and Rs. 3,719 per hectare in pigeon pea, while black gram and chickpeas net profit is Rs. 3,061 per hectare and Rs. 3,034 per hectare, which is negative in monetary terms. The estimated benefit cost ration

(BCR) of legumes were 0.74 in chickpea, 1.27 in lentil, 0.68 in black gram and 1.30 in pigeon pea (Kumar & Bourai, 2012).

In Nepalese scenario, lentil is mainly relay cropped with paddy and minorities of the farmers plough their land for lentil cultivation. Lentil is also mixed cropped with other oilseed crops and other legumes. Another study was also conducted in western Terai region of Nepal to find economics of lentil production in different farming practices and study found that while doing the benefit cost analysis of lentil crop in different farming practices in the study area, benefit cost ratio was found higher (1.26) in lentil grown as a relay crop followed by lentil grown as a sole crop (1.16) and as a mixed crop (1.15) respectively. Although lentil grown as relay crop had lower productivity than lentil grown as sole and mixed crop, the cost associated with relay cropped lentil was much lower than sole and mixed cropped lentil and the profit per hectare of land was also as high as that of sole cropped lentil. This indicates that relay lentil could be a useful lentil farming practice in order to generate higher return with low cost particularly to the resource poor farmers (Thapa Magar et al., 2014).

2.6. Export scenario of lentil from Nepal

Total worldwide lentil consumption has increased steadily during the last 10 years (AAC, 2010). It is also an important diet in many poor countries such as Bangladesh, Eritrea, Nepal, and Sri Lanka. Lentil consumption is the highest in Canada with 6 kg per person per year followed by Sri Lanka (4.5 kg) and Nepal (4.1 kg). In Nepal, lentil is the predominant pulse and its consumption is relatively high (USAID, 2011). About 68 percent of the lentils produced in the world are consumed locally where they are produced while remaining 32 percent are exported (Erskine et al., 2009). According to USAID (2011) processor and exporters sell split lentils to the national market while polished whole lentils are exported mainly to Bangladesh. Member countries of the Organization for Economic Cooperation and Development import a small volume of Nepalese lentils. Bangladesh is the largest buyer of Nepali lentils.

Nepal has previously imported large amount of lentil from neighboring country India but due to the policy constraints of India, Canada ranked apex among import destination of lentil. Large amount of lentil nowadays imported from Canada followed by India, USA, Australia, Myanmar, Turkey, Argentina etc. Import quantity remained higher than export quantity during previous years. Among the exportable countries, Bangladesh was the major export destination of Nepalese lentil with almost 80 percent of total lentil exported from Nepal (FAOSTAT, 2021).

Despite a high export potential, there are many constraints that are limiting the production and export of lentils. Constraining export growth are proper linkages with international buyers, compatible policies, information gaps, and quality standards and certification (USAID, 2011). USAID (2011) further reported that Nepalese exporters are not able to export large quantities of lentil to a number of Organizations for Economic Cooperation and Development (OECD) countries such as the USA, UK, Italy, Germany, Spain and France due to restrictive sanitary and phyto-sanitary measures (SPS). Nepalese exporters find it difficult to compete in global markets due to weak standardization and conformity assessment infrastructure. Nepal lacks an accreditation system and sufficient testing facilities (ITC, 2012).

2.7. Concept of value chain and value chain analysis

The concept of value chain was developed during eighties to gain competitiveness by firms as focus shifted from product to value. Michel Porter was pioneer for this concept and popularized widely with his seminal work on "Competitive Advantage" to describe a firm's internal value-adding activities. He argued that secondary activities of the firm (i.e. firm infrastructure, human resource management, technology and procurement) exist to support its primary activities, which are directly related the production, marketing and delivery of goods or services (Porter, 1985). Value chain in agriculture as identified set of actors and activities that bring a basic agricultural product from production in the field to final consumption, where at each stage value added to the product. The activities that comprise a value chain can be contained within a single firm, divided among different firms, as well as a single geographical location, or spread over wider areas (Herr, 2007).

According to Jurevicius (2013), value chain analysis (VCA) is a process in which a firm organizes its primary and support activities that add value to its final product and then analyze these activities if they can reduce costs or can increase differentiation. Value chain analysis has one advantage because it forces the analyst to consider both the micro and macro aspects of production and exchange activities. The commodity-based analysis can provide better insights into the organizational structures and strategies of different actors, which is the analysis that was used in our study. Kaplinsky and Morris (2002) stressed that there is no "correct" way to conduct a value-chain analysis; rather, the approach taken fundamentally depends on the question that is being asked. However, four aspects of value-chain analysis of agriculture are particularly important. At the most basic level which is the first step, a value chain analysis systematically

maps the actors participating in the production, distribution, marketing, and sales of a particular product (or products). Secondly, a value chain analysis requires additionally the mapping of the major constraints within the opportunities and the institutional environment of each actor to identify the options to upgrade the value chain network. Third, value chain analysis can be used to examine the role of upgrading within the chain. Finally, value chain analysis highlights the role of governance internally or externally in the value-chain. Governance in a value-chain refers to the structure of relationships and coordination mechanisms between actors.

2.8. Relationship, linkage and networks in value chain

The relationships that exist among value streams in the value chain consist of non-equity strategic alliances in which partners are stakeholders not shareholders (Barney & Hesterly, 2011). In such relationship there is weak vertical control, obligations extend beyond contractual requirements and relationships add value beyond that which the firms could achieve acting individually (Sporleder, 2006). As a result, firms acting in a value-chain increase their interdependency and collaboration. Relationships in the value chain evolved through trust, reputation and power in the value chain and shape economic considerations (Uzzi, 1997). Value chains are outcomes of good relationship, linkages and networks among business streams. Marketing for poor tool book described evolution of value chains through persistent network relations embedded with high level of trust and interdependence. Network relations are important in value chain as mentioned by, as networks enhance the knowledge, information and innovation transfer and financial support between partners (Humphrey & Schmitz, 2002). In the value chain analysis linkages are analyzed carefully to draw upgrading strategy. Mapping of knowledge networks as part of a value-chain value-network analysis is to identify role of actors, transaction and flows among them (Allee, 2008). The flow of products, money and information in value-chains is highly dependent upon the relationships among members (Collins et al., 2016). Based upon this theoretical background, this study also focused linkages and relationship between the value chain actors.

3. MATERIALS AND METHODS

3.1. Study design, data types, sources and methods of collection

The study started with a description of the development of foreign trade in the historical perspective based on secondary sources. Description of such a historical scenario helps to understand the past performances and make a comparison with the present for future policy prescriptions. To derive the objectives, both primary and secondary types of data were used in this

study. Primary data was collected by using semi-structured interview schedule from lentil producing farmers and lentil value chain traders. Further, primary data was also collected and validated through direct observation, focus group discussion, key informant survey and rapid market appraisal (RMA).

The collection of secondary data was also the important part of this research study. Secondary data was assessed with the help of desk review and internet sources. 30-years data (1990-2019 A.D.) for analyzing export performance were mainly assessed from FAOSTAT and TRADEMAP.

The details of the data type, respondents, sample size, instruments and methods for data collection used for this study purpose is presented in table 1.

3.1.1. Producers survey: study area, sample size and data collection procedure

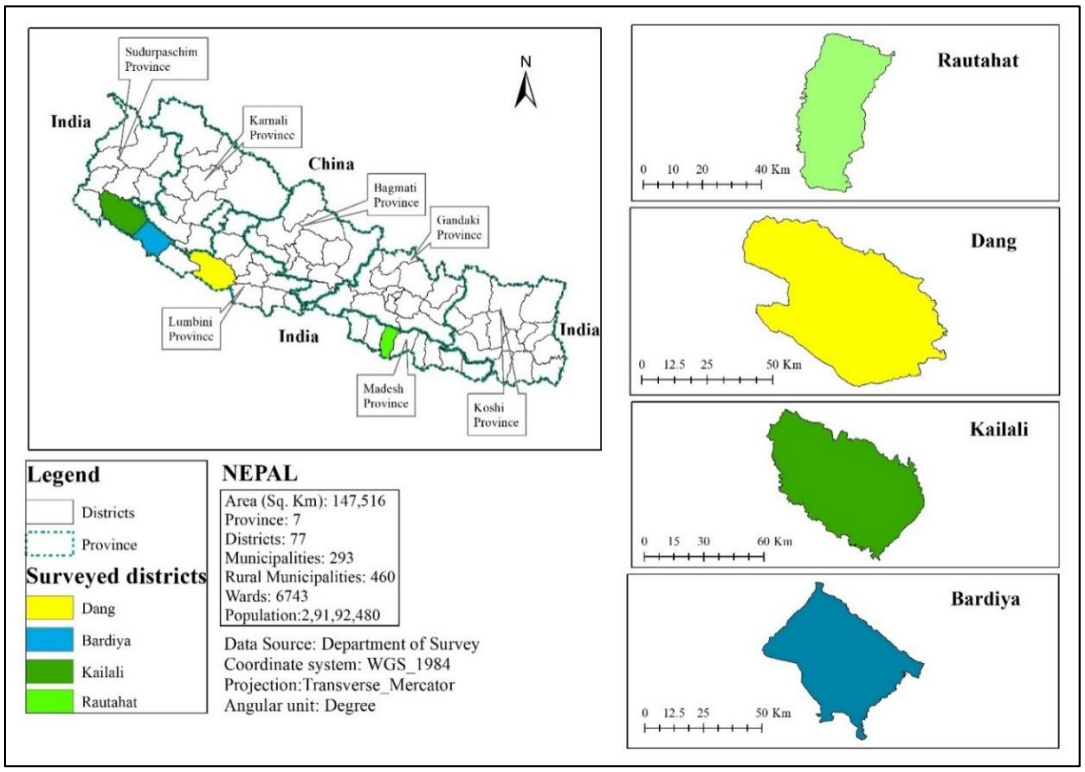

Figure 2. Map of Nepal showing study areas for producer level study

Considering the Terai region of Nepal where potential production pockets of lentil are available and commercial trade arrangement occurs, Dang, Rautahat, Kailali, and Bardiya districts were purposively selected for the study (Figure 2). These districts represent Madhesh Province, Lumbini Province, and Sudurpaschim Province and are the top four districts sharing 43.9% of total production and 42.5% of total lentil cultivated area of Nepal (MoAD, 2018).

A multistage sampling technique was followed for this study. In the first stage, a purposive sampling

procedure was adopted to select districts based on production potentiality. The second stage involved the selection of potential pockets within the districts based upon the concentration of lentil producers in the area with the help of a piloting survey. Thereafter, a simple random sampling procedure was adopted to select the desired sample size and was calculated by using the method suggested by Cochran (1977) to calculate a representative sample for proportions as:

$$n_0 = Z^2 pq / e^2 \quad \text{.....(1)}$$

Where, n_0 = the required sample size

Z = Selected critical value of desired confidence level 95%= 1.960

p = estimated proportion of an attribute that is present in the population=0.5, q=p−1=0.5

e = the desired level of precision; acceptable sampling error (e = 0.05)

$$n = (1.96)^2 * (0.5) * (0.5) / (0.05)^2 \quad \text{.....(2)}$$

$$n = 384.16$$

Thus, based on the Cochran formula the minimum number of sample size required was 384. For more accuracy, less error, reliability and representation, the total sample size for the study was maintained 473 (Table 1). Based on the coordination schema, the primary data for this study were collected through the use of a well-designed and pretested semi-structured questionnaire. The questionnaire was pre-tested on 12 lentil farmers in the Bardiya district and adjusted before the main survey. The data collected were cross-sectional data using face-to-face interview methods with randomly selected farmers in 2022 following the lentil harvest. Also, one focus group discussion and 20 key informant survey in each district was done to complement the data collected through the questionnaire.

3.1.2. Trader's survey: study area, sample size and data collection procedure

For the analysis of the lentil value chain in Nepal, primary data were taken from all value chain streams to better understand the situation and functionaries. Following the lentil harvest, traders level survey was done from 12 major markets of Nepal in 2023. Following both simple random sampling and purposive sampling technique, face-to-face interview method was applied for collecting primary data from 155 lentil traders including local collectors, large collectors, processors, wholesalers and retailers in the lentil value chain. Selection of traders were supported by the information from farmers to a chain basis as per the flow of product in linkage. The data were further collected, validated and added with the help of focus group discussions (FGD) done at Rautahat and Banke district using checklist. Moreover, 12 key informants from directly related stakeholders were interviewed including government officials, public representatives, members from chambers of commerce and industry etc.

Table 1. Sample size, respondent types and data collection methods

Survey level	Respondents' type	Instrument	Survey method	Sample size
Producers level survey	Lentil farmers	Semi-structured questionnaire	Face to face interview	473
Traders level survey	Traders in all VC stages	Semi-structured questionnaire a checklist	Face to face interview	155

3.2. Methods and technique of data analysis

Primary data collected from the farmer level field survey 2022 and traders level survey 2023 and also secondary data were used for both descriptive and inferential analysis in this study. To fulfil the specific objectives collected data were made an entry in a Microsoft Excel sheet and processed. Descriptive statistical tools were applied such as frequency, mean, ratio, standard deviation, percentage, minimum, maximum, etc. to summarize the socio-economic characteristics of respondents from different lentil value chain stream. Most of the other inferential analyses were done with the help of STATA software version 14.

3.2.1. Descriptive and analytical analysis

3.2.1.1. Farm and socio- economic characteristics analysis

It deals with descriptive analysis of the study area, farmers and traders about lentil production and marketing system. For this analysis, descriptive statistical tools such as frequencies, percentages, means, standard deviations and standard errors were used. Different socio-economic variables such as family size, gender, occupation, land characteristics, and technical parameters was analysed.

3.2.1.2. Value chain mapping and illustrations

To understand the traits of value chain players and interrelationships among them, a value chain map of a lentil sub-sector was prepared with all attempts to make the maps easily comprehendible. Analytical tools used were value chain map, marketing channels and their transaction share, and sustainability performance assessment were done using analytical tools. In order to have a visual representation of the whole chain, common chain was mapped with product, money and information flow along the actors and different channels transaction share.

3.2.1.3. Scaling technique

Following Likert (1932), a five-point Likert scale method was applied to evaluate the farmers' problems perceptions on lentil production and traders' perception on challenges related to market

system of lentil in Nepal. For ranking perceptions were analyzed on a five-point Likert scale basis based on the response frequencies. Also, for identifying major motivating factors for production and problems in lentil production, indexing method was used based on the response frequencies. Following Ghimire et al. (2016), variables were ranked by five-point scale method using weighted average mean to calculate the index value for each factor in order to rank by using following formula;

$$I_{inf} = \sum \frac{s_i f_i}{N}$$

Where, scale values were taken as 1, (1-1/n), (1-2/n), …. (1-5/n) and so on.

Where; I = Index of importance/ severity, Σ = Summation, Si = Scale value at i^{th} importance/severity, fi = Frequency of importance/severity given by the respondents, N = Total number of respondents (Σfi).

3.2.1.4. SWOT Analysis

In-depth discussion with key actors of the value chain was made on SWOT analysis; on strengths, weaknesses, opportunities, and threats of the respective value chains. The strength, weakness, opportunities, and threats (SWOT) related to the cardamom sub-sector were analyzed from the group discussion, interview, and key informants. Information was obtained from each stage of the value chain. The information thus obtained from different actors in the value chain was used in SWOT analysis.

3.2.2. Mathematical models and empirical analysis

3.2.2.1. Compound annual growth rate (CAGR) analysis

For analytical purpose, the entire 30 years period (1990-2019 A.D.) was divided subjectively in to two sub-periods i.e., pre-WTO and post-WTO phase, with the implicit assumption that each sub-period would have distinct nature and pattern of development due to WTO. To analyze the CAGR, following Potnuru et al., (2018) the exponential form of regression analysis was employed to analyze export and import situation.

$$Yt = ab^t e^u$$

Where;

Y_t= dependent variable (export/import)

a= intercept term, b= (1+r) and "r" is the compound growth rate

t= time period, e^u= error term

The above model in the Logarithmic form was expressed as;

ln Y= ln a +t ln b+ ln u

ln a and ln b values were obtained using the ordinary least squares procedures. The compound growth rate "r" was computed by using relationship; r= (Antilog of (ln b)-1) *100.

3.2.2.2. Cuddy Della Valle Instability Index (CDVII)

Instability is simply the deviation from the trend and is one of the important decision parameters in development dynamics, more so in the context of agricultural production. The fluctuation magnitude depends on the nature of production technology, its sensitivity to weather, economics environment, availability of material inputs and many other factors (Krishan and Chanchal, 2014). Instability results provide great insight in the adjustment or improvement in the production scenario of the crops. Instability in export and import of lentil during the study period was measured using coefficient of variation (Dhakre, 2015).

CV=(SD/MEAN)*100 where, CV is co-efficient of variation, SD is the standard deviation of the variables used.

In time series data characterized by long trends, the simple coefficient of variation overestimates the level of instability, whereas Cuddy-Della Valle index corrects the coefficient of variation. To examine the extent of variability in the export and import, the Cuddy-Della Valle Index was used (Cuddy & Della Valle, 1978).

CDVI index (%) =CV* $\sqrt{(1-AdR^2)}$ Where;

CV = Coefficient of variation (in percent)

R squared = Coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom. The range of Cuddy-Della Valle Instability Index is as (Sihmar, 2014); CDVI= 0 to 15= Low Instability; 30<CDVI>15= Medium Instability; CDVI>30= High Instability

3.2.2.3. Revealed Comparative Advantage (RCA)

Revealed comparative advantage is one of the measures of international competitiveness and has gained general acceptance (Utkulu & Seymen, 2003). The RCA, first introduced by Balassa (1965) is mathematically estimated as:

$$RCA_{ij} = \frac{(X_{ij} / X_i)}{(X_{wj} / X_w)}$$

Where;

RCA_{ij} is the revealed comparative advantage of the i^{th} country for the j^{th} commodity (lentil),

X_{ij} is the ^{i}th country's global exports of the commodity j,

X_i is the ^{i}th country's total exports to the world, Xwj is the world exports of the commodity j, and

Xw is the total world exports

A product for which the value of RCA index exceeds one is said to possess global comparative advantage.

RCA<1: the product has no capacity of competitiveness

1<RCA<2.5: the product has a low capacity of competitiveness

RCA>2.5: the product has a high capacity of competitiveness

3.2.2.4. Revealed Symmetric Comparative Advantage (RSCA)

The Revealed Symmetric Comparative Advantage measure reflects the RCA in its symmetric form as an index of competitiveness. As applied by Kondal (2018), RSCA for Nepalese lentil was calculated as;

RSCA = (RCA-1)/(RCA+1)

Where; the RSCA ranges from [-1 to +1]. The closer the value is to +1, the higher the competitiveness of a country in the commodity of interest.

3.2.2.5. Export Performance Ratio (EPR)

Export performance ratio is a measure of international trade specialization. It identifies the comparative advantage or disadvantages a country has for a commodity with respect to another country or group of countries or the world. As suggested by Balassa (1965), export performance ratio (EPR) was used to measure the comparative advantage of the lentil exports from Nepal from 2015 to 2019 A.D.

The EPR of the i^{th} commodity can be expressed as;

$$EPR_i = (E_i/CE)/(W_i/We)$$

Where;

E_i=Export of lentil commodity from Nepal

CE=Aggregate export of agricultural products from Nepal

W_i= Total world export of lentil product

WE=Total world export of agricultural products

A value of EPR greater than unity implies that Nepal has a comparative advantage in the exports of lentil products and vice versa.

3.2.2.6. Trade Specialization index

The trade specialization index evaluates the comparative advantage of product exports and its competitiveness (Sujova et al., 2015). Following Verter (2016) the export trade specialization

index (TSI) for lentil commodity from Nepal was analyzed using following mathematical equation;

$$TSI_{ji} = \frac{x_j^i - M_j^i}{x_j^i + M_j^i},$$

where: TSI_{ji} is the index of trade specialization of economy j for goods i in a given period; i denotes the product or product group; j stands for the economy (nation or nation group); X_{ij} represents economy's j exports of goods i; and M_{ij} denotes economy's j imports of goods i. For a country and a specific product, the TSI would be -1 if there is import only and no export means perfect import specialization and value +1 if there is export only and no imports means perfect export specialization (Quansah and Ahn, 2017).

Table 2. Decision rules based on trade specialization index value

TSI value	Decision criteria
TSI equals to -1	Introduction stage
Greater than -1 and less than 0	Import substitution stage
Greater than 0 and less than or equal to 1	Export growth stage

3.2.2.7. Export market concentration and degree of diversification

The Herfindahl Hirschman Index (HI) was used in this study to measure the degree of diversification based on the shares of various importing countries in Nepal's lentil export at a point of time. The index was computed by taking the sum of the squares of the proportion of each importing country (Hirsch & Lev, 1971). Algebraically,

$$HI = \sum_{i=1}^{n} P_i^2 \quad i = 1,2,\dots,n.$$

Where;

Pi = proportion of i^{th} country in Nepal's total export (lentil), and

n = number of all importing countries.

Increases in the Herfindahl index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite.

As followed by United State Department of Justice and Federal Trade Commission (2010) the value of HHI can be interpreted as;

HHI<1500= competitive market, 1500<HHI>2500= moderately concentrated market, HHI>2500= highly concentrated, HHI= or Around 10,000= monopoly market

3.2.2.8. Gross Margin and cost benefit analysis

Analysis of gross margin is generally used to evaluate the capability of farms to allow justifiable decisions and is one of the methos of estimating cost-effectiveness of small enterprises (Olukosi et al., 2006). In this study total cost accounts for the sum of all the variable costs including costs on labor, land preparation, organic manure, chemical fertilizers, disease pest management (plant protection), irrigation, harvesting and post-harvest activities.

Gross Margin= Gross revenue- Variable cost (Total cost). Here, Total variable cost is the sum of all variable inputs, and gross return represents market value as per produced lentil.

The profitability index measures how efficiently the lentil farm utilized its total costs which covered the investment to produce revenue. As followed by Sharma et al., (2017), the profitability index was estimated as;

PI = Gross Margin/Total Variable Cost

Likewise, Benefit cost ratio is the quick and easiest method to determine the economic performance of farm business. Benefit cost analysis was calculated using the total variable cost and gross return from the cultivated lentil. For calculating gross return, income from the sale will be accounted by using formula;

$$\text{B: C ratio} = \frac{\text{Gross return (NRs.)}}{\text{Total variable cost (NRs.)}}$$

3.2.2.9. Marketing margin, producer's share, return on investment (ROI) and value addition

Marketing margin (MM) is the difference between the farm gate price and the retailer's price which was calculated as:

MM = Retailer price (PR) – Farm gate price (PF)

Producer's share is the price received by the producer's (farmers) expressed as a percentage of the retailer price, that is, price paid by the consumers. It will be calculated by using following formula:

$$\text{Producers}' \text{ share } (P_S) = \frac{\text{Retailer price}(P_R)}{\text{Farm gate price}(P_F)} * 100$$

Return on investment on per kg of lentil will be calculated to understand the strength of the value chain to attract investment in different value streams.

$$\text{ROI } (\%) = \frac{\text{Total revenue} - \text{Total cost}}{\text{Total cost}} * 100$$

Where, ROI = Return on investment (%)

Total revenue and cost were calculated as per kg of lentil during the given period of time.

Similarly, Value addition % used by Miah, (2013) on his study is given by;

$$\text{Value addition (\%)} = \frac{\text{Marketing margin}}{\text{Purchased price}}$$

3.2.2.10. Price spread and market efficiency

Price-spread is the difference between the actual price received by the producers, the price paid by the consumers, costs incurred and margins earned by the various market intermediaries in the process of marketing of lentil. The net price received by the producers, total marketing costs and margins was analyzed separately for lentil producer in order to evaluate the marketing efficiency.

$$\text{Price spread (\%)} = \frac{\text{PF}}{\text{PC}} * 100$$

Where, PF= Price received by the farmers

PC= Price paid by the consumer

Further, marketing efficiency was estimated by using Shepherd's equation (Shepherd, 1965) and is an important measure of market efficiency. It is interpreted as higher the index of marketing efficiency greater is the efficiency of value chain.

$$\text{ME} = \frac{\text{V}}{\text{I}} - 1$$

Where; ME = Marketing efficiency (Index)

V = Value of the lentil sold or buyer's price (NRs.)

I = Total marketing cost (including margins) (NRs.)

3.2.3. Econometric models

3.2.3.1. Cobb-Douglas production function for allocative efficiency analysis

The Cobb-Douglas production function has been widely used in many empirical studies particularly in the developing nations (Brave-Ureta and Pinheiro, 1997) which exhibits functional relation between inputs and output. While applying production function, this study assumes that the return from lentil is majorly dependent of expenses on labor, land preparation, seed use, nutrients management, disease-pest management, irrigation and harvest as well post-harvest related activities. Following Prajneshu (2008), in this study due its wider applicability and convenient in the aspect of comparing the partial elasticity coefficient, the extended form of the Cobb-Douglas production function was used as described below;

$Y = \alpha X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} e^{\mu}$…… (1)

The above-mentioned function was log transformed as:

$\ln(Y) = \ln\alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \mu$

Where; Y is the gross revenue from lentil (NRs.), X_1 = Labor cost (NRs.), X_2 = Land preparation cost (NRs.), X_3 = cost on seed (NRs.), X_4= cost on nutrient management (NRs.), X_5 = Plant protection cum irrigation cost (NRs.), X_6 = Harvesting and post-harvest cost (NRs.), u = error term, a=intercept, e= natural logarithm base and β1, β2……., β6 were coefficient of respective independent variables. For the calculation of return to scale from lentil, Cobb-Douglas production function will be used and calculated using formula;

$RTS = \sum b_i$

Where, b_i =coefficient of i^{th} variables.

The sum of b_i from the Cobb-Douglas production function indicates the nature of return to scale. Return to Scale decision rule: RTS<1: Decreasing return to scale; RTS=1: Constant return to scale; RTS>1: Increasing return to scale.

Allocative efficiency analysis

Resource allocative efficiency used in the production process of lentil was estimated by the ratio of marginal value product (MVP) to marginal factor cost/price per unit input (MFC) of each variable inputs with respect to estimated regression coefficient. the efficiency of resources allocated (r) was calculated as marginal value product/ marginal factor cost (Rahman and Lawal 2003; Iheanacho et al., 2003).

$r = MVP/MFC$

Where;

r= Efficiency ratio

MVP= Marginal value product of a variable input.

MFC= Marginal factor cost (Price per unit input)

The value of MVP will be estimated using the regression coefficient of each input and the price of the output.

$MVP = MPPxi \times Py$ (Unit price of output)

Where; Marginal physical product (MPP) of inputs was estimated using the regression and the geometric means of the variable inputs (Puozza, 2015).

And, $MPPx_i = d_y/dx_i = bi\bar{y} / \bar{XI}$ Where; bi= estimated regression coefficient of input Xi, $\bar{y}$= geometrical mean value of output, $\bar{Xi}$= geometrical mean value of input used. For marginal factor cost prevailing market price of inputs was used. As $MFC = Px_i$ (Unit price of input x_i).

The basis of estimation for allocative efficiency as a rule that "the slope of the production function (MPP) should equal the inverse of input price at profit maximization point" (Ellis, 1998). The decision rule for the efficiency analysis as;

r=1; Efficient use of a resource, r>1; Underutilization of a resource, r<1; Overutilization of a resource. The percentage adjustment rate of marginal value product of each input fitted in the model is vital to estimate in order to acquire value for optimum resource allocation i.e., MVP=MFC. Following Ghimire and Dhakal (2013), the percentage adjustment in marginal value product of each input was estimated using following equation;

$D= (1-MFC/MVP) \times 100$

$D= (1-1/r) \times 100$, where D is an absolute value of percentage change in marginal value product of each resource (Mijindadi, 1980) and r= efficiency ratio.

Diagnostic tests

In econometrics theory and analysis, serious problem of multicollinearity and heteroscedasticity have potentially observed (Emmanuel and Maureen, 2021). To avoid statistical error on the regression coefficient and correlation, diagnostic test for normality, multicollinearity and heteroscedasticity on production function related empirical estimation is an important part of the research analysis (Khanal et al., 2022). Variance inflation factor (VIF) test was done to detect multicollinearity where the VIF value larger than ten exhibits a multicollinearity problem in the data (Gujrati, 2004). Also, Breusch-Pagan/Cook Weisberg tests was done to assess heteroscedasticity. Histogram was performed for normality and RAMSEY RESET test was done to assure omitted variables in the model.

3.2.3.2. Stochastic frontier production model for technical efficiency analysis

The stochastic frontier production function model of the Cobb-Douglas functional form was employed to estimate the firm-level technical efficiencies of lentil farmers in the study areas. The parametric SPF model is the most widely used technique of efficiency analysis (Coelli et al., 2005). The Cobb-Douglas production functional form which specifies the production technology of the farmers was expressed as follows:

$Yi = f(X_i; \beta) \exp V_i - U_i$ ……. (2)

Where, Y_i represents the value of output, which is measured in Nepalese Rupees; X_i represents the quantity of input used in the production. The V_s are assumed to be independent and identically distributed random errors, having normal distribution N (0, ζ2y) and independent of the U_i. The U_i

are technical inefficiency effects which are assumed to be non-negative truncation of the half-normal distribution N (μ, ζ2i).

3.3.2.1. Technical efficiency analysis

The stochastic frontier production model was used to examine the input-output relationship; the implicit form of the stochastic frontier production model is specified as follows;

$LnY_{ij} = \beta_o + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + (V_i - U_i)$ …….... (3)

Where, Y_i = lentil output (kg/ha), X_1 = land area under lentil cultivation (ha), X_2= labor used (man-days/ha), X_3 = Tractor used (hours/ha), X_4 = quantity of seed used (kg/ha)

ln = logarithm to base e, i_j = j^{th} observation of the i^{th} farmer, Vi-Ui= error term, (ε) β_o = constant term to be estimated, β_1 to β_4 = coefficients of the independent variables to be estimated.

The technical efficiency of lentil producer for the i^{th} farmer, defined by the ratio of observed production to the corresponding frontier production, is expressed by;

$$TE = \frac{Yit}{\exp(xit;\beta) * \exp vit} = \frac{\exp(xit;\beta) * \exp vit * \exp(-uit)}{\exp f(xit;\beta) * \exp vit}$$

$TE = Y_i / Y_i^* = \exp(-U_i)$, so that $0 \leq TE \leq 1$.

Where Y_i is the observed output represents the actual output and Y_i^* is the minimum output and represents the frontier output. Thus, technical efficiency is the ratio of observed output to the corresponding stochastic frontier output. The measure of technical efficiency takes a value between zero and one and 1 indicates a fully efficient farmer. It measures the output of the firm relative to output that could be produced by a fully efficient firm using the same input vector.

$Y = f(X_i; b_i) + l$. The Stochastic frontier production function model was estimated using the maximum likelihood estimation procedure (MLE). Technical efficiency levels were predicted from the stochastic frontier production function estimation and categorized in an interval of 10.

Diagnostic tests

Multicollinearity and heteroscedasticity have potentially been a serious problem in the theory of econometrics (Emmanuel and Maureen, 2021). The models were tested for the specification tests of normality, multicollinearity, and heteroscedasticity. Multicollinearity was detected using the variance inflation factor (VIF) test. As a general principle, the value of VIF greater than ten (10) exhibits a problem in data due to multicollinearity (Adnan et al., 2006; Gujarati, 2004). Secondly, the heteroscedasticity test in the data was assessed using the Breusch-Pagan/Cook Weisberg test. For the normality test histogram and Kernel Density Estimate were performed.

4. RESULTS

4.3. Descriptive analysis

4.3.2. Demographic and socio-economic characteristics of sampled farm households

The detail socio-economic characteristics of the 473 randomly sampled farmers producing lentil is presented in Table 3 and Table 4 highlighting the diverse socio-economic profile of the sampled farm households. Among the total households under study, about 68% were headed by male and the average age of household head was about 49 years with only 3.38 mean years of education. Majority of the households were aadibasi/janajati category. The lentil farmers were mostly small scale and about 52 percent were involved in farmer's group and cooperative. Only 36 percent of farmers use improved seed and 27 percent practice weeding in lentil farming. The average family size was 7.04 and among them 4.73 were economically active members. Average family size in the study area was higher may be due to dominance of ethnic groups in the study areas. About 52% farmers were involved in organization, 63% were aware of post-harvest loss, 21% has received training related to lentil production and only 32.7% have their own transport facility. About 74% of farmers have access to credit, 37% were using improved seed. The lentil farms were found somehow accessible to technical source and the average distance was 4.68 km. The average area under lentil cultivation was 0.38 ha. in the study area.

Table 3. Socio-demographic characteristics of lentil farmers (n=473)

Categorical Variables	Frequency (%)
Gender of HH head	
Male	322 (68.08)
Female	151 (31.92)
Ethnic groups	
Brahmin/Chhetri	94 (19.87)
Aadibasi/Janjati	347 (73.36)
Dalit	15 (3.17)
Other (Muslim etc.)	17 (3.59)
Family type	
Joint	230 (48.63)
Nuclear	243 (51.37)

Major occupation	
Agriculture	418 (88.37)
Non-agriculture	55 (11.63)
Membership	245 (51.80)
Types of seed used	
Local	299 (63.21)
Improved	174 (36.79)
Own transportation facility (yes=1)	155 (32.77)
Aware about post harvest losses (yes=1)	297 (62.79)
Access to credit (yes=1)	351 (74.21)
Received training (yes=1)	100 (21.14)
Received Technical assistance (yes=1)	216(45.66)

Source: (Field survey, 2022)

Table 4. Socio-demographic characteristics (continuous variables) of lentil farmers (n=473)

Variables	Mean (SD)
Age of household head	49.12 (12.54)
Education years of schooling of household head	3.38 (3.41)
Total family size	7.04 (4.22)
Economically active HH members[1]	4.73 (2.71)
Dependency ratio (%)	58.01 (55.60)
Total numbers of illiterate family members	1.23 (1.56)
Livestock standard unit LSU	1.26 (1.36)
Average years of involvement in groups/cooperatives	3.09 (5.06)
Distance for technical source from farms in km	4.68 (5.70)
Area under lentil cultivation (ha)	0.38 (0.36)

[1] represents the members of household of age group 15 to 59 years.

4.3.3. Socio-economic characteristics of lentil traders

Socio-economic characteristics of lentil traders provide a comprehensive overview highlighting their roles, activities, and market engagement (Table 5). Among the traders' survey (n=155), around 10% were collectors (local and distant), 6% were processors, 28% were wholesalers and 57% were retailers and among them about 79% were male. Majority of the traders were running

their business with no partnership and fully diversified nature. About 52% of the trader's main occupation was agriculture trading. About 68% of the traders were member in the trade related organization. Around 87% of the traders perform year-round trade of lentil whereas only 10% trade only in main season. Mostly processed form of lentil found traded (58.7%) followed by raw (38.06) and both type (3.23%). The mean age, education and experience in lentil trade of the sampled traders were 40.14 years, 10.41 years and 10.25 years respectively. For the traders, the average market distance for buying and selling of lentil was 37.82 Km. and 16.32 Km. respectively which signifies that trader bears higher transportation distance for buying rather than selling (Table 4).

Table 5. Socio economic characteristics of lentil traders

A. Continuous variables	Mean (SD)
Age	40.14 (10.34)
Education	10.41 (3.57)
Experience in trade of lentil	10.25 (7.01)
Initial investment in NRs. Lakh	62.68 (312.35)
Average annual quantity of lentil traded (MT)	566.44 (4892.66)
Market distance (Km) for buying	37.82 (87.37)
Market distance (Km) for selling	16.32 (43.19)
Years of registration	11.03 (7.22)
Years of business start	10.69 (7.32)
B. Categorical variables	Frequency (%)
Trader's type	
Local collector	9 (5.81)
District collector	6 (3. 87)
Processors	9 (5.81)
Wholesalers	43 (27.74)
Retailers	88 (56.77)
Business model	
Alone	134 (86.45)
Partnership	21 (13.5)
Main occupation (Agriculture trading=yes)	81 (52.26)
Gender	

Male	123 (79.35)
Female	32 (20.65)
Diversification in trading products (yes=1)	155 (100.0)
Timing of lentil trade	
Main season only	17 (10.97)
Year round	135 (87.10)
Occasionally when buyers demand	3 (1.94)
Traded lentil type	
Raw	59 (38.06)
Processed	91 (58.71)
Both	5 (3.23)
Membership in trade related organization (Yes=1)	106 (68.39)

Source: Trader's survey, 2023

4.4. Economics and efficiency of lentil production

Table 6 presents the overall cost structure and profitability assessment of lentil production in the study area. The average minimum and maximum productivity of lentil in the study area was 188 Kg./ha. and 1410 Kg./ha. with mean level of productivity 672.6 Kg./ha. The average total cost (average variable cost) was NRs. 36261.3 per hectare and among the variable cost components, the higher cost was shared by labor (40.3%) followed by land preparation (18.5%), harvesting and post-harvest activities (16.7%), and seed (12.7%). Although pod formation stage followed by flowering is a critical stage for moisture stress, very few lentil farms were suing irrigation which shares only 1.2% in total cost. Similar to this result, Paudel (2020) reported about 1.5% (510 NRs./ha.) share of cost on irrigation within total cost of lentil production in Nepal. Study further showed that the lentil farmers were earning average gross revenue of NRs. 61350.01 per hectare. An average of NRs. 25096.70, constituting around 41% of gross return was earned as profit per hectare. Also, farmers were getting NRs. 22.55 net profit on average per kg sold lentil with an average benefit cost ratio 1.78 and profitability index 0.78.

Table 6. Per hectare costs and profitability assessment (n=473)

A. Cost structure (NRs./ha.)	Mean	Std. Dev.	% of total cost
Labor	14628.5	5873.3	40.3
Land Preparation	6697.9	3221.0	18.5

Seed	4613.8	1814.7	12.7
Organic manure (FYM/compost)	1467.8	2337.8	4.0
Irrigation	438.5	1210.7	1.2
Chemical fertilizer	1453.4	2006.3	4.0
Plant protection	901.2	1423.2	2.5
Harvesting and post-harvest	6060.4	3150.9	16.7
Average total cost	36261.3	8446.7	100
B. Benefit-cost and profitability assessment			
Average cost (NRs. / Kg.)	69.66	41.78	
Average yield (Kg/ha.)	672.59	321.70	
Farm gate price (NRs. /Kg.)	92.20	12.88	
Gross farm income (GFI) (NRs. /ha.)	61358.01	29345.40	
Gross-margin (GM) (NRs. /ha.)	25096.70	30331.35	
Profit (NRs. /Kg.)	22.55	40.71	
Benefit cost ratio (BCR)	1.78	0.96	
Profitability index	0.78	0.96	
Profit % (% as of GFI)	40.90	-	

4.5. Estimated results from the Cobb-Douglas production function

4.5.2. Estimation of production elasticity of inputs in lentil production

Independent variables that were included in the model elucidated output variation with F-value of 102.62 significant at 1% level showing good explanatory power. R-squared value of 0.56 indicates that 56% of the difference in gross income from lentil was explicated by the independent variables included in the model (Table 7).

All variables that were included in the model were found with positive coefficients and were statistically significant except for variable cost on nutrient management. Thus, ceteris paribus, increase in labor cost, land preparation, seed, nutrient management, plant protection cum irrigation, harvesting and post-harvest by 100% would cause an increase in gross return from lentil business significantly by 19%, 15%, 41%, 2.1%, 2.2% and 8% respectively.

Table 7. Statistics and estimated coefficients value for lentil (Cobb-Douglas production function)

Variables	Coefficient	S.E	t-stat	Multicollinearity statistic

				VIF	1/VIF
Ln (labor cost)	0.1897***	.0577	3.29 (0.001)	2.31	0.4337
Ln (land preparation cost)	0.1488***	.0471	3.15 (0.002)	3.26	0.3063
Ln (seed cost)	0.4092***	.0598	6.83 (0.000)	3.25	0.3074
Ln (nutrient cost)	0.0021	.0046	0.45 (0.652)	1.20	0.8319
Ln (Plant protection cum irrigation cost	0.0216***	.0045	4.75 (0.000)	1.11	0.8976
Ln (Harvest and post-harvest cost)	0.0754**	.0363	2.07 (0.039)	1.75	0.5711
Constant	3.4777***	.3269	10.64(0.000)	-	-
**p<0.05, ***p<0.01; Figure in parentheses indicate p-value					
Statistical summary					
N (Number of observations)	473 (df=472)				
Adjusted R-square	0.5637				
R-square	0.5692				
F-value	F (6, 466) =102.62***, Prob>F=0.0000				
Return to Scale RTS	0.85				
Diagnostic Tests					
Variance inflation factor (VIF)	2.15 (Mean VIF); Maximum=3.26				
Breusch-Pagan/Cook-Weisberg test	Chi^2 (1) =1.31, prob>chi^2=0.2518 (constant variance)				
RAMSEY regression specification-error test (RESET Test)	F (3, 463) = 2.28; Prob>F=0.0786 (model has no omitted variables)				

Summing the coefficients of the independent variables yields a scale elasticity of 0.85 indicating that lentil production function exhibits decreasing returns to scale <1 (Table 4). The result revealed that expenses on all the variable inputs if added by 1% would increase the output level by 0.85%.

4.5.3. Allocative efficiency of productive inputs

Study resulted that majority of variables that were included in model were underused except labor cost and cost incurred in harvest and post-harvest related activities which were overutilized. As presented in Table 8, the expenses on land preparation, seed, nutrient management, plant protection cum irrigation have an allocative efficiency coefficient (r) of 1.38, 5.21, 1.49, and 46.89 respectively, meaning underutilization of these resources and with the increment in utilization of

these resources would result in an efficient allocation that may optimizes profit in lentil. Further, the expenses on labor and harvest as well as post-harvest activities were overutilized with efficiency coefficients 0.77 and 0.81 respectively indicating that deduction in their expenses will optimize profit in lentils. Lacking mechanization and a labor-based farming system might have cause overutilization of these resources.

Table 8. Estimated inputs allocative efficiency level in lentil production

Inputs/variable cost	GM	Coeff.	MVP	MFC	r	Efficiency	D
Labor	3924.489	0.1897	0.77	1	0.77	OU	30.1
Land preparation	1713.282	0.1488	1.38	1	1.38	UU	27.6
Seed	1248.313	0.4092	5.21	1	5.21	UU	80.8
Nutrient	22.37042	0.0021	1.49	1	1.49	UU	33.1
Plant protection cum					46.6		
irrigation	7.3745	0.0217	46.68	1	8	UU	97.9
Harvest and post harvest	1482.142	0.0754	0.81	1	0.81	OU	23.6

Note: GM= Geometric mean, MVP= marginal value product, MFC= marginal factor cost, r= efficiency ratio, OU= overutilized, UU=underutilized

4.5.4. Percentage adjustment in MVP of resources

Resources were not optimally utilized in the case of lentil cultivation in the study area and to achieve maximum return, the model revealed that expenses on land preparation, seed, nutrient, plant protection cum irrigation should be increased by 27.6%, 80.8%, 33.1% and 97.9% respectively. About 80% increment in seed expenses has suggested farmers to expense more money to purchase improved high yielding seeds to enhance farm yield and profitability instead of using locally available home saved seed. Similarly, expenses on labor and harvesting related cost should be decreased by 30.1% and 23.6% respectively to achieve optimized resource allocation and return.

4.5.5. Diagnostic tests

To confirm multicollinearity in the model, variance inflation factor (VIF) test was done. Regression analysis result depicted that all the 6 predictors have VIF less than 10 with a mean VIF of 2.15 and a maximum 3.26 confirming that the model doesn't exhibits a serious problem with multicollinearity as Adnan et al., (2006) mentioned VIF above 10 were considered problems of multicollinearity in the dataset. A small chi-square value of 1.31 and prob>chi^2= 0.2518; ($p>0.05$)

indicating that there was no problem of heteroscedasticity. Again, RAMSEY RESET Test was performed and resulted F (3, 463) = 2.28; Prob>F=0.0786 (p>0.05) indicating that there has no any omitted variables in the model and a linear regression model is sufficient to explain this input-output relationship. Also, the dependent variable total return (gross farm income) from lentils showed normality in the histogram. The test results of all the diagnostics tests performed are presented in Table 8.

4.6. Influencing factors and production related problems in lentil

Based on farmers perception and rank, higher return from lentil cultivation was found most important influencing factors of lentil farming with index value 0.84 followed by high market demand (0.82), nutritive food (0.67), profitable than other crops (0.65), maintain soil fertility (0.57), land suitability (0.49), adaptation to climate change (0.32), and support from government (0.19). Farmers opinioned government support as a least motivating factor for lentil cultivation (Table 9).

Table 9. Perception ranking on factors influencing lentil cultivation (n=473)

Influencing factors	Weight	Index	Rank
Higher return	397.75	0.84	I
Higher market demand	387.38	0.82	II
Nutritive food	317.38	0.67	III
Profitable than other crops	306.38	0.65	IV
Maintain soil fertility	270.00	0.57	V
Land suitability	232.25	0.49	VI
Adaptation to climate change	151.75	0.32	VII
Government support	90.75	0.19	VIII

(Source: Field survey, 2022)

Results presented in Table 10 revealed that the major problem perceived by lentil farmers related to production is occurrence of climatic hazards (0.93). During focus group discussion, most of the farmers mentioned that they were heavily suffered from the drought or irregular rainfall during lentil cultivation. Incidence of disease ranked as second most serious problem (0.74) followed by unavailability of improved varieties (0.73), lack of government support (0.57), and lack of improved technology (0.55). Major disease reported by lentil farmers in the study area was Stemphylium blight, wilting and root rot.

Table 10. Perception ranking on problems in lentil cultivation (n=473)

Production Problems	Weight	Index	Rank
Climatic hazards	442.13	0.93	I
High incidence of disease	349.13	0.74	II
Unavailability of improved seed	345.25	0.73	III
Lack of government support	267.88	0.57	IV
Lack of improved technology	259.75	0.55	V
Lack of insurance/security	184.25	0.39	VI
Lack of irrigation	155.50	0.33	VII
Labor shortage	97.25	0.21	VIII

(Source: Field survey, 2022)

4.7. Results from Technical Efficiency (TE) analysis

4.7.2. Descriptive statistics of inputs and outputs for lentil production in the study area

On average lentil farmers of the study area applied 57.2 kg of seed, on average 14.79 hours of tractor for land preparation and other production activities ranging between 5 and 35 hours. About 17.64-man days of labor ranging from 8 to 55 was used for lentil production per ha with average allocation of 0.38 ha. of land (Table 11). Thus, the average owned land by sampled farmers was 1.1 ha with minimum of 0.04 ha. and maximum 17.33 ha. and on an average the lentil was cultivated in only 0.38 hectares ranging from 0.03 hac. to 3.83 hac. Similarly, from the mean area of 0.38 hectare, the average production of lentil was 251.1 Kg ranging from 19 kg to 3000 Kg. The productivity of lentil in the study area was 672.6 kg/ha with minimum of 188 to maximum of 1410 kg per hectare.

Table 11. Mean inputs and output level in lentil production in the study area (n=473)

Variables	Mean	SD.	Minimum	Maximum
Inputs				
Total owned land (ha.)	1.10	1.50	0.04	17.33
Lentil area (ha.)	0.38	0.36	0.03	3.83
Seed (kg/ha.)	57.29	8.20	36.0	90.0

Tractor (hrrs/ha.)	14.79	4.42	5.0	35.0
Labor (man days/ha.)	17.64	11.93	8.0	55.0
Output				
Average production (Kg)	251.13	264.51	19.0	3000.0
Productivity (Kg/ha)	672.61	321.70	188.0	1410.0

Source: (Field survey, 2022)

4.7.3. Model specification tests

Few statistical tests were performed to assure test of multicollinearity, heteroscedasticity, normality and ovtest. Variance inflation factors (VIF) were calculated to test the potential multicollinearity as it necessary to ascertain the independence of regression variables. With the stochastic production frontier, the VIF was found low with mean of 1.02 and maximum 1.04 showing no problem of multicollinearity in the dataset. Likewise, the Breusch-Pagan test resulted a small chi^2 value 1.02 and prob>chi^2=0.3128; (p>0.05) implying there was no problem of heteroscedasticity in the dataset. Also, normality test and Ramsey reset test were performed and the result indicated good normality with higher chi^2 value of 20.12 and the model has no omitted variables as prob>F value is greater than 0.05.

4.7.4. Stochastic production frontier estimates

The result of the maximum likelihood estimate (MLE) of the stochastic production frontier with "t" statistics for the lentil crop are presented in table 12. The coefficient of labor and seed used as inputs were found statistically significant. The parameter Lambda is greater than one indicates a good fit for the model (Tadesse & Krishnamoorthy, 1997). The coefficient of labor was 0.066 and is negatively significant denotes possible negative change by 6.6% in aggregate output of lentil as a result of unit man-days increment in labor use. The coefficient of seed input was positively significant indicating 1% increased in seed quantity will lead to an increase in lentil production by 37.6%. Other input factors tractor hours and land area were found non-significant (Table 12). The positive elasticity of seed used signifies that farmers should increase the quantity of improved seed to increase the lentil production. This may be due to the reason that most of the farmers in the study area were using local seeds that may come up with poor germination and plant vigor.

Table 12. Stochastic production frontier of lentil production

Variables	Coefficient	SE	Z	Multicollinearity statistic	
				VIF	1/VIF

Stochastic frontier half normal model					
Land (X_1)	-.0325	.032	-1.00(0.319)	1.04	0.958
Labor (X_2)	-.066*	.0374303	-1.78(0.075)	1.02	0.976
Tractor hours (X_3)	.0279	.0676356	0.41(0.680)	1.02	0.979
Seed (X_4)	.3763**	.1477797	2.55(0.011)	1.00	0.998
Constant	5.4955***	.6499826	8.45(0.000)	-	-
sigma_v	.2889	.0457			
sigma_u	.6949	.0712			
$sigma^2$	.5663	.0775			
Lambda	2.4046	.1128			
*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.					
Note: Figure in parentheses indicates p value.					
Summary Statistics					
Log likelihood	-339.55				
Number of observations	473				
Wald chi2(4)	11.66, Prob > chi2= 0.0200; Stoc. frontier normal/half-normal				
Likelihood-ratio test of sigma_u=0: $chibar^2(01)$	10.71 Prob>=chibar2 = 0.001				
Statistics tests					
Variance Inflation Factor (VIF)	1.02 (mean VIF), maximum VIF=1.04				
Breusch-Pagan/Cook-Weisberg test)	Chi^2 (1) = 1.02, prob> chi^2 = 0.3128 (constant variance)				
Ramsey RESET test	Model has no omitted variables (ovtest) F (3, 463) =1.41, Prob > F = 0.2378				

Source: Authors' estimation based on field survey, 2022

4.7.5. Farm technical efficiency level

The model estimated the mean technical efficiency percentage estimated by the model for the pooled sample is 61.5% with range between 23.0% and to the maximum of 89.9% within 7 categories. This implies that on an average, farmers were able to get 61.5% potential outputs from given combination of production inputs. Further, the 61.5% mean technical efficiency implies that on an average 38.5% more output would have been produced with the same level of inputs if producers were to produce on the most efficient frontier following best practices and cost minimization methods.

In the study areas only 18.39% lentil farms were found operated at 80% efficiency level. The lowest level of efficiency was 23.9% which is far below the coefficient frontier 89.9% indicating

such production units are technically inefficient. The mode of the technical efficiency was 0.619 indicating that the majority of farmers has technical efficiency of 61.9%. Within the sampled household, 210 farms (44.4%) were operating below mean level and 263 (55.6%) were operating above mean level. Further, the observed mean yield were 216.9 kg, 297.8 kg, 393.4 kg, 505.7 kg, 629.9 kg, 844.6 kg and 1196.1 kg operating at efficiency level of 0.2-0.29, 0.3-0.39, 0.4-0.49, 0.5-0.59, 0.6-0.69, 0.7-0.79 and 0.8-0.89 respectively (Figure 3).

In short run, there is a scope of increasing lentil output by 28.4% by adopting the techniques and technologies adopted by the best lentil farmers.

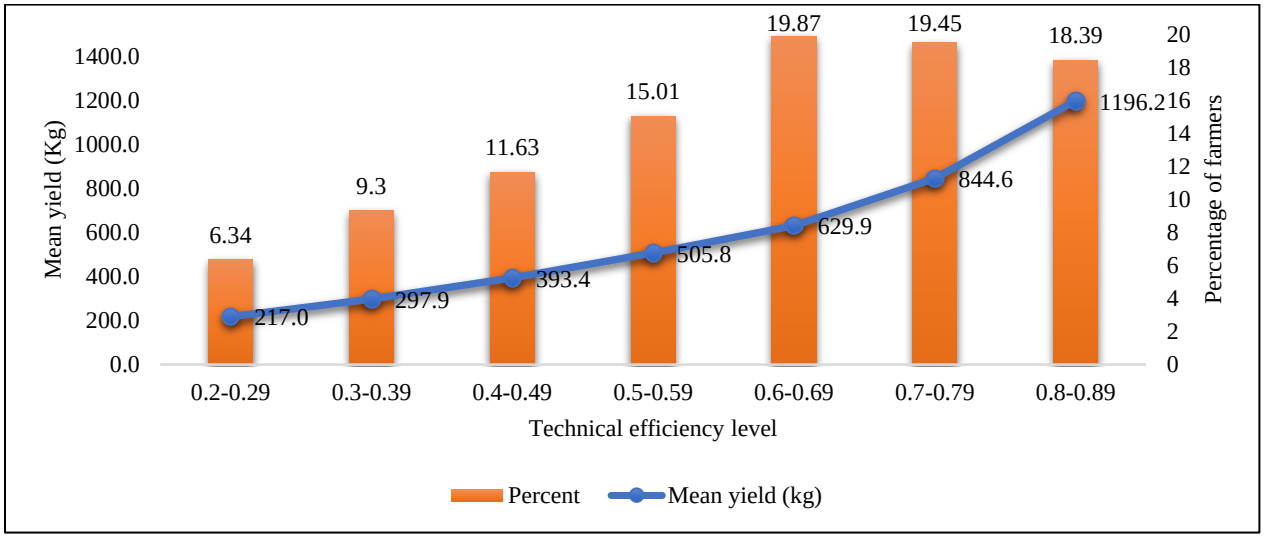

Figure 3. Technical efficiency level of lentil farmers with mean yield (n=473)

4.8. Lentil value chain mapping, market margin and efficiency analysis

4.8.2. Lentil value chain map, actors, stages and linkages

The survey results in this study revealed six major actors in the current lentil value chain in Nepal namely input suppliers, producers, collectors, processers, distributors (wholesalers and retailers) and consumers. Lentil value chain in Nepal involves multiple actors, all performing various activities at different scales of operation. The value chain map in Figure 2. shows the business relationship, flow of product, payment and information in the chain. It also depicts activities carried out by and the relationships between different stakeholders at each stage of the lentil chain i.e. input supplying, production, collection/aggregation, processing/exporting, wholesaling, retailing, and consumption carried out by different actors in diverse capacities and situations as an informal system.

As illustrated in the chain map (Figure 2), the product flow begins from the farmer and ends with the consumer, flow of money directs back from consumer to farmers and flow of information follows two ways channel. Here, lentil is marketed as a raw product up to the processors and after processing, it is marketed as whole or split lentil and goes to the consumers of domestic and overseas market as well. There is horizontal and vertical flow of market information for traders, with limited horizontal flows of information among lentil farmers. Survey result from traders showed that about 52% of traders create informal linkage with their lentil suppliers by giving short term credit. Result also indicated that 82.8% sample households accepted the price determined by the buyers whereas; only 17.2% have chance to bargain and take a negotiating price. This implies that the lentil farmers had limited bargaining power, weak market information and weak integration and buyer-driven chain. The details about lentil value chain actors, their role and characteristics are presented in Table 5. The characteristics, role and function of the major actors are described hereunder;

Input supplier

Value chain analysis in any agriculture sector starts with input supply level. Input suppliers in lentil value chain are private and government type including agro-vets, agri-dealers, seed producer groups, companies and cooperatives, NARC, commodity programs, AKCs, Local level's agriculture offices, National Seed Company etc. supplying mostly seed, pesticide, machinery and tools, herbicides, packaging materials, technical services etc. Suppliers are available at remote area, profit oriented, low coverage, no adequate after sale services, supportive to extension services. They Provides material inputs and technical advice to farmers with dealers in the district/village. Input suppliers possesses low capacity to meet demand, low coverage, diverse working nature, profit oriented of the private type and service oriented but with low capacity of NARC and commodities program to supply seed. Local level and district level government offices plays role in coordination and linkage, provide seed and technical services on a subsidy basis covering remote areas as well although suffering from limited manpower and budget.

Producer

In this study producers generally refers to small and large farmers, Farms, farmer groups, agriculture cooperatives and local collectors as well those involved in production of lentil. They paly major role from land preparation, seed sowing to harvesting. Producers of lentil were mainly smallholders, use basic farm implements and traditional methods in production, rarely use external

inputs, fragmented land and scattered production. Majority of them are illiterate and suffered from low bargaining power. They are mostly engaging in farm gate and trading points (village level) selling; consume a significant portion of their produce and also save some volume as seed purpose. Depending on market conditions, producers have a variety of market outlets for their product. They may sell directly to rural consumers, local collectors, large collectors, small and large processors. Producers found maintained some sort of business relationship with local collectors connecting with credit/advance services and selling most of their produce.

Commission agent

Commission agent in the lentil value chain are also known as contact persons, brokers, middleman etc. They are profit oriented, seek commissions from buyers or sellers or both, good negotiator and business facilitator. They have an established relationship with producer and collectors working as a contact person between value chain actors on a commission basis linking product to market, sharing market information and negotiating prices.

Collector

Collectors or aggregators were of two types; Local collector/Gallawala and large collector. Local collector/Gallawala are operating lentil business in small scale, village-based small traders, mainly permanent residents of their collection areas. Local collectors somehow built good linkage with producer and also sometimes provides credits, advance money to the producer. They have lower investment and low storage capacity. About 70% of the total lentil produce found collected by local collectors. They purchase newly harvested lentil and transport to small and large processors and large collectors. Local collectors are primarily involved in collection, drying, and storage activities. Large collector generally operates lentil business in large scale, reside in the district or urban areas and mobilize commission agents in the villages for price negotiation and product assurance. Their investment, product holding capacity and transaction volume is higher compared to local collectors. They collect lentil from local collectors and directly from producers (about 25%) for supplying small and large processors. Large collectors are primarily involved in collection, drying, storage and occasionally grading. They maintain informal linkages with local collectors, producers and processors.

Processor

Processors were characterized as village level small daal mill and district or regional level large processors having large volume purchasing power with influencing role on setting market price,

access to information and decision power on market related issues. They possess higher investment and large storage capacity. Majority of the processors are of mixed commodity type. They purchase raw lentil from local and large collectors and processed to edible pulse. Most of the value addition activities in the chain were performed by processors which includes grading, sorting, cleaning, drying, de-hulling, processing, polishing, storing, packaging, labelling and branding. They supply major volume of processed lentil daal to wholesaler and small volume to retailers. Informal and trust-based linkages were found between processors and wholesalers as well.

Exporter

Exporters were well known as processors cum exporters as they themselves function as exporters. The processors working as exporters possess large scale operation, few in numbers, informal linkages with domestic wholesalers for processed product and with international importers for graded raw product. Exporters were keen concerned in quality of the product. They export lentil with company's brand and attractive packaging. Sorting, cleaning, grading, drying, packaging and branding are the major activities performed by exporters to supply lentil to foreign importers.
Also, exporters conduct both export and import function to fulfill domestic demand.

Wholesaler

Wholesalers were known as large distributors in the chain. Majority of them were stationed in large markets, purchase bulk volume, store and supply to retailers and direct consumer. Majorly they work as a supplier without adding values to the product. They distribute domestic as well as imported lentil throughout the country. Wholesalers buy spilt lentil from exporters and large processors and sell it to retailers within and outside their respective markets.

Retailer

Retailers in the chain were generally vendors, marts, grocery shops, cycle traders, haat bazar vendors etc. They are many in numbers, stationed at major markets and even at village and tole level. Retailers sell product to individuals, hotels and restaurants. Low investment and less value addition activities were performed by retailers. Retailers majorly buy split lentil from wholesalers and processors/exporters and sometime raw lentil directly from producers and sell it to the final consumers. Some retailers found performing the branding of the products while selling raw lentil in the name of organic, hills products.

Business enablers/facilitators

Based on nature of work and responsibilities, large number of business enablers representing private sector, development partners and government organizations are found in the lentil chain. Federal and provincial Ministry, NARC, DFTQC, PMAMP, (AKCs), Local level, Custom, TEPC, Quarantine, laboratories, Agriculture training centers, Commodity organizations, SEAN, Development partners (USAID, CIMMYT), CBOs, Financial institutions (Banks, Micro-finance, Cooperatives, Groups), Insurance companies, AEC, CCI, Commodity federations etc. are facilitating lentil business with their mandate. The business enablers are generally urban centered, low coverage, less priority to lentil commodity, fragmented and duplicated types of services. Their support is mainly centered to producer but no adequate business-related support was provided to traders and exporters. They lack effective coordination and sometimes observed duplications in program activities. Insurance and credit acquiring process are complex and nominal. Nature of services were supply based rather than demand driven. Some sort of credit facilities is made available to farmers through financial institutions including saving and credit cooperatives, groups revolving fund.

Consumers

The ultimate lentil consumer are domestic and international citizens. Function of buying and utilizing the lentils. Consumers of lentils were individual, households, restaurants, hotels and international citizens. Consumer provide market opportunity for lentil products. In spite of high prices, consumers demand highly Nepalese lentil. They preferred to buy clean, graded, local, labelled, packaged and branded product. Poor and marginalized families majorly grow and consume lentil themselves; middle- and higher-income families are the major domestic buyer. The overall value chain map, flow of product, money and information, linkages among actors, functions and enabling environment for the chain is illustrated in figure 4.

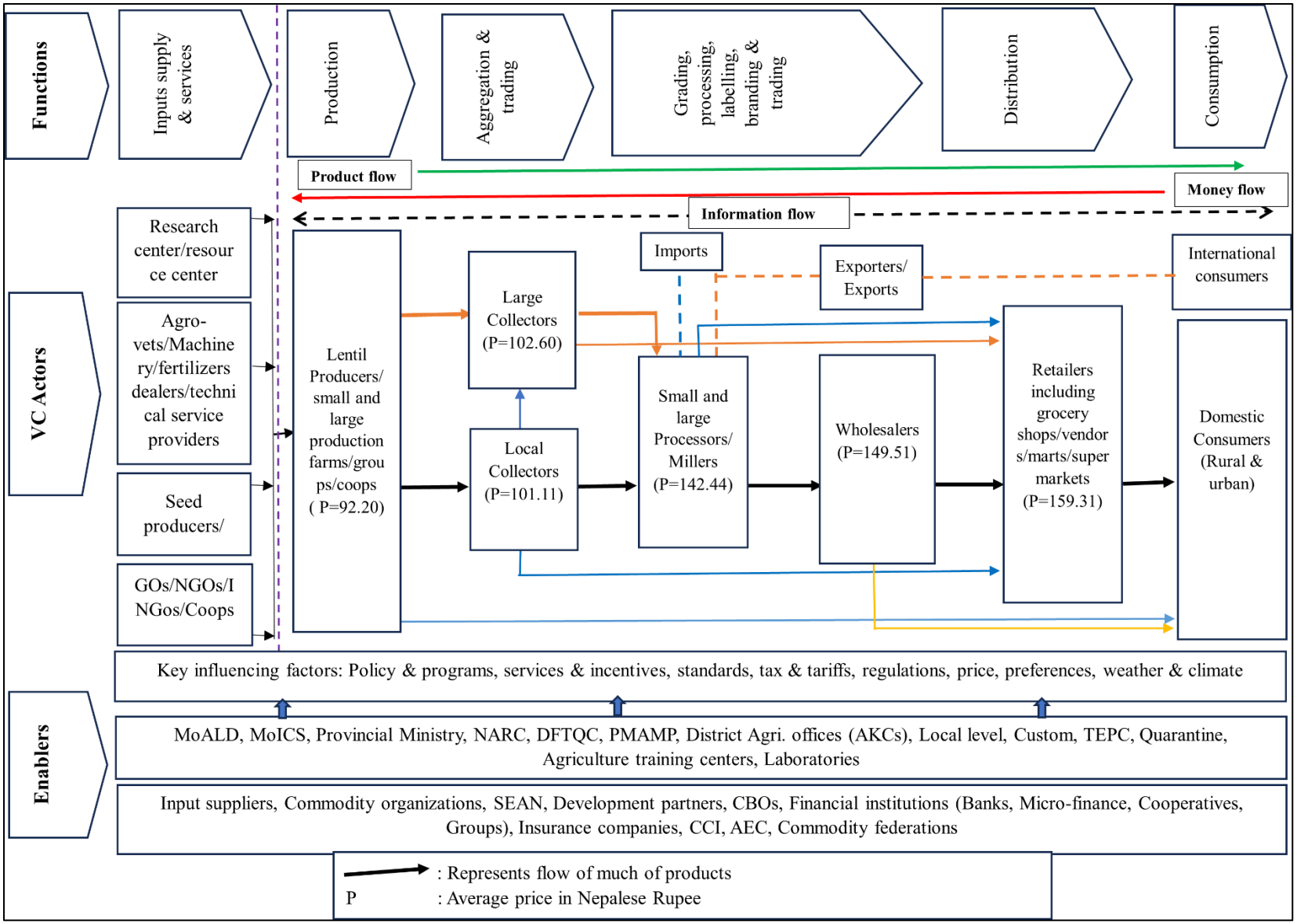

Figure 4. Lentil value chain map in the study area (Source: Author's design based on field survey, 2022)

4.9. Associated cost, marketing margin, return on investment and market efficiency along the lentil value chain

The performance of the lentil market was assessed by taking into account associated costs, profit margins, marketing margins, value addition for the value chain's major actors. Producers, local collectors, large collectors, processors, wholesalers, retailers and consumers were the major actors in the lentil value chain in the study area. Table 14 indicated that the cost items un/loading, cleaning packaging and labelling, grading and processing, transportation, storage, taxes, advertisements, extra charges, fuels and electricity, and product loss. To calculate the share of profit captured by key actors in product marketing, marketing costs are estimated accordingly. Per kg marketing cost was incurred higher with processor (17.04) followed by retailer (6.53), large collector (6.23), local collector (5.56) and wholesaler (4.83). In lentil value chain, processor had the highest share of market margin (37.08%) followed by producer (21.63%), and retailers (14.21%). The highest profit share (36.02%) was obtained by processors followed by producers (30.85%), retailers (13.81%), local collectors (7.25%) and large collector (6.45%). In the chain, wholesalers obtained lowest (5.62%) profit share compared to other actors. Similarly, higher return on investment was obtained by producers (25.10) followed by processor (18.02) and retailers (5.48).

Table 14: Marketing costs and benefits among actors along the lentil value chain (n=155)

Items (NRs./Kg)	Producer	Local collector	Large collector	Processor	Wholesaler	Retailers
Production/purchased cost (a)	69.66	91.2	92.5	102.8	141.3	144.5
Total marketing cost (b)	4.04	5.56	6.23	17.04	4.83	6.53
Total cost (a+b)	73.70	96.76	98.73	119.84	146.13	151.03
% share of total cost	10.74	14.10	14.39	17.46	21.30	22.01
Selling price (SP)	92.20	101.11	102.60	141.44	149.50	159.31
Market Margin (SP-a)	22.54	9.91	10.10	38.64	8.20	14.81
Profit margin (SP-TC)	18.50	4.35	3.87	21.60	3.37	8.28
% Share of profit	30.85	7.25	6.45	36.02	5.62	13.81
RoI	25.10	4.50	3.92	18.02	2.31	5.48
% value addition (MM/a)	32.36	10.87	10.92	37.59	5.80	10.25
Price spread (NRs./Kg.)	67.11					
Price spread (%)	42.13					
Farmers share (%)	57.87					
Marketing efficiency						
Shephard's method	2.60					
Acharya and Agrawal method	1.52					

Source: Trader's survey, 2023

The profitability analysis showed that all lentil marketing actors are in profitable range receiving relatively high profit by adding relatively little value and small cost in the business. Highest proportion of value addition was done by processors (37.59%) followed by producers (32.36%), large collectors (10.92%), local collectors (10.87%), retailers (10.25%) and wholesalers (5.80%). The price spread of overall lentil value chain was 42.13% (67.11 NRs./kg) with 57.87% of farmers share. The marketing efficiency of lentil was 2.60 (Shephard's method) and 1.52 (Acharya and Agrawal method).

4.10. Lentil Marketing channels

The formal survey has identified seven frequently transacted marketing channels for lentil in Nepal. The total estimated amount of lentil that supplied by sample respondents to ultimate users through various intermediaries was 1021 metric tons. Most frequently and largest volume transacted marketing channel for lentil was channel IV as producer-local collector-processor-wholesaler-retailer-consumer accounting 44.56% of the share in total transaction. Also, about 18.4% of total lentil was transacted through channel V followed by III (11.26%), channel IV (9.50%), VII (8.62%), I (4.02%) and II (3.62%). The smallest volume of lentil was passed through channel II this was due to the small capacity of retailers to sell the whole grain to the consumer without the presence of processors. The identified lentil market channels and their transaction share is presented in table 15.

Table 15. Different marketing channels and their transaction share for lentil trade in Nepal

Marketing Channels	Channels	Quantity traded (Mt.)	% transaction
Producer-consumer	I	41.0	4.02
Producer-Large Collector-Retailers-Consumer	II	37.0	3.62
Producer-Local Collector-Processors-Retailers-Consumer	III	115.0	11.26
Producer-Local collector-large collector-Processor-wholesalers-Retailers-Consumer	IV	97.0	9.50
Producer-Local Collector-Processors-wholesalers-Retailers-Consumer	V	455.0	44.56
Producer-large collector-Processors-Wholesalers-Retailers-consumers	VI	188.0	18.41
Producer-Large collector-processor/exporters	VII	88.0	8.62

Source: Trader's survey, 2023

4.11. Barriers to entry in the lentil trade business

The study resulted that among the sampled traders 54.83% of the traders responded face barriers to entry in the lentil business. Among the various barriers asked for responses, the study resulted that product unavailability and capital shortage were the major factors followed by licensing and other legal procedures facilitating as a barrier to entry (Figure 5).

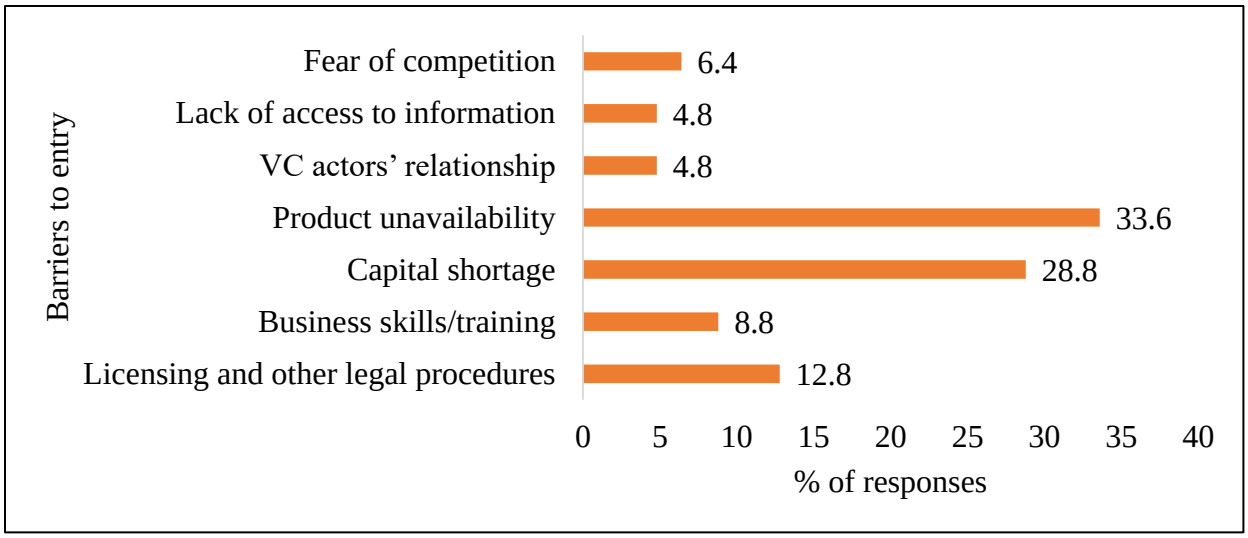

Figure 5. Barriers to entry in lentil business (n=155)

4.12. Marketing constraints

Based on index value among various marketing related challenges, price fluctuation with index value 0.9 was listed as the major trade related challenge. Likewise, quality and volume of lentil availability (0.71) and poor linkages with value chain actors (0.60) were also the challenges in lentil marketing system in Nepal followed by poor lacking market related infrastructures and irregular demand-supply (Figure 6). Similar to this result, Gautam et al., (2022) reported that low seasonal price/price fluctuation has the highest index value (0.783) and ranked as major marketing problem among categorized problems in lentil sector of Nepal. By mitigating these challenges, stakeholders can enhance market performance, strengthen value chain linkages, and create a more conducive environment for traders to thrive and contribute to the growth of the lentil sector.

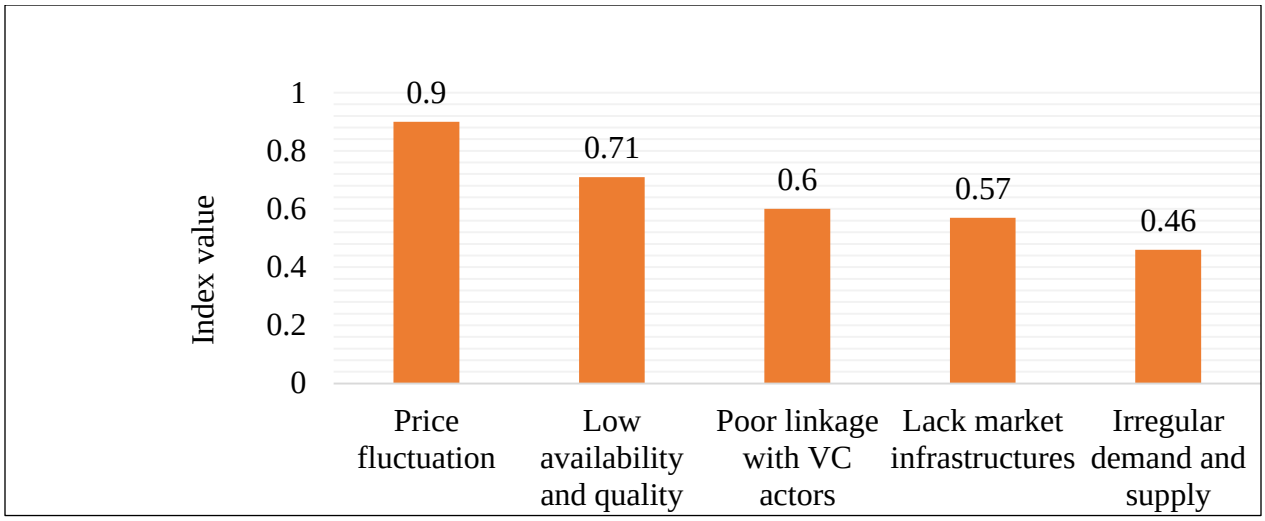

Figure 6. Constraints of lentil marketing system (source: traders survey, 2023)

4.13. Export performance of Nepalese lentil

4.13.2. Export and import growth trend of lentil from Nepal

The compound annual growth rates (CAGR) for export and import of lentil in Nepal in terms of quantity and value during the period 1990-2004, 2005-2019 and 1990-2019 (Table 16). Result showed that there is negative growth in export value, export quantity in pre-WTO and post-WTO period respectively. Further, the growth rate of 40.31 and 42.24 per cent per annum has been noticed in import value and quantity during the overall period. In 30 years, the export quantity is found negative growth with 0.43 percent whereas; export value found with the growth of 1.44 percent positively. During post-WTO period, the export value of lentil found with positive growth of 3.12 percent from negative of 0.46 percent during the pre-WTO period in Nepal. Also, the percent growth in import value and quantity of lentil in Nepal during post-WTO period found 9.32 and 10.72 which was 62.50 and 66.79 percent respectively in pre-WTO period. The export performance of lentil in terms of quantity and value was found somehow better in post-WTO period. The result revealed that the export growth of lentil from Nepal during 30 years (1990 to 2019) is very poor and nominal (1.44) whereas; growth in import is very high showing high economic risks and deficit situation in the country. During the period 1991-2013, Kumar et al., (2016) reported CAGR of 2.1 and 2.6 in export quantity and export value and CAGR of 60.9 and 53.9 in import quantity and import value of lentil in Nepal respectively.

Table 16. CAGR (in %) of export and import of Lentil, Nepal (1990-2019)

Variables	Period I (1990-2004)	Period II (2005-2019)	Overall (1990-2019)
% Change in Export Value	-0.46	3.12	1.44
% Change in Export Quantity	1.18	-1.72	-0.43
% Change in Import Value	62.50	9.32	40.31
% Change in Import Quantity	66.79	10.72	42.24

*Value in thousands USD and Quantity in metric ton.

Source: FAOSTAT, 2019 and author's computation

4.13.3. Instability in export and import of lentil from Nepal

Details of instability in lentil export and import in terms of quantity and value during overall period (1990 to 2019 A.D.) and sub-periods are presented in Table 17. During the entire period, high instability was found in all variables. Wherever, highest variation was noticed for period I in comparison to period II. Higher variation was observed in export value (92.46) and import quantity (94.85) during the overall period.

During the sub-period analysis, highest instability was noticed in import value (215.82) and import quantity (225.45) during Pre-WTO period (1990 to 2004) which may be due to sudden increment in import of lentil compared with previous years. During post-WTO period higher instability was found in export value (95.58) and export quantity (83.18). Taking consideration to growth trend and instability both, the lentil export in Nepal is showing low growth and high instability indicating moderate to high risks in future trade.

Table 17. Cuddy Della Valle Instability Index (CDVII) of export/import of Lentil during pre and post WTO period in Nepal (1990-2019 A.D.)

Period I	Variables	CV	AdR^2	CDVII	Inference
(1990-2004) Pre-WTO	Export Value	72.63	-0.02047	73.36	High Instability
	Export Quantity	69.49	-0.07604	72.08	High Instability
	Import Value	250.58	0.25824	215.82	High Instability
	Import Quantity	258.59	0.23988	225.45	High Instability
Period II	Variables	CV	AdR^2	CDVII	Inference
(2005-2019)	Export Value	93.45	-0.04612	95.58	High Instability
	Export Quantity	83.09	-0.00220	83.18	High Instability

Post-WTO	Import Value	91.66	0.57766	59.57	High Instability
	Import Quantity	85.06	0.61078	53.07	High Instability
Overall	Variables	CV	AdR^2	CDVII	Inference
period	Export Value	93.45	0.02094	92.46	High Instability
(1990-	Export Quantity	83.09	-0.00325	83.22	High Instability
2019)	Import Value	91.66	0.56035	60.78	High Instability
	Import Quantity	149.91	0.59968	94.85	High Instability

Source: TRADEMAP and author's computation, 2021

4.13.4. Trade Performance of Lentil export from Nepal

Export performance details of lentil in Nepal are presented in Table 18. For the analysis, value for total exports of Nepal and Total exports from the world was taken as total merchandise trade from trade map and FAOSTAT website. From the result, export of Nepalese lentil from 2015 to 2019 enjoys RCA greater than 1 which means Nepal lentil export had a comparative advantage in the world export of total lentil. From the Table 4 it can be depicted that; Nepal enjoys relatively strong competitiveness in export of lentil and it's increasing constantly. In the year 2015 Nepal's RCA index in lentil export was measured 68.31 and in 2019 it jumped to 125.45 which clearly showed the comparative advantage and export strength in lentil export. Further the RSCA value in all years from 2015 to 2019 was found nearby +1 i.e., 0.97 to 0.98, indicating higher competitiveness of Nepal in the export of lentil. Taking in consideration to this, Nepal can be benefited from the export of lentil in world's market with higher comparative advantage.

Table 18. Export performance and comparative advantage for Nepalese lentil (2015-2019)

Indicators	2019	2018	2017	2016	2015
Export performance ratio (EPR)	21.16	36.41	24.54	34.47	19.85
Revealed Comparative Advantage (RCA)	125.45	165.37	88.57	118.75	68.31
Revealed Symmetric Comparative Advantage (RSCA)	0.984	0.987	0.977	0.983	0.971

Source: TRADEMAP and author's computation, 2021

4.13.5. Trade specialization index for lentil from Nepal

While assessing the export competitiveness of lentil commodity from Nepal in-between the period 1990 to 2019, the TSI value ranges from 1.0 in 1990 to -0.23 in 2019 (Table 19). This result showed that the export performance of lentil from Nepal was highly competitive and lying in the export

growth stage. From 1990 to 2019, Nepali lentil observed losing the competitiveness strength and lying in the import substitution stage from export growth stage. The export performance was strong enough till 2014 and thereafter loosing continuously. The TSI value in the range of negative value (TSI<0), Nepal is experiencing dependency on imports of the lentil commodity. Trade specialization index value suggest that even though the country's performance fluctuated over the years, it remains in the stage of import substitution declining from growth stage and have witnessed positive direction to revive and regain the lentil export performance from Nepal.

Table 19. Export performance competitiveness of lentil commodity by Trade Specialization Index

Year	TSI	Decision criteria	Competitiveness
1990	1.00	Export growth stage	Strongly competitiveness
1991	1.00	Export growth stage	Strongly competitiveness
1992	1.00	Export growth stage	Strongly competitiveness
1993	1.00	Export growth stage	Strongly competitiveness
1994	1.00	Export growth stage	Strongly competitiveness
1995	1.00	Export growth stage	Strongly competitiveness
1996	1.00	Export growth stage	Strongly competitiveness
1997	1.00	Export growth stage	Strongly competitiveness
1998	1.00	Export growth stage	Strongly competitiveness
1999	0.95	Export growth stage	Strongly competitiveness
2000	1.00	Export growth stage	Strongly competitiveness
2001	0.99	Export growth stage	Strongly competitiveness
2002	0.97	Export growth stage	Strongly competitiveness
2003	0.67	Export growth stage	Strongly competitiveness
2004	0.74	Export growth stage	Strongly competitiveness
2005	0.20	Export growth stage	Strongly competitiveness
2006	0.11	Export growth stage	Strongly competitiveness
2007	0.93	Export growth stage	Strongly competitiveness
2008	0.98	Export growth stage	Strongly competitiveness
2009	0.70	Export growth stage	Strongly competitiveness
2010	0.88	Export growth stage	Strongly competitiveness
2011	0.79	Export growth stage	Strongly competitiveness

2012	0.86	Export growth stage	Strongly competitiveness
2013	0.09	Export growth stage	Strongly competitiveness
2014	0.11	Export growth stage	Strongly competitiveness
2015	-0.59	Import substitution stage	Weakly competitiveness
2016	-0.25	Import substitution stage	Weakly competitiveness
2017	-0.58	Import substitution stage	Weakly competitiveness
2018	-0.35	Import substitution stage	Weakly competitiveness
2019	-0.23	Import substitution stage	Weakly competitiveness

Data source: FAOSTAT, 2019

4.13.6. Export market concentration and diversification for Nepalese Lentil

The Herfindahl-Hirschman Index in lentil export from Nepal showed on and around 9000 in year 2018 and 2019 indicating a decrease in competition and an increase of market power with high concentration and low competitive (Table 20). The export scenario of lentil in the year from 2015 to 2019 can be said highly concentrated and almost monopoly market. The export seems higher concentrated with Bangladesh and diversified only in 4 to 7 countries. As lentil export is concentrated only in few countries with higher index value, Nepal will certainly face economic risks in short and long run. However, the result showed that in 2009 there was comparatively low market concentration of lentil export (3773.7) and export diversified in 27 countries including Bangladesh, Singapore and other European and African countries. Government should promote and explore new diversified markets for lentil export.

Table 20. Market concentration and degree of diversification of lentil export from Nepal

Year	Herfindahl-Hirschman Index	Inference	Number of importing countries
2019	9273.21	Monopoly	6
2018	9144.71	Monopoly	7
2017	8551.96	Nearly Monopoly	6
2016	7892.31	Highly concentrated	6
2015	6397.76	Highly concentrated	4
2009	3773.70	Concentrated	27

Source: TRADEMAP and author's computation, 2021

4.13.7. SWOT analysis

Although the commodity possesses potential opportunities there exist numbers of weakness and threats. Marketing sector of lentil is of complex nature and suffered from various constraints and threats although lentil itself is a high demanded and exportable commodity. The study conducted a comprehensive analysis of the strengths, weaknesses, opportunities, and threats for the sustainability of the lentil value chain in Nepal. This analysis helps in identifying internal and external factors that impact the competitiveness and resilience of the value chain. The detailed SWOT analysis of lentil value chain is illustrated in Table 21.

Table 21. SWOT analysis of lentil value chain in Nepal

Strengths	**Weakness**
• Years long farming experience, success cultivation practices and traditional knowledge. • Favorable agro-climatic condition. • Accelerated research and availability of improved varieties including disease/drought resistant and biofortified. • High nutritional value and cultural food, locally available diverse genetic resources • Sufficient number of producers and traders • Availability of labor in local conditions, easy access to capital through banks and cooperatives • Well established production pockets, producer groups/cooperatives	• Weak extension and technical advisory services. • Lack of quantity, quality and timely availability of productive inputs • traditional types of production system, low mechanization, low technology transfer and adoption. • Scattered pockets and production governing high cost of aggregation and distribution loss • Poor storage and transportation facilities • Low farm gate price, weak bargaining power of farmer. • Lack expertism with the official.
Opportunities	**Threats**
• Unique and divine taste, good cooking quality and preferred size & color demanding higher in national and international market • Scalability opportunity in terai and hilly regions to produce organic product • Major importing countries in the neighbor, potential for market diversification due to export quality	• Unpredictable weather patterns and crop failure from climate related hazards and diseases (wilting, Stemphylium blight, root rot etc.) • Informal pricing mechanism, high price fluctuation and lacks minimum support price • Lacks quality standard, poor quality control and market regulation

• One of the worlds largest producers, with prioritized exportable commodity of the country • Exist large space for value adding and product diversification opportunities • Ready markets and substantial installed mills and industries with large capacity • Established international road connectivity and dry ports facilities	• Lack risk coverage strategies and weak implementation of insurance policy favoring shifting of business. • Increasing import trend and increased preferences and willingness of Nepali consumer for international lentil • Delayed payments mechanism and international financial issues hindering trade

Sources: Household survey (2022), Trader's survey (2023), FGDs, and KII

5. Summary, Discussions and Implications

5.1. Summary and Conclusion

The study was carried out to analyze the lentil economics and efficiency in production, market performance and value chain assessment, trade, export performance, competitiveness assessment and determinants with strength, weakness, opportunities and threats in Nepal. Sample size for production level household survey was determined by using Cochran formula. Simple random sampling, snowball sampling and purposive sampling methods were used for the data collection from lentil producers and traders. Descriptive analysis and different econometric models were used to draw the results based upon objectives.

The thirty years data on export and import of lentil from Nepal shows increasing trend of import with high fluctuation. There is negative growth in export value, export quantity in pre-WTO and post-WTO period respectively which revealed that the export growth of lentil from Nepal during 30 years is very poor and nominal whereas; growth in import is very high showing deficit situation in the country. The annual growth rate observed higher in value compared to quantity indicating price competitiveness and increased world demand for Nepalese lentil. Instability indices for export and import in value and quantity were found higher and can be interpreted as higher variability during the study period. Taking consideration to growth trend and instability both, the lentil export in Nepal is showing low growth and high instability indicating moderate to high risks in future trade. The major portion of exports of Nepali lentils is found only limited to few countries and is found largely dependent upon Bangladesh. With concentration analysis, a decrease in competition and an increase of market power with high concentration and low competitive nature was found creating undiversified trade leading to economic risks. Top importers like India, Sri

Lanka and Pakistan could become potential neighbor markets and new destinations apart from Bangladesh and also export volume can be increased.

Nepal by implementing its trade competitiveness strategies, export promotion schemes and diversification in export destinations for lentil can only improve lentils trade.

The study provided the evidence that farmers do not make use of best available technique varies with higher magnitude among sampled lentil farms in the study areas. The mean technical efficiency percentage for the pooled sample is 61.5% with range between 23.0% and to the maximum of 89.9%. Study summarized majority of farmers in lentil are small scale, allocating only about one third of land under lentil farming possessing smaller lentil farm size. Lower yield but higher profit was observed in lentil production due to higher farm gate price and higher market demand but suffered with low adoption of improved seed and lower seed replacement rate, poor crop management practices, no record keeping, poor access of technical information. In total cost, higher cost was shared by labor indicating labor intensive production technology of lentil with low farm mechanization. Most influencing factor for lentil cultivation was because of higher return whereas; climatic related hazards, high incidence of disease and unavailability of improved seed were found major problems.

The lentil market in the study area is characterized by an informal chain, lack of clear market information to disseminate to all actors, low bargaining power, entry barriers (lack of capital and unavailability of lentil) and high price differentials between producers and consumers, which make the lentil market imperfect. Therefore, responsible government bodies and stakeholders are expected to intervene to improve the challenges by disseminating current lentil market information, providing improved market linkages and credit services, linking producers to the market with formal linkages and providing market information timely.

The study concluded that along the lentil supply chain, the majority of the product flows from producer-local collector-processors-wholesalers-retailers-consumers channel and were the major actors in the chain. Active participation and service motive of these market actors can increase the competitiveness in lentil sub-sector of Nepal. Similarly, Nepalese traders are facing diverse constraints in trade of lentil from Nepal and among them price fluctuation and unavailability of lentil are the major.

5.2. Discussions

This section briefly describes the results and link findings with available literatures to make it easily understandable. Study has covered most important aspects of lentil value chain and trade performance including socio-economic characteristics, production profitability and efficiency status, lentil value chain structure, performance and efficiency and trade performance.

5.2.1. Productivity, profitability and efficiency of lentil production

Lentil productivity is found low, but farmers do not hesitate to agree that lentil cultivation is more profitable than other cereal crops. The reason is that the cost of inputs is low and farm gate prices are appreciable. The average productivity of lentil in the study area was 672.6 Kg./ha. Similar to this result, Gautam et al. (2022) reported 885.5 Kg per hectare yield of lentils among local seed users in Nepal and mentioned that Nepalese lentil production is stagnated after 2016 due to various factors including biotic and abiotic stresses, low investment, lacking improved technology and use of older varieties. Focus group discussion concluded that lentil yield this year was low due to unfavorable climate and incidence of disease.

The average total cost (average variable cost) was NRs. 36261.3 per hectare and among the variable cost components, the higher cost was shared by labor (40.3%) followed by land preparation (18.5%). Although pod formation stage followed by flowering is a critical stage for moisture stress, very few lentil farms were using irrigation which shares only 1.2% in total cost. Similar to this result, Paudel (2020) reported about 1.5% (510 NRs./ha.) share of cost on irrigation within total cost of lentil production in Nepal. Study further resulted that the lentil farmers were earning average gross revenue of NRs. 61350.01 per hectare. An average of NRs. 25096.70, constituting around 41% of gross return was earned as profit per hectare. Also, farmers were getting NRs. 22.55 net profit on average per kg sold lentil with an average benefit cost ratio 1.78 and profitability index 0.78. This figure indicates that the lentil producing enterprise is a profitable business, which resembles with the findings of Gautam et al., (2022) reported as 28 to 36% cost shared by labor and benefit cost ratio of 1.91, 2.23 and 2.14 for lentil seed producer, improved seed user and grain producer respectively in Nepal. Also, CRS (2018) reported 1.7 benefit cost ratio in lentil production in Nepal. Similarly, study conducted by Kumar et al. (2016) found that total cost of lentil cultivation for contract farmer as NRs.54,333 with profit of NRs.48,128 per hectare and for non-contract farmer, total cost of lentil cultivation was found as NRs. 52,231 per hectare with total profit of NRs. 23,482 per hectare. Also, the result is in line with the study of

Thapa Magar et al. (2014) in which benefit cost ratio of lentil cultivation was found as 1.16 as sole crop, 1.15 as mixed crop and 1.26 as relay crop.

Estimated results from Cobb-Douglas production function explained that, increase in labor cost, land preparation, seed, nutrient management, plant protection cum irrigation, harvesting and post-harvest by 100% would cause an increase in gross return from lentil business significantly by 19%, 15%, 41%, 2.1%, 2.2% and 8% respectively. Summing the coefficients of the independent variables yields a scale elasticity of 0.85 indicating that lentil production function exhibits decreasing returns to scale <1. From the very past land degradation and decreasing soil fertility over time due to improper nutrient management and extensive cultivation with less adoption of efficient technology might have caused decreasing return to scale in production. Similar to this result, Gautam et al., (2022) resulted decreasing return to scale in lentil production in Nepal.

Allocative efficiency analysis of the productive inputs resulted that the expenses on land preparation, seed, nutrient management, plant protection cum irrigation have an allocative efficiency coefficient (r) of 1.38, 5.21, 1.49, and 46.89 respectively, meaning underutilization of these resources and with the increment in utilization of these resources would result in an efficient allocation that may optimizes profit in lentil. Also, lower yield was observed in the study area compared to national average. Mbanasor and Kalu (2008) reported that lower level of productivity is achieved with inefficient resource allocation and use. Under use of this productive inputs by lentil farms might be due to timely unavailability, low purchasing power, poor technical know-how and lack farm managerial skills with regards to the best agronomic practices and farm management. Further, the expenses on labor and harvest as well as post-harvest activities were overutilized with efficiency coefficients 0.77 and 0.81 respectively indicating that deduction in their expenses will optimize profit in lentils. Lacking mechanization and a labor-based farming system might have cause overutilization of these resources.

5.2.2. Influencing factors and production related problems in lentil

Based on farmers perception and rank, higher return from lentil cultivation was found most important influencing factors of lentil farming with index value 0.84 followed by high market demand (0.82). Similar to this result, Gautam et al., (2022) reported good return from the lentil cultivation was the most decisive factor with index value 0.784 followed by the high market demand. Similarly, the major problem perceived by lentil farmers related to production is occurrence of climatic hazards (0.93). During focus group discussion, most of the farmers

mentioned that they were heavily suffered from the drought or irregular rainfall during lentil cultivation. Incidence of disease ranked as second most serious problem (0.74) followed by unavailability of improved varieties (0.73). Major disease reported by lentil farmers in the study area was Stemphylium blight, wilting and root rot. Similar to this finding, Dhakal (2021) also reported that disease Stemphylium blight is a most serious which may cause loss up to 100% in lentil. Also, Gautam et al., (2022) mentioned lack of technical knowledge was the major problem in lentil production in Nepal.

5.2.3. Lentil value chain development, mapping and governance

Gibbon (2001) described a value chain as a bond of activities where products pass through all process of the chain and at each process, the product gains some value. The survey results in this study revealed six major actors/market players in the current lentil value chain in Nepal namely input suppliers, producers, collectors, processers, distributors (wholesalers and retailers) and consumers. Lentil value chain in Nepal involves multiple actors, all performing various activities at different scales of operation. Study revealed that the majority of actors involved in the lentil value-chain are small and informal, with limited resources, lacks credit and technical business skills leading to market distortion. Similar to this result, USAID (2011) mentioned that the Nepalese lentil value chain is explained by a largely informal type of market system.

Survey result from traders showed that about 52% of traders create informal linkage with their lentil suppliers by giving short term credit. Result also indicated that 82.8% sample households accepted the price determined by the buyers whereas; only 17.2% have chance to bargain and take a negotiating price. This implies that the lentil farmers had limited bargaining power, weak market information and weak integration and buyer-driven chain. Buyer-driven chains are common in labor-intensive, consumer goods industries where large retailers and trading companies play a central role in creating production networks usually in developing nations (Zamora, 2016). Proper value chain assist in developing local micro and small enterprises and help in overcoming constraints of poor market access and low bargaining power (ILO, 2011). Therefore, a holistic treatment is needed that satisfies all stakeholders through a high level of operational performance, which provides economic prosperity, environmental protection, and social integrity (Asif et al., 2011) through sustainable value chain development.

The lentil value chain in Nepal is characterized by an immature and informal market system due to an absence of mutual trust among the key players of the chain. Lentil traders have diffused and

need-based interlinkages across the country. Lentil producers work as individuals rather than as a large commodity group which restricts their bargaining capacity when dealing with collectors. Large collectors and processors dominate the value chain by holding large share of lentils and influencing role in price setting to a rate that suits them. Actors' make entry or participate in the chain for profit motive only, lacks services and information sharing mechanism. Similar to these findings, Neupane et al., (2013) mentioned improvements in value chains and marketing play crucial roles in enhancing farm level profitability and commercial farming of lentil in Nepal where product flow is without adequate value addition, high quality branding and after sale services. Also, USAID, (2011) reported a large number of market actors are involved in the lentil value chain in Nepal, playing different roles.

5.2.4. Barriers to entry in the lentil trade business and trade constraints

The study resulted that among the sampled traders 54.83% of the traders responded faced barriers to entry in the lentil business. Among the various barriers asked for responses, product unavailability and capital shortage were the major factors followed by licensing and other legal procedures facilitating as a barrier to entry. Based on index value among various marketing related challenges, price fluctuation with index value 0.9 was listed as the major trade related challenge. Similar to this result, Gautam et al., (2023) also mentioned price fluctuation as a major problem with index value 0.783 mainly as a result of scientific pricing mechanism. Likewise, quality and volume of lentil availability (0.71) and poor linkages with value chain actors (0.60) were also the challenges in lentil marketing system.

5.2.5. Export-import growth, instability and trade performance of lentil from Nepal

The compound annual growth rates (CAGR) analysis result showed growth rate of 40.31 and 42.24 per cent per annum in import value and quantity during the 30 years period, whereas; the export quantity is found negative growth with 0.43 percent and export value with the growth of 1.44 percent positively. Similar to this result Subedi et al., (2021) reported that the import value has been growing at the rate of 22.7% annually whereas the export value has decreased with 17% per annum. During post-WTO period, the export value of lentil found with positive growth of 3.12 percent from negative of 0.46 percent during the pre-WTO period in Nepal. Similar to this result, During the period 1991-2013, Kumar et al., (2016) reported CAGR of 2.1 and 2.6 in export quantity and export value and CAGR of 60.9 and 53.9 in import quantity and import value of lentil in Nepal respectively. Likewise, higher variation was observed in export value (92.46) and import quantity (94.85) during the overall period. Similarly to this result, Rimal & Gurung (2016) reported

that the instability indices indicate that there has been substantial fluctuation in the export and import of pulses in Nepal. USAID (2011) in the study about value chain/ market analysis of the lentil subsector in Nepal also reported that, the lentil exports have significantly fluctuated in volume and value over the last ten years, mainly due to lack of production and export diversification. Also, Deve et al. (2007) also mentioned that, Nepal's lentil export performance is thus somewhat irregular and suffers instability. Lentil export value has decreased with 17% per annum (Subedi et al., 2021).

Export of Nepalese lentil from 2015 to 2019 enjoys RCA value greater than 1 which means Nepal lentil export had a comparative advantage in the world export of total lentil. Further the RSCA value was found nearby +1 i.e., 0.97 to 0.98, indicating higher competitiveness of Nepal in the export of lentil. Similar to this finding, the Nepal Trade and Competitiveness Study pinpointed lentil as a top most product as the "areas of opportunity" (MoICS, 2004). Salike & Lu (2012) resulted that, in accordance with Nepal's priority strategy in the agricultural sector lentils have the highest RCA indices as; 755.9, 624.2 and 319.8 in 2009, 2010 and 2011 respectively.

While assessing the export competitiveness of lentil commodity from Nepal in-between the period 1988 to 2019, the TSI value ranges from 1.0 in 1990 to -0.23 in 2019. From 1990 to 2019, Nepali lentil observed losing the competitiveness strength and lying in the import substitution stage from export growth stage. The export performance was strong enough till 2014 and thereafter loosing continuously. Similar to this result, Subedi et al., (2021) reported TSI value 0.13 which suggests lentil is in the stage of growth.

5.3. Research and Practical Implications

Yield enhancement will be the leverage point of lentil value chain in Nepal as farmer's are forced to harvest lower yield due to inefficient farm management. Study suggests integrated crop management practices including use of improved seed, weeding practice and farm machineries by the producers. Study further resulted price fluctuation and low availability and quality of lentil as the major marketing constraints as opinioned by lentil traders. Maintaining of formal and strong relationship between the market actors and increasing the production area and yield of lentil is vital to sustain the lentil business. Strengthening the business skills of traders, facilitating pricing and market functionaries, linking with producers and providing subsidized credit with technical support will strengthen the current supply chain and support pulling effect "market pull" that

ultimately boost production process. Production pockets level or district level multi-stakeholder platform will assist adequate linkages between the actors. Practical implications of this study are;

- Initiation of yield enhancement programs on lentil especially by introducing high yielding varieties, climate change adaptation technology, farm mechanization and judicious use of input resources.
- Implementing minimum support price and insurance scheme by government to further ensure stability and higher growth in future.
- Formulation of Lentil export promotion strategy and export subsidy scheme as incentives should be provided.
- Maintaining formal linkages between producer, traders and business enablers through multi-stakeholder platform.

Outcomes of the study based on objectives

the study provides a holistic view of the lentil value chain dynamics and trade performance in Nepal. This integrated approach allows for a comprehensive understanding of the challenges, opportunities, and potential strategies for enhancing the competitiveness and sustainability of the lentil sector.

Objectives	**Outcomes**
Objective 1: Export Growth Trends and competitiveness	• The analysis of export growth trends revealed the historical performance of Nepalese lentil exports, highlighting periods of growth, instability, and competitiveness in the market. • This objective provided a foundation for understanding the overall trajectory of lentil exports and assessing the market dynamics over time.
Objective 2: Productivity, Profitability and efficiency	• The estimation of productivity, profitability, and efficiency of lentil production in the study area offered insights into the economic viability of lentil farming practices of Nepal. • Understanding the productivity and profitability levels is essential for identifying areas of improvement and optimizing farm management practices to enhance overall performance.
Objective 3: Lentil Value	• The evaluation of the performance and efficiency of the lentil market along the value chain provided a comprehensive view of the market structure, governance, and profit-sharing mechanisms.

Chain Performance	• Assessing the value chain performance helps in identifying bottlenecks, optimizing processes, and enhancing collaboration among market actors to improve overall market efficiency.
Objective 4: SWOT Analysis	• The SWOT analysis conducted for the sustainability of the lentil value chain identified key strengths, weaknesses, opportunities, and threats impacting the sector. • Linking the SWOT analysis results with other objectives helps in understanding how internal and external factors influence export growth, productivity, and market performance in the lentil sector.

5.4. Critiques of the study

The availability and validity of the available data were the key factors assessing the results and interpretations of this research. Further, the study was more confined in only four terai districts and was unable to cover other districts including mid-hill which were also potential for lentil cultivation in Nepal. Also, the lentil seed system and climate change aspects were not covered in this research. The sample size for lentil business traders were made limited due to their availability, accessibility, time and budget constraints. The detailed analysis on consumer behavior and preferences were limited for this study. As only 473 lentil producers and 155 traders from 12 representative major markets were captured, this study was not able to capture the whole national production and marketing sites.

REFERENCES

AAC. (2010). Market outlook report-lentils: situation and outlook. Market analysis group, Agriculture and Agri-food Canada. Vol. 2(2).

Acharya, K. R. (2019). Nepalese Foreign Trade: Growth, Composition, and Direction. NCC Journal, 91-96.

Adams, J., & Adhikari, S. (2005). "Nepal's Economy and International Trade" in Maskay, Bishwa and John Adams (eds.), Developing Nepal's Trade Advantage in Competitive Markets. Kathmandu: Centre for Development & Governance.

ADB. (2017). Country Poverty Analysis, Nepal. In Asian Development Bank. https://doi.org/https://www.adb.org/sites/default/files/linked-documents/cps-nep-2013-2017-pa-detailed.pdf.

Adhikari, B. N., Shrestha, J., Joshi, B. P., & Bhatta, N. R. (2018). Agronomic traits evaluation and correlation study in lentil (Lens culinaris Medikus) genotypes. International Journal of Advanced Research in Biological Sciences, 5(12):1-10, DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.12.001.

Adnan, N., Ahmad, M. H., & Adnan, R. (2006). A comparative study on some methods for handling multicollinearity problems. Mathematika, 22: 109-119. https://doi.org/10.11113/matematika.v22.n.179.

ADS. (2015). Agriculture Development Strategy (ADS 2015-2035). In Agriculture Development Strategy (ADS). (pp. 22–38). MoALD. Ministry of Agriculture and Livestock development.

AITC. (2020). Krishi Diary. Department of Agriculture, Agriculture Information and Training Centre, Government of Nepal.

Ajibefun, I. A., Battese, G. E. & Daramola, A. G. (2002). Determinants of Technical Efficiency in Small Holder Crops Farming: Application of Stochastic Frontier Production Function. Quarterly Journal of International Agriculture41(3): 225 -240.

Allee, V. (2008). Value network analysis and value conversion of tangible and intangible assets. Journal of Intellectual Capital 9 (1): 5–24.

ANSAB. (2011). Value Chain / Market Analysis of the Lentil Sub-Sector in. In USAID (Issue August).

Bajracharya, M., & Sapkota, M. (2017). Technical efficiency of certified maize seed in Palpa district, Nepal: A stochastic frontier production approach. Journal of Maize Research and Development, 3(1), 45-52. DOI: http://dx.doi.org/10.3126/jmrd.v3i1.18920.

Baksh, M. E. (2003). Economic Efficiency and Sustainability of Wheat Production in Wheat Based Cropping Systems in North-West Bangladesh. Ph.D. Thesis, 2003. Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Balassa, B. (1965). Trade liberalization and revealed comparative advantage. Manchester School of Economics and Social Studies, 33(2): 99-124.

Barney, J. B. & Hesterly, W. S. (2011). VRIO framework in 'Strategic management and competitive advantage', 4th edn. Pearson Education: New Jersey, USA. pp. 68–86.

Battese, G. E. & Coelli, T. J. (1995). "A Model for Technical Inefficiency Effects in Stochastic Frontier Production for Panel Data." Empirical Economics, 20: 325 – 345.

Battese, G. E. (1992). Frontier production functions and technical efficiency: a survey of empirical applications in agricultural economics. Agricultural economics, 7(3): 185- 208.

CBS. (2021). Statistical year book. National Planning Commission, Central Bureau of Statistics, Kathmandu, Nepal.

Cochran, W. G. (1963). Sampling Techniques, 2nd Ed., New York, 1963: John Wiley and Sons, Inc.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J., & Battes, G.E. (2005). An introduction to efficiency and productivity analysis. In Biometrics (Vol. 41). https://doi.org/10.2307/2531310.

Collins, R. (2009). alue chain management and postharvest handling: partners in competitiveness. In Postharvest Handling: A Systems Approach, edited by W. J. Florkowski, R. L. Shewfelt, B. Brueckner and S. E. Prussia: Elsevier.

CRS. (2018). Inclusive Value Chain Study for Lentil Sub-sector in Nepal. Study report in collaboration with Agriculture and Forestry University. Catholic Relief Services.

Cuddy, J.D.A., & Della Valle, P.A. (1978). Measuring the Instability of Time Series Data, Oxford Bulletin of Economics and Statistics. Vol.40, No.10, Oxford OX1 3UQ, 1978, pp,79-84.

Darai, R., Sarker, A., Agrawal, S. K., Poudel, P., Aryal, L., Dhakal, K. H., Neupane, R. K., & Pokhrel, A. (2020). Lentil improvement in Nepal. In: 7th International Food Legumes Research Conference at Grain Legumes Research Program, Khajura.

Darai, R., Sarker, A., Sah, R. P., Pokhrel, K., & Chaudhary R. (2017). AMMI biplot analysis for genotype × environment interaction on yield trait of high Fe content lentil genotypes in terai and mid-hill environment of Nepal. Ann Agric. Crop Sci., 2(1),1026.

Deve, F., Munankami, R., & Bijl, B. (2007). THE LENTILS SECTOR IN NEPAL Export performance and potential. Project Report. Project NEP/A1/01A A project financed by the EU and ITC under the Asia Trust Fund

Dhakal, A. (2021). Present Status of Grain Legumes Production in Nepal. Food & Agribusiness Management, 2(1): 06-09. DOI: http://doi.org/10.26480/fabm.01.2021.06.09.

Dhakre, D. S. (2015). National trends on agricultural crop (tea) production and export, A statistical analysis. International Journal of Biological Research, Environmental, Agriculture Science. 1(1):39-44.

Emmanuel, B. O. & Maureen, N. T. (2021). Investigating heteroscedastic disturbances in some transformed economic models while eliminating multicollinearity. International Journal of Statistics and Applied Mathematics; 6(5): 01-07.

Erskine, W., Muehlbauer, J.f., Sarkar, A., Sharma, B. (2009). The Lentil: Botany, Production and Uses. In B. Erskine, W., Muehlbauer, J.f., Sarkar, A., Sharma (Ed.), The lentil: Botany, Production and Uses (pp. 1–4). CABI International.

FAOSTAT. (2019). Agricultural data on primary crops; 2019. Retrieved on February, 2024. http://www.fao.org/faostat/en/#data/QCL.

FAOSTAT. (2021). Food and Agricultural Organization (FAO). Food and Agricultural Organization. Retrieved fromhttp://www.fao.org.

Farrell, M. J. (1957). The Measurement of Productive Efficiency, Journal of the Royal Statistical Society, Series A. 120: 253-290.

Gautam D., Dhakal S. C., Kattel R. R., & Khanal, N. P. (2022). Nepalese lentil: possible forthcoming transition from the top exportable to the most importable legume. RJOAS, 2022; 5(125):122-137, DOI: 10.18551/rjoas.2022-05.14.

Gautam, D., Dhakal S. C., Kattel R. R., & Khanal, N. K. (2023). Strengthening the competitiveness of the lentil seed system of Nepal: A value chain approach. J. Agribus. Rural Dev., 1, (67), 63–77. http://dx.doi.org/10.17306/J.JARD.2023.01640.

Gautam, D., Dhakal, S.C., Kattel, R.R. & Khanal, N.P. (2022). Resource Use Efficiency (RUE) in Lentil Production in Terai and Inner Terai Regions of Nepal. Journal of Nepal Agricultural Research Council, (8): 72-87, DOI: https://doi.org/10.3126/jnarc.v8i.44865.

Gharti, D. B., Darai, R., Subedi, S., Sarker, A., & Kumar, S. (2014). Grain Legumes in Nepal: Present Scenario and Future Prospects. World Journal of Agriculture and Research. doi: 10.12691/wjar-2-5-3.

(https://www.researchgate.net/publication/285815919_Grain_Legumes_in_Nepal_Present_Scenario_and_Future_Prospects).

Ghimire, B., Dhakal S. C., Marahatta S., & Bastakoti R. C. (2022). Lentil production in Nepal: analysis of trends, instability and decomposition (1989-2019). Research Journal of Agriculture and Forestry Sciences; 10(4), 27-34, Available online at: www.isca.in, www.isca.me.

Ghimire, B., Dhakal S.C., Marahatta S. & Bastakoti, R.C. (2022). Lentil production in Nepal: analysis of trends, instability and decomposition (1989-2019). Research Journal of Agriculture and Forestry Sciences, 10(4), 27-34, Available online at: www.isca.in, www.isca.me.

Ghimire, B., Dhakal S.C., Sharma S. & Poudel S. (2018). Factors affecting adoption of sustainable soilmanagement practices among vegetable producers inDhading, Nepal. African Journal of Agricultural Research, 13(44):2510-2515, DOI: 10.5897/AJAR2015.10243

Ghimire, B., Dhakal, S. C., & Sharma S. (2016). Prospects of Adopting Eco-Friendly Measures of Soil Sustainability among Vegetable Producers in Dhading, Nepal. Universal Journal of Environmental Research and Technology; 6(4): 195-202.

GLRP. (2017). Annual Report 2006/07, National Grain legumes Research Program, Nepal Agriculture Research Council, Nepal.

Gujarati, D.N. (2004). Basic Econometrics. 4th Edition, New York; McGraw-Hill Companies.

Herr, M. L. (2007). An operational Guide to Local Value Chain Development (Issue February). International Labor Organization (ILO).

Hirsch, S. & Lev, B. (1971). "Sales Stabilization through Export Diversification." Review of Economics and Statistics, 53(3), pp. 270-277.

Humphrey, J. & Schmitz, H. (2002). How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters? Regional Studies, 36: 1017-1027.

IFAD. (2017). Improved Seeds for Farmers' Programme (Kisankalagi Unnat Biubijan Karyakaram). Review of seed component activities, Main report and Appendices, KUBK-ISFP, 23 November–31 December, 2015, Nepal.

ILO. (2015). A rough guide to value chain development: a short guide for development practitioners, government and private sector initiatives / Nadja Nutz and Merten Sievers; International Labour Office. - Geneva: ILO, 2015. ISBN: 9789221296560; 97 89221296577 (web, pdf)

IMF. (2006). World Economic Outlook 2007. Washington, D.C: World Bank.

ITC. (2012). WTO; Trade policy review: Nepal.

ITC. (2017). Export potential assessment in Nepal: Implemented by the International Trade Centre (ITC). Market Analysis Section In collaboration with the Trade and Export Promotion Centre (TEPC) of Nepal,

Joshi, P. K., & Rao, P. P. (2016). Global and regional pulse economies: Current trends and outlook. (IssueJuly).

Kaplinsky, R. & Morris, M. (2001). A Handbook for Value Chain Research. Report prepared for IDRC (Issue January 2001). Internation Development Research Center (IDRC).

Kaplinsky, R., & Morris, M. (2000). A Handbook for Value Chain Research. Vol. 113. Brighton: University of Sussex, Institute of Development Studies.

Kondal, A. M. (2018). The Determinants of the Export Competitiveness of the Coffee Industry in Ethiopia". Unpublished thesis. Department Of Marketing, School of Commerce, Addis Ababa University.

Krishan, B. & Chanchal, A. (2014). Agricultural Growth and Instability in Western Himalayan Region: An Analysis of Himachal Pradesh, India. Journal of Agriculture and Life Sciences. Vol. 1 (1). 21-27.

Kumar, A., Roy, D., Joshi, P.K., Tripathi, G. & Adhikari, R. P. (2016). Impact of contract farming on profits and yield of smallholder farms in Nepal: An evidence from lentil cultivation. 2016 Agricultural & Applied Economics Association Annual Meeting. http://ebrary.ifpri.org/cdm/singleitem/collection/p15738coll5/id/5447%5Cnhttp://purl.umn.edu/235848

Kumar, A., Roy, D., Tripathi, G., Joshi, P. K., & Adhikari, R. P. (2016). Impact of Contract Farming on Profits and Yield of Smallholder Farms in Nepal: An Evidence from Lentil Cultivation. Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2.

Mijindadi, N.B. (1980). Production Efficiency on Farms in Northern Nigeria. Ph.D Thesis, Unpublished. Cornell University, USA.

MoAD. (2018). Statistical Information on Nepalese Agriculture 2018/19. Ministry of Agriculture Development, Nepal.

MoALD. (2021). Statistical Information on Nepalese Agriculture 2020/21. Ministry of Agriculture and Livestock Development, Nepal.

MoCS. (2010). Trade Policy 2009. Ministry of Commerce and Supplies.

MoF. (2018). Economic Survey 2017/18, Ministry of Finance, Government of Nepal, Kathmandu, Nepal.

MoICS. (2004). Ministry of Industry, Commerce and Supplies. Nepal: Trade and Competitiveness Study. Kathmandu.

NPC. (2019). Multidimensional Poverty Index 2021, Analysis towards action. Report. National Planning Commission, Nepal. Available at: https://npc.gov.np/images/category/MPI_Report_2021_for_web.pdf.

NTIS. (2010). Nepal Trade Integration Strategy 2010 - Background Report. Ministry of Commerce and Supplies, Kathmandu. http://www.mocs.gov.np/uploads/NTIS per cent202010 percent20Background per cent20Report_052411.pdf.pdf

NTIS. (2016). Nepal Trade Integration Strategy 2016. Background Report. Ministry of Commerce and Supplies, Kathmandu.

Ogundari K., Ojo S.O., Ajibefun I.A. (2006). Economics of scale and cost efficiency in small scale maize. Agric. Econ. – Czech, 55, 2009 (3): 139–148 production. Empirical evidence from Nigeria. Journal of Social Sciences, 13 (2): 131–136.

Olukosi, J.O., Isitor, S.U., & Ode, M.O. (2006). Introduction to agricultural marketing and prices: principle and application. Living Book Series, GU publications Abuja, 115p.

Pande, S., Bourai, V.A., Neupane, R.K. & Joshi, P.K. (2003). Chickpea Production Constraints and Promotion of integrated Pest Management in Nepal. On –farm IPM of Chickpea in Nepal-1. Information bulletin no. 64. Patancheru, 502 324, Andhra Pradesh, India. International Crops Research Institutes for the Semi-Arid Tropics (ICRISTAT), Department for International Development (DFID). pp 4-8. ISBN 92- 9066-462-2.

Paudel, G. P., Devkota, M., Keil, A. & McDonald, A. J. (2020). Climate and landscape mediate patterns of low lentil productivity in Nepal. Plos one 15(4): e0231377.DOI:https://doi.org/10.1371/journal.pone.0231377.

Paudel, M. N. (2016). Multiple Cropping for Raising Productivity and Farm Income of Small Farmers. Journal of Nepal Agricultural Research Council, 2(December), 37–45. https://doi.org/10.3126/jnarc.v2i0.16120.

Porter, M.E. (1985). The Competitive Advantage: Creating and Sustaining Superior Performance; The Free Press: New York, NY, USA, 1985.

Potnuru, S. K., Kulkarni, V. S., Sajjan, S. S., & Israel, K. S. (2018). Growth performance of area, production and productivity of ginger in India. An economic analysis, Journal of Pharmacognosy and Phytochemistry, Vol.3, No.2, Rohni, New Dehli, pp.198-200.

Prajneshu, (2008). Fitting of Cobb-Douglas production functions: Revisited. Agricultural Economics Research Review. 21: 289-292.

Rahman, S.A. & Lawal A.B. (2003). Economic analysis of maize based cropping systems in Giwi local Government area of Kaduna state, Nigeria. An international J. of Agric. Sci. Env. and Tech. 3(2): 139-148.

Rimal, N. S., & Gurung, B. (2016). Growth and Dynamics of Pulses Production in Nepal: 1980-2014. International Conference on Mountains in the Changing World, At Kathmandu, Nepal,August,3,2018.https://www.researchgate.net/publication/318959777_Growth_and_Dynamics_of_Pulse_Production_in_Nepal_1980-2014.

Rimal, N.S., & Gurung, B. (2017). Growth and dynamics of pulses production in Nepal: 1980-2014. Agriculture and Food Security Project, Kathmandu, Nepal.

Salike, N., & Lu, B. (2012). An Examination of Nepal's Export Choice based on Revealed Comparative Advantage. NRB economic review. Pp: 75-89.

Sapkota, M. & Joshi, N.P. (2021). Factors Associated with the Technical Efficiency of Maize Seed Production in the Mid-Hills of Nepal: Empirical Analysis. International Journal of Agronomy Volume 2021, Article ID 5542024: 1-8. https://doi.org/10.1155/2021/5542024

Sehgal, A., Sita, K., Rehman, A., Farooq, M., Kumar, S., Yadav, R. & Siddique, K.H. (2021). Lentil. In Crop Physiology Case Histories for Major Crops. Academic Press; pp. 408-428. DOI: https://doi.org/10.1016/B978-0-12- 819194-1.00013-X.

Sharma, R., Kumar, A., & Joshi, P.K. (2017). Nepal-India Agriculture Trade: Trends, Issues and Prospects. Agriculture Economics Research Review, Vol. 30(2). pp. 245-263.

Shepherd, G.S. (1965). Farm produce Economic Analysis. Iowa, USA: Lawa University press, 254.

Sihmar, R. (2014). Growth and Instability in Agricultural Production in Haryana: A District level Analysis. International Journal of Scientific and Research Publications, 4(7): 1-12.

Subedi, S., Ghimire, Y. N., Kharel, M., Adhikari, S.P., Shrestha, J., & Sapkota, B.K. (2020). Technical efficiency of rice production in terai district of Nepal. Journal of Agriculture and Natural Resources, 3(2), 32-44. DOI: https://doi.org/10.3126/janr.v3i2.32301.

Tadesse, B. & Krishnamoorthy, S. (1997). Technical Efficiency in Paddy Farms of Tamil Nadu. An Analysis based on farm Size and Ecological Zone. Agricult. Econ. 16:185-192.

TEPC. (2018). Trade and Export Promotion Centre: Nepal Foreign Trade Statistics, Kathmandu, Nepal.

Thapa Magar, D.B., Gauchan, D. & Darai, R. (2014). Varietal Adoption and Marketing of Lentilin the Mid and Far Western Terairegion of Nepal. Advances in Plants & Agriculture Research, 1(5), 1–6. https://doi.org/10.15406/apar.2014.01.00026.

Tithi, S.M. & Barmon, B.K. (2018). Comparative Advantages of Lentil (Lens culinaris) and Mustard (Brassica nigra L.) Production and their Profitability in a Selected District of Bangladesh. The Agriculturists, 16(1): 21-33

TRADEMAP. (2019). Trade statistics for international business development. Retrieved on October, 2021. https://www.trademap.org/Index.aspx.

USAID. (2011). Nepal Economic Agriculture, and Trade Activity—value chain/ market analysis of the lentil sub-sector in Nepal. Publication prepared by ANSAB- sub-contractor to NEAT Activity under Prime Contract No. EEM-I-00-07-00008, AID-367-TO-11-00001.

Utkulu, U., & Seymen D. (2003). "Trade and Competitiveness between Turkey and the EU: Time Series Evidence", Europe in Global World-blending differences, OPEN MINDS Conference, University of Lodz, Lodz-Poland, September.

Uzzi, B. (1997). Social Structure and Competition in Inter firm Networks: The Paradox of Embeddedness. Administrative Science Quarterly 42: 35-67.

World Bank. (2018). Systematic Country Diagnostic A new approach for a federal Nepa. In Systematic Country Diagnostic A new approach for a federal Nepal (Issue February). https://doi.org/10.1596/31130.

Khanal, S., Lohani, S. & Khanal, Saurav. (2022). Multicollinearity diagnostics upon Cobb-Douglas production function for estimating resource use efficiency of tomato in Chitwan, Nepal, RJOAS, 6(126): 170-180. DOI 10.18551/rjoas.2022-06.20.

Poudel, G. P., Devkota, M., Keil, A., & Andrew, M. J. (2020). Climate and landscape mediate patterns of low lentil productivity in Nepa. Plos one, 15(4): e0231377. https://doi.org/10.1371/journal. pone.0231377.

Zamora, E. A. (2016). Value Chain Analysis: A Brief Review. Asian Journal of Innovation and Policy, 5(2), 116–128. https://doi.org/10.7545/AJIP.2016.5.2.116.

Asif, M., Searcy, C., Garvare, R., & Ahmad, N. (2011). Including Sustainability in Business Excellence Models. Total Qual. Manag. Bus. Excell. 22: 773–786.

Mbanasor, J. A. & Kalu, K.C. (2008). Economic Efficiency of Commercial Vegetable Production Systems in Akwa Ibom State, Nigeria. A Tran-slog Stochastic Frontier Cost Function Approach, Tropical and subtropical Agro ecosystems, 8: 313-318.