ECOLOGICAL STATUS AND SOCIO ECONOMIC BENEFITS OF *Choerospondias axillaris* AT PHALEWAS, PARBAT DISTRICT, NEPAL

A THESIS

SUBMITTED FOR THE PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE MASTERS DEGREE IN BOTANY

BY

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SYMBOL NO.: 551/2074

T.U. REGISTRATION NO.: 5-2-0053-0322-2013

SUBMMITED TO

DEPARTMENT OF BOTANY

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DECLARATION

I, "Pratima Acharya", hereby declare that the work enclosed here is entirely my own, except where states otherwise by reference or acknowledgement, and has not been published or submitted elsewhere, in whole or in part, for the requirement for any other degree or professional qualification. Any literature, data or works done by others and cited within this thesis has been given due acknowledgement and are listed in the reference section.

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RECOMMENDATION

This is to recommend that the master's thesis entitled **"Ecological status and socio economic benefits of *Choerospondias axillaris* at Phalewas, Parbat District, Nepal"** is carried out by "Pratima Acharya" under our supervision. The entire work is based on original scientific investigation and has not been submitted for any other degree in any institution. We therefore, recommend this thesis work to be accepted for the partial fulfillment of Master's Degree in Botany.

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ACKNOWLEDGEMENT

My academic dream of studying about *Choerospondias axillaris* in Nepal has come true for master degree thesis entitled ″Ecological status and socio-economic benefits of *Choerospondias axillaris* at Phalewas, Parbat district, Nepal" with the great support of following respected persons.

I would like to express my gratitude to my supervisor Dr. Biva Aryal and co-supervisor Prof. Dr. Kanta Poudyal for their valuable guidance, encouragement and co-operation to bring this work in the present form. I admire for their inspiration, effective guidance, frequent monitoring and support for completion of this thesis successfully.

Similarly, I would like to acknowledge Head of Department of Amrit Campus Associate Prof. Shila Singh and Coordinator of Msc. Botany Department Assistant Prof. Dr. Laxmi Joshi Shrestha for all time support and guidance. I am also thankful to the faculties of Amrit campus, Botany Department Prof. Dr. Mukesh Kumar Chettri, and Assistant Prof. Krishna Prasad Sharma for their valuable guidance, encouragement and co-operation in this work.

I am thankful to Mr. Thaneshwor Bhusal, a local entrepreneur of *C. axillaris* in Parbat district, Phalewas Municipality, Parbat and some of the government offices (Agriculture Knowledge Center, District Forest Office) in Parbat district for their continuous support in carrying out this work.

I am grateful to Mr. Narayan Sharma and Mr. Purushottam Paudel for supporting in field work during data collection and my family for continuous inspiration and support. Also my sincere thank goes to my dear friends (Rashika Kafle, Nisha Gaire, Sunny Maharjan, Sharmila Sharma, and Prerana Khadka) for their valuable suggestions, support and love.

Last but not the least I heartily express my sincere gratitude to all those who directly and indirectly assisted in the completion of this thesis.

Pratima Acharya

May, 2022

ACRONYMS AND ABBREVIATIONS

ANOVA	-	Analysis Of Variance
BA	-	Basal Area
C	-	Coverage
cm	-	Centimeter
CBD	-	Convention on Biological Diversity
D	-	Density
DBH	-	Diameter at Breast Height
DHM	-	Department of Hydrology and Metrology
etc	-	Etcetera
F	-	Frequency
GPS	-	Global Poisoning System
ha	-	Hectare
IVI	-	Importance Value Index
KATH	-	National Herbarium and Plant Laboratory, Godawari
m	-	Meter
MAP	-	Medicinal and Aromatic Plants
MEDEP	-	Micro Enterprise Development Program
mt	-	Metric ton
No.	-	Number
NTFP	-	Non-timber Forest Product
OVOP	-	One Village One Product
p	-	Level of significance
r	-	Correlation Coefficient
RBA	-	Relative Basal Area
RC	-	Relative Coverage
RD	-	Relative Density
RF	-	Relative Frequency
SD	-	Standard Deviation

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ABSTRACT

Choerospondias axillaris (Roxb.) B.L.Burtt & A.W.Hill is one of the important non-timber forest products of Nepal belonging to family anacardiaceae. It is grown in hills of 900 to 2000m above sea level. It is a native tree to Nepal. The main objective of the study was to assess ecological status, vegetation structure and socio-economic benefits of *C. axillaris* in four wards of Phalewas Municipality of Parbat district namely Shankarpokhari, Thapathana, Thanamaula, and Bhangara areas. For ecological study systematic random sampling was applied for vegetation study. Total 72 quadrate were laid. Quadrate of 10 m radii were laid for trees and sub quadrates of 5 m radii were used for sampled of shrubs and sapling of *C. axillaris* and quadrates of 1m radii was sampled in each 10 m radii quadrate for sampling of herbs and seedlings of *C. axillaris*. For socio-economic survey; questionnaire was done with the 61 people from 4 wards including local farmers, local government officials, and small entrepreneurs trading *C. axillaris.* Likewise, secondary data were collected from the concerned authorities. Altogether, seventy two quadrates were sampled from 4 different wards. Ninety plants species belonging to 51 families were recorded along with *C. axillaris* from the study area. The highest density of *C. axillaris* was recorded from Bhangara area and lowest density was recorded from Thanamaula area. Similarly ecological parameters including frequency, density, and IVI were found highest for *C. axillaris* among the associate trees in all study sites. Besides *C. axillaris* major associated tree species were *Schima wallichi* and *Ficus nerifolia.* Similarly the biodiversity indices Shannon-Wiener's index (H) was found in between 2.31- 2.53 and Simpson index of diversity (D) of trees was found in between 0.84-0.91. The regeneration pattern of *C. axillaris* was found very poor in all study sites. DBH and height class showed irregular distribution of *C. axillaris.* Economic status showed people sell *C. axillaris* fruits in raw form while some prepare Achar and Candy to earn money. The trend of the annual production and productive area of *C. axillaris* over period of 10 years (2067/68-2077/78) in Parbat district was slightly decreasing while that of productivity was increasing. *C. axillaris* is most important and dominant plant species in study sites with high socio-economic value from which local people were directly benefited.

Key words; regeneration, species diversity, Phalewas Municipality, associated species

CHAPTER I
INTRODUCTION

1.1 Background of the study

Non-Timber Forest Products (hereafter NTFPs) are also known as minor forest products and have been collected, used and traded by people since time immemorial.). They range from edible and non-edible plant products such as fruits, nuts, seeds, leaves, herbs, medicinal plants, tubers, rattan, bamboo, fibers as well as bush meat and other animal products. However, plant products have been more important and extracted more often than animal products. These products have always been an important life support system (Chandrashekharan, 1998). NTFPs are the primary resources from forests in developing countries (Harbia *et al*., 2018). The combination of NTFPs and timber can be an economically viable option to generate revenue for government and income for local users (Ashton *et al.,* 2001).

During the early 1990s the role of non-timber forest products limited to sustain life and poverty alleviation and after the publication of the Peters *et al,* (1989) which has since been widely criticized the original idea on the potential of NTFP and started to use for sustainable forest management. Extraction of non-timber forest products for both subsistence and trade remains common and widespread today because it is highly significant to the rural and national economies in provision of food, material, construction, energy, cash income, employment, and other benefits (Devkota *et al*., 2004). Broadly speaking there are two principal objectives for promoting NTFP commercialization from the livelihoods perspective and Conservation side (Peters *et al.,* 1989). 80% of the people living in developing countries use wild plants to meet some of their health and nutritional needs. NTFPs are also acknowledged as being positively associated with forest conservation (Chanthayod *et al.,* 2017). Indeed, extraction of non-timber forest products is less ecologically destructive because it does not critically impact forest functions and regeneration of species (Harbia *et al*., 2018).

NTFPs are an important part of Nepalese economy as well. About 100 plant

species are already in trade and some 800 additional species find subsistence uses in Nepal (Subedi, 1997). It is estimated that about 10,000 to 15, 000 tons of plant products of more than 100 species are exported to India annually, i.e., 90% of total NTFP trade (Edwards, 1996). Because of its diverse ecosystem due to great variation in rainfall and elevation, Nepal has been habitat for many MAPs and NTFPs. The NTFPs sector in Nepal is being promoted with the concept of sustainable development as articulated by the Convention on Biological Diversity (CBD) (Heinen and Acharya, 2011). In recent decades, with growing concern about conservation, together with rural poverty and sustainable development, researchers, as well as conservation and development organizations, have made efforts to bring NTFPs at the center of discourse (Belcher *et al.,* 2005, Subedi, 2006). As a result, the governments of several developing countries, including Nepal, received pressure to formulate policies that promoted NTFPs. *Choerospondias axillaris* is one of the main NTFPs in Nepal. The tree has been considered as suitable crop for multiple uses in mountain farms and the Nepalese government has emphasized the production and processing of such high value agro forestry products as its whole parts is essential (APP, 1995).

1.2 *Choerospondias axillaris* species

Choerospondias axillaris (Roxb.) B.L.Burtt & A.W.Hill is an important NTFPs, belongs to family Anacardiaceae also known as, *hog plum*, *chanchin, modoki* and many others that are specific to region/community and ethnicity. It is grown in hills, at an altitude of 900 – 2000 m above sea level (Paudel *et al*., 2001). *Choerospondias axillaris* trees are distributed from North – East India to South – East China, Japan, Assam, Sikkim, Vietnam, Thailand, and Hongkong. *Choerospondias axillaris* is native to Nepal (Roxburgh, 1832). It is wild, large and deciduous trees growing up to 20 meters tall (Shah, 1978).

Choerospondias axillaris tree is dioecious, but it is difficult to distinguish male and female plants at the seedling stage (Agrawal *et al*., 1992). The trees producing pistilate flowers are locally called as *Pothi C. axillaris* (female plants), and others producing staminate flowers are called as *Bhale* (male plants) (Paudel *et al.*, 2001). A common misnomer for *C. axillaris* is *Spondias axillaris* (Brodie *et al.,* 2009).

Choerospondias axillaris is found in association with other species and the most common associates are: Chilauni (*Schima wallichi*), Katush (*Castonopsis indica*), Baan aiselu (*Rubus ellipticus*), Chutro (*Berberis aristata*), Kalopati (*Ageratina adenophora*) and, Setopati (*Artemesia vulgaris*). It grows best in full sun and saturated soil (Lai *et al*., 2014) and has lower potential to shade and frost and is moderately tolerant to low fertility and drought (Tyystjarvi, 1981). *Choerospondias axillaris* is propagated primarily by seed or it can be vegetatively propagated by chip budding, grafting, propagation of hardwood and softwood cuttings and by tissue culture (Paudel *et al*., 2003).

1.3Ecological status of plants and its regeneration pattern

Ecological status of a particular region is determined by assessing its biodiversity, prevailing conditions of the environment and their interactions with the species. Understanding species diversity and distribution patterns is important to evaluate the complexity and resources of the forests (Kumar *et al.,* 2006). Different growth forms of woody plant species is the main constituent for the formation of community structures of forest and the ecological characteristics of sites, species diversity and regeneration status (Khumbongmayum *et al.*, 2006). The population structure characterized by the presence of sufficient number of seedlings, saplings and adults indicates successful regeneration of forest species (Saxena and Singh, 1984). The structure of plant as well as animal communities in many natural ecosystems is largely influenced by the disturbances, frequently occurring in the system naturally or due to anthropogenic activities (Bennett and Adams, 2004).

Regeneration is a key process for the existence of species in a community under varied environmental conditions. It is a critical part of forest management, because it maintains the desired species composition and stocking after various disturbances (Khumbongmayum *et al.,* 2005). Regeneration status of tree species depends on the maturity and diameter structure of their population (Bhuyan *et al.,* 2003), ability of its seedlings and saplings to survive and grow (Good and Good, 1972). Characteristics of the forest floor, micro-environmental conditions under the forest canopy and anthropogenic activities influence the regeneration status of trees (Mishra *et al.,* 2003). The potential regenerative

status of tree species often depicts the future composition of forests within a stand in space and time (Henle *et al.,* 2004). Successful regeneration is perhaps the single most important step towards achieving long term sustainability of forests (Saikia and Khan, 2013).

1.4Socioeconomic benefits of *Choerospondias axillaris*

Choerospondias axillaris was used only for domestic purpose in past, recently it has been used for commercial purpose as well. People from mountainous region mostly liked this fruit. It is one of the delicious fruits in Nepal (Paudel *et al* ., 2002) especially sweet and sours in taste. The fruit has been used for several products: (i) Mada –a dried mixture of *C. axillaris* pulp and salt used as snacks and to make pickles; (ii) Candy, made up of *C. axillaris* pulp and sugar; (iii) ground skin a powder made by grinding fruits skin, which is widely used as sour topping in restaurants and hotels in Nepal. It is a multipurpose tree that has higher income and employment generating potential without deteriorating natural environment and it is also targeted by Micro enterprise development program (MEDEP) as one of the major NTFPs product among ten species for value chain analysis in Nepal (Paudel, 2012).

1.5Statement of the problem and justification

Choerospondias axillaris is a native plant of Nepal, and it is an economically valuable tree with diverse utilization of its different parts**.** It is regarded as one of the major cash crops generating plants especially in Hill farming community in Nepal. This plant has high medicinal value as well. Despite of its importance the tree is quietly exploited all over Nepal mostly by anthropogenic activities. Since the cultivation and collection of NTFPs are increasing to support the livelihood and to increase living standard of people over that area in recent years. Among the number of NTFP's, *C. axillaris* is one of the common plant in the study area. There are a little quantitative information on the population of *C. axillaris* and very few researches regarding the ecology of this species in Nepal. Scientific study regarding vegetation composition, regeneration and socio-economic benefits of *C. axillaris* in existing four Wards of Phalewas Municipality, Parbat district has not been done yet.

This study has attempted to find out the ecological status and socio economic benefits of *C. axillaris* in existing four Wards of Phalewas Municipality, Parbat district. The study about the status and importance of *C. axillaris* is essential for its sustainable management, protection and development of this economically and socially valuable plant. This thesis will fill up this gap of knowledge of ecological status and its proper management.

1.6Research questions

The study has attempted to answer the following research questions;

1. What is the ecological Status of *Choerospondias axillaris* in the study areas?
2. What are the major associated plant species of *C. axillaris* ?
3. What is trees, seedling and sapling density of *C. axillaris* ?
4. Whether the local people are benefited through the *C. axillaris* or not?
5. What is the annual income of *C. axillaris* per household?
6. What are the trend of production, productivity and productive area of *C. axillaris* in Parbat district over a decade?

1.7Objectives of the study

The main objective of this study is to assess ecological status, vegetation structure and socio-economic benefits of *C. axillaris* in Parbat district and its specific objectives are;

1. To determine the density of *C. axillaris* in the study area,
2. To determine the species composition and Importance Value Index (IVI) of *C. axillaris* and its associated plants species (including herbs and shrubs) in the study area,
3. To find out the regeneration pattern of *C. axillaris* in the study area,
4. To find out the socio-economic benefits of *C. axillaris* in Parbat district,
5. To analyze the trend of production, productivity and productive area of *C. axillaris* in Parbat district.

1.8Limitations of the study

The study was to assess ecological status, vegetation structure and socio-economic benefits of *C. axillaris* in Parbat district, western Nepal. This study was limited to the followings matters;

1. The study has covered the ecological status of *C. axillaris* only in Phalewas Municipality of Parbat District.
2. The study is limited for regeneration pattern *C. axillaris* only. The regeneration of other associated species was not included.
3. The study covers only 61 respondents to get socio-economic data.

CHAPTER II
LITERATURE REVIEW

2. Status and importance of Non-timber Forest Products in Nepal

Non-timber Forest Products are an important source of income of rural people, the value of NTFPs is increasing even more than the timber (Peter *et al* ., 1989). The varied topography of Nepal has favored the growth of different important NTFPs, (Edwards, 1996). Among NTFPs, sub-sector of NTFPs, are of special significance to the Nepalese economy because of their value to the local collectors, small traders, herb dealer, Ayurvedic practitioners, Ayurvedic/Pharmaceuticals companies and essential oil producing factories (Shrestha *et al* ., 1998). It is estimated that about 10,000 to 15,000 tons of plant products of more than 100 species are exported to India annually, and it comprises 90 % of total NTFPs trade (Edwards, 1996). A survey of NTFPs producers, traders and processers from the eastern border of Nepal to the mid-western town of Nepalgunj shows that a total of 100 entrepreneurs handled 42 thousand tons of over 100 different NTFPs items, equivalent to USD 26 million (Subedi, 1997).

NTFPs are especially important for study since they have the potential to contribute to the local economy; local health needs of remote communities, and also to conservation of ecosystems and biodiversity (Subedi, 1998).

According to Subedi, (1999) the forests (37.4%), and shrub and grass lands (15.7%) of Nepal, covering 53% of the total geographical area of the country or 7.8 million hectares of land, form the major ecosystems for the provision of NTFPs. However Shrestha *et al.,* (1998) stated that NTFPs are being overused and degraded due to lack of local control over the resources, social and cultural traditions. Acharya, (2000) revealed that in the absence of proper management and control in the collection and trade NTFPs are becoming vulnerable, endangered and even extinct. Hence for the biodiversity conservation and sustainable resource management the forest products have to be utilized in forest-based enterprises without depleting the forest (GoN, 2002).

2.2Status and distribution of *Choerospondias axillaris* in Nepal

Choerospondias axillaris trees are reported native to Nepal hills (850-1900 m asl) grown in temperate climate and found in east to west in Nepal, (Paudel and Parajuli, 1999). However its range includes Japan, China, India, Bhutan, Thailand, and Vietnam (Paudel *et al*., 2002). A total of 301 Village Development Committees (VDCs) in 29 hill districts have reported cultivation and protection of *C. axillaris* trees for some socio-economic purpose in Nepal, however total information about occurrence and distribution of Lapsi trees in Nepal are scanty, (Paudel *et al.,* 2003). There available very little information regarding documentation of *C. axillaris* in different sites of Nepal. Parbat district of Nepal has medium potential for *C. axillaris* production (Paudel *et al* ., 2003). According to Shu, (2008), *C. axillaris* trees observed during the years of 2015 and 2016 in Mudikuwa, of Parbat district.

Choerospondias axillaris trees are commonly found in places like Pharping, Machhaya gaon (Kirtipur), Phulbari, Panchkhal, Namobuddha, Kavre, Panauti and Dhulikhel of Kavrepalanchowk district as well as in Jiri, Charikot of Dholka district and Chautara of Sindhupalchowk district (Labh *et al* ., 2016). *C. axillaris* tree is familiar and scattered in the mid hills of Nepal in the forest as well as private land as a preferred agro forestry tree (Rajbhandari, 2017). Government of Nepal, Ministry of Agriculture Development in collaboration with Federation of Nepal Chamber of Commerce and Industry (FNCCI) has initiated One Village One Product (OVOP) program of *C. axillaris* fruits in Bhaktapur (Rajbhandari, 2017). Though *C. axillaris* is native to Nepal documentation and quantitative analysis of this plant has not been done extremely. Detailed information about the occurrence and distribution its ecological status of *C. axillaris* is still not available.

2.3 Propagation of *Choerospondias axillaris*

Choerospondias axillaris is propagated primarily by seed, there is no known stratification or scarification requirements for *C. axillaris* seed propagation (Seber, 2016). Observations of seeds that were consumed by ruminant animals appeared to germinate sooner than non-digested seeds. Dried seeds are viable

for 9 months to 1 year (Brodie *et al* ., 2000). According to Paudel *et al* ., 2003), *C. axillaris* can be vegetatively propagated by chip budding, grafting, propagation of hardwood and softwood cuttings and by tissue culture.

2.4Regeneration status of *C. axillaris*

Research regarding regeneration status of *C. axillaris* in Nepal are very poor or nearly absent. Shrestha *et al.,* (2015) studied the regeneration status of forest trees in Kathmandu scared groove and found that *C. axillaris* has poor regeneration status in Pashupati scared grove and no regeneration in Bajrabarahi scared grove while in other places of Nepal regeneration status of *C. axillaris* is not mentioned yet. Identification, selection, evaluation and propagation of selected germ plasma of *C. axillaris* are still in its infancy in Nepal (Paudel, 2004). However some domestication of *C. axillaris* for fruit production in the middle mountain agro forestry was done. Major *C. axillaris* production areas fruit processing, location and market centre for forest and precede fruit products have been identified and documented (Paudel, 2001). Its cultivation has been much influenced by marketing facilities such as access to motorable road and market center (Paude *et al* ., 2002).

2.5Importance of *C. axillaris*

Choerospondias axillaris i s a medicinal plant used in Mongolia; fruits have been reported to possess several properties for treatment of myocardial ischemia, calming nerves, blood circulation and improving microcirculation (Dai *et* al., 1992). Fruits are very rich in essential amino acid especially arginine, glutamic acid, vitamin C and minerals such as potassium, calcium and magnesium and bark has a medicinal value for treating secondary burns (Quang, 1994).

The tree has been considered as suitable crop for multiple uses in mountain farms and the Nepalese government has emphasized the production and processing of such high value agro forestry products as its whole parts is essential (APP, 1995). *C. axillaris* wood is used as light construction timber and fuel woods seed stones area used as fuel in brick kilns (Nguyen *et al* ., 1996). This species has great potential as a cash generating tree for hill farming communities in Nepal as well (Paudel and Parajuli, 1999). The annual

transaction of *C. axillaris* fruit, in Kathmandu alone, is estimated worth over 50 million Nepalese Rupees (approx. 0.65 m US$; BM, 1999). There is a tremendous opportunity for income and employment generation through proper Management and use of *C. axillaris* tree since it has social economical medicinal and ecological values in Nepal (Paudel, 2001). According to Paudel *et al.*, (2002) Nepal is unique for processing and use of *C. axillaris*, fruits are consumed fresh or pickled or processed for preparing varieties of sweet, sour and tasty food products including Candy, Madaa.

Paudel *et al*., (2002) stated that *C. axillaris* is said to be important to many Nepali people and people of the Hindu faith. The fruits are used in Hindu rituals, Newari feasts, festivals and celebrations. In Hinduism, the fruits are used as offerings to the Gods and Goddesses (Chhetri and Gauchan, 2007). It has some cultural significance to Newari people; a traditional feast for Newari people contains *C. axillaris* soup, which is believed to aid in digestion and purify the elements (Bajracharya, 2015).

In Nepal regarding *C. axillaris* certain studies were carried out related to market study of *C. axillaris*, value chain analysis (Paudel, 2012), evaluation of *C. axillaris* tree for fruit production (Paudel *et al*., 2003) only and regeneration status were recorded only from one place along with other species. However ecological status of this plant has not been studied from others parts of Nepal. Therefore study about the ecological status and regeneration pattern of *C. axillaris* has been carried out at Phalewas Municipality of Parbat district.

CHAPTER III
METHODOLOGY

3. Geographical location of study area

Parbat district the hilly district of Gandaki Province situated between 27°28' N to 28°39' N latitude and 83°34' E to 83°59 E longitude at an altitude of 860 m from the sea level having total area of 494 km^2 with total population of 145,586 (Figure 1). Shankarpokhari (Ward No. 3) Thapathana (Ward No. 2), Thanamaula (Ward No. 8) and Bhangara (Ward No. 9) the four Wards of Phalewas Municipality of Parbat district are selected for the study because these areas are regarded as core area for *C. axillaris* production. Total production of *C. axillaris* of Parbat district is exported from these four areas. Shankarpokhari ward located at an altitude of 1440 m from the sea level situated between 28°9'0" N latitude to 83°42'36"E longitude. Thapathana area located at an altitude of 1480 m from sea level situated between 28°10'14" N latitude and 83°43'26" E longitude. Likewise, Thanamaula is located at an altitude of 1400 m from sea level and in between 28°9'14" N latitude to 83°40'37"E longitude. Similarly, Bhangara located at an altitude of 1400 m from sea level and in between 28°10'48" N latitude to 83°41'24"E longitude respectively (Figure 1).

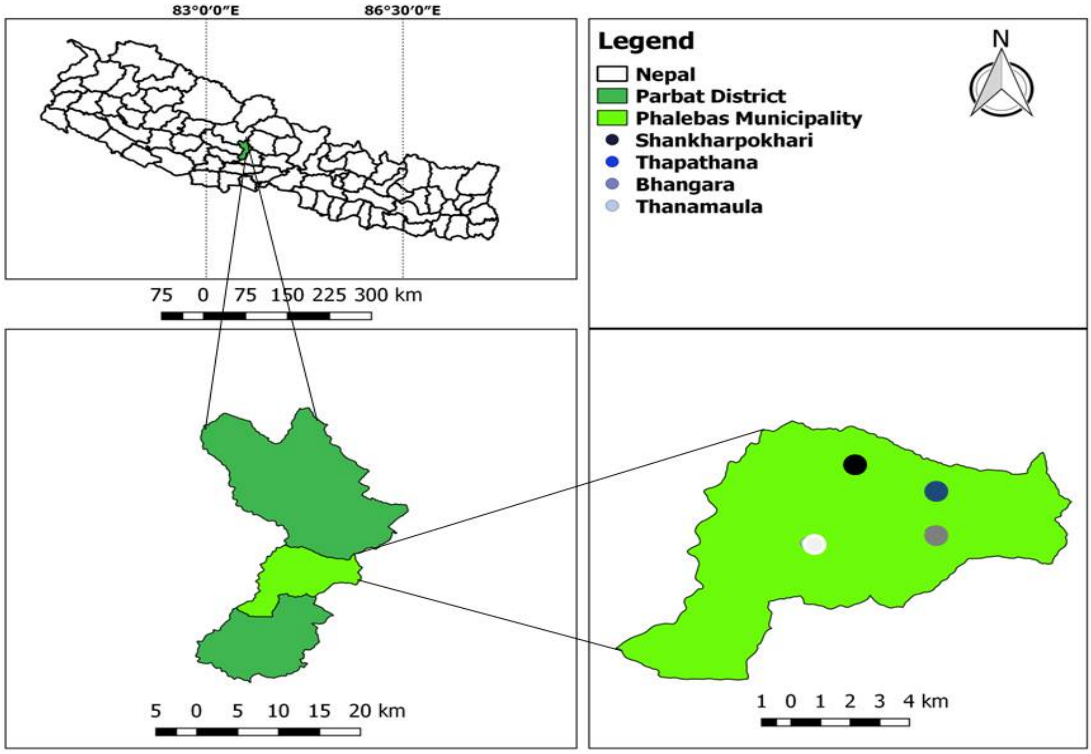


Figure 1 : **Map of the study area showing four study sites in different colored points.**

(Source: Department of Survey, Government of Nepal, 2020)

3.2Climate

The climate of study sites has humid, subtropical climate. Their Average maximum temperatures 32.41°C which occur in the month of August where average minimum temperature is 5.54°C occur in the month of December (Figure 2). Rainfall ranged between 1.95 to 707.84 mm, maximum rainfalls occur in July with value 650 mm where minimum rainfall in the month of November with 0 mm. Ten years (2010-2021) of temperature record of Kushma municipality (nearest station from study sites and is located at 28°13'06N 83°40'45E at an altitude of 1294 meters) shows that there was increasing trend of temperature from January to August and decreasing in both maximum and minimum temperature.

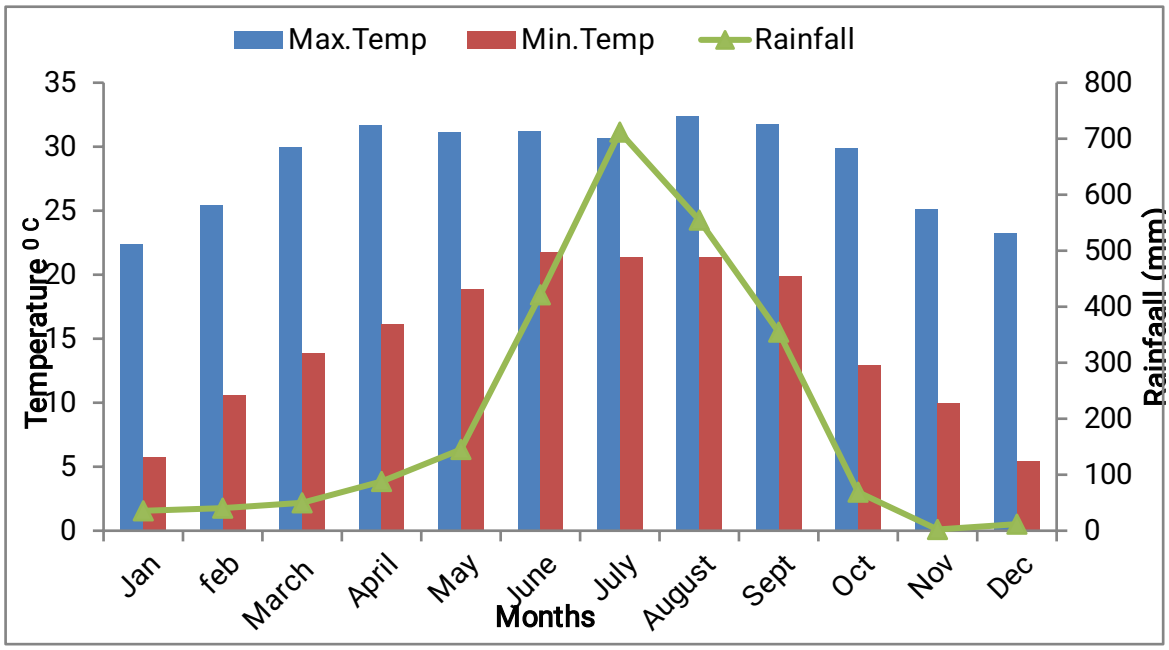


Figure 2: Average maximum and minimum temperature and rainfall status over Last one decade (2010-2021) of Kushma Municipality.

(Source: Department of Hydrology and Meterology, 2021)

3.3 Vegetation

All the forests (Thapathana, Thanamaula, Shankarpokhari and Bhangara) selected for study of *C. axillaris* are community forests. The forest is generally covered by naturally regenerated plants species. Forest is mixed forest types. *Choerospondias axillaris* (Lapsi) and *Schima wallichi* (Chilauni) are the dominant plants species in all selected forests. Whereas other plants species include *Castonopsis indica* , (Katush),

Ficus nerifolia , (Dudhilo), *Fraxinus floribunda* (Lakuri), *Rubus ellipticus* , (Aiselu), *Berberis aristata* , (Chutro) *Ageratina adenophora* (Banmara) and *Dryopteris intermedia* .

3.4 Materials and Methods

3.4.1. Field work

For the study of ecological and economic status of *C. axillaris* , study area was visited three times during study periods. The preliminary visit was carried out before writing the proposal in the month of Kartik, 2076. In first visit, selection criteria (Forest types, fruit production, Trade etc) were identified. Similarly, second visit was conducted in Ashwin, 2077. In this visit four wards (Shankarpokhari, Thapathana Thanamaula and Bhangara) were selected for the study due to high productive trees of *C. axillaris* are growing in these four wards. The primary data has been collected by carrying out vegetation sampling, field observation and interviews with local communities during 2077-10-08 to 2077-10 -25.

3.4.2. Vegetation sampling

Vegetation sampling was done in forest of Shankarpokhari, Thapathana, Thanamaula and Bhangara wards of Phalewas Municipality of Parbat district. Systematic random sampling was applied for vegetation analysis. Quadrate of 10 m radii was laid for trees and within that quadrate two sub quadrates of 5 m radii were used for sampled of shrubs and sapling of *C. axillaris* . Four quadrates of 1m radii were sampled in each 10 m radii quadrate for sampling of herbs and seedlings of *C. axillaris* . Distance between two qudrates is about 100m.Total 72

quadrates were sampled from 4 different wards (Shankarpokhari, Thapathana, Thanamaula and Bhangara) associated species in *C. axillaris* forest was also recorded within the main plot. Plants were divided into different habitats (trees, shrubs and herbs) according to Press *et al.*, (2000). Quadrates were laid in different horizontal strata of forests. The horizontal distance between successive quadrates was about 100m. DBH (diameter at breast height) and height of the trees are measured by DBH tape and clinometers respectively. Longitude, latitude and altitude of each quadrate were recorded by using Global Positioning System (GPS).

Plants were identified with the help of standard literatures such as Flora of Nepal, volume 3), Flora of Mustang and floristic works (thesis, checklist) online specimens and updated name of species were studied from Kew, catalogue of life plant of the world online and also plants were compared with the herbarium specimens from KATH (National herbarium and plan laboratories TUCH. Then final confirmation was done with the help of experts.

3.5Data presentation and analysis

3.5.1. Numerical analysis

Data obtained from the quadrate sampling method was used to calculate frequency, relative frequency, density, relative density coverage, relative coverage and importance value index, Simpson value index, Shannon wiener index as described by (Zobel*et al*., 1987).

1) **Frequency**

   Frequency is the number of times a plant species occurs in a given number of quadrates. It indicates the probability of finding a species in a series of quadrates. It is given by;

$$\text{Frequency} = \frac{\text{No.of qudrate in which species occur}}{\text{Total no. of qudrate studied}} \times 100$$

2) **Relative frequency**

   Relative frequency is calculated by dividing the frequency by the sum of the frequencies of all species, multiplied by 100 (to obtain a percentage). It is expressed as;

$$\text{Relative frequency} = \frac{\text{Frequency of individual species}}{\text{Total frequency}} \times 100$$

3) Density

Density is defined as the number of individuals of a given species that occurs within a given sample unit or study area. It is often used in a vegetation survey to describe a species status in a plant community. It is given by;

$$\text{Density } (ha^{-1}) = \frac{\text{Total number of individual species in all qudrate}}{\text{Total qudrate study} \times \text{area of qudrate}} \times 10000$$

4) Relative Density

Relative density is the density of one species as a percent of total plant density. It is expressed as;

$$\text{Relative Density} = \frac{\text{Density of individual species}}{\text{Total density of all species}} \times 100$$

5) Basal area

It is the average amount of an area occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height. It is given by the following formulae;

$$\text{Basal area} = \pi r^2$$

6) Relative Basal Area

Relative basal area is the basal area of one species as a percent of total basal area. It is given by;

$$\text{Relative basal area} = \frac{\text{Basal area of individual species}}{\text{Total basal area}} \times 100$$

7) Importance Value Index (IVI)

Importance Value is a measure of how dominant a species is in a given forest area. A total picture of the ecological importance of a species in a community is obtained by IVI. It can be calculated by using following formulae;

Importance Value Index (IVI) = Relative frequency + Relative density

+ Relative basal area

8) Simpson Index of Diversity

Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases.

Simpson index of diversity (D) = $\frac{n(n-1)}{N(N-1)}$, (Margalef, 1958)

Where, n is total number of individual species and N is total number of all species.

9) Shannon-Wiener Index (H)

The Shannon Diversity Index (sometimes called the Shannon-Wiener Index) is a way to measure the diversity of species in a community. It Denoted as *H* , this index is calculated as:

Shannon-Wiener Index (H) = - Σ Pi (Ln Pi), (Shannon and Weaver, 1963)

Where, pi is the proportion of individual found in species

10) Evenness

Evenness was calculated by dividing Shannon-Weiner diversity index with the log value of total number of species found in the area f species. Evenness was calculated by dividing Shannon-Weiner diversity index with the log value of total number of species found in the area.

11) Productivity

Productivity is a measure of economic performance that compares the amount of goods and services produced (output) with the amount of (input) used to produce those goods and services. It is calculated by;

Productivity = $\frac{\text{Total production}}{\text{Total productive area}}$

(Sources; Agriculture Knowledge Center, Parbat)

3.5.2. Socio economics data collection

For carrying out the socio-economic benefits of *C. axillaris* of the study area, questionnaire survey was done with the stakeholders; local farmers, and small entrepreneurs trading *C. axillaris.* Likewise, *C. axillaris* production and related data were collected from the concerned local governments, District Forest Office, Parbat, Agriculture Knowledge Center, Parbat and other concerned offices and other related stakeholders. The published and unpublished related reports, journals' literatures were used to collect the secondary information.

3.6 Statistical data analysis

In order to meet the objectives of the study, the collected primary and secondary data were analyzed and presented. Correlation coefficient and average comparison (One-way ANOVA test) analyses have been applied to the ecological and socio economic variables for the following reasons;

a. Comparative study of the density of *C. axillaris* in the study areas (One-way ANOVA test).
b. Correlation analysis between DBH and Height of *C. axillaris* in the study areas (Correlation Coefficient).
c. Comparative study of species richness in the study areas (One-way ANOVA test).
d. Comparative study of the average land used (ropani) of *C. axillaris* in the study areas (One-way ANOVA test).
e. Comparative study of the last year production of *C. axillaris* in the study areas (One-way ANOVA test).
f. Correlation analysis between productive area, productivity and production of *C. axillaris* in Parbat district over last one decade (Correlation Coefficient).

CHAPTER IV

RESULTS

4. Species composition

Ninety plants species belonging to 51 families were recorded along with *C. axillaris* from the study area. Family Poaceae occupied the largest number of species (10 species) followed by Asteraceae (9 species) and Moraceae (7 species). Families like Liliaceae, Amaranthaceae, Berberidaceae, Lauriaceae, and Myriaceae contain only one species (Figure 3).

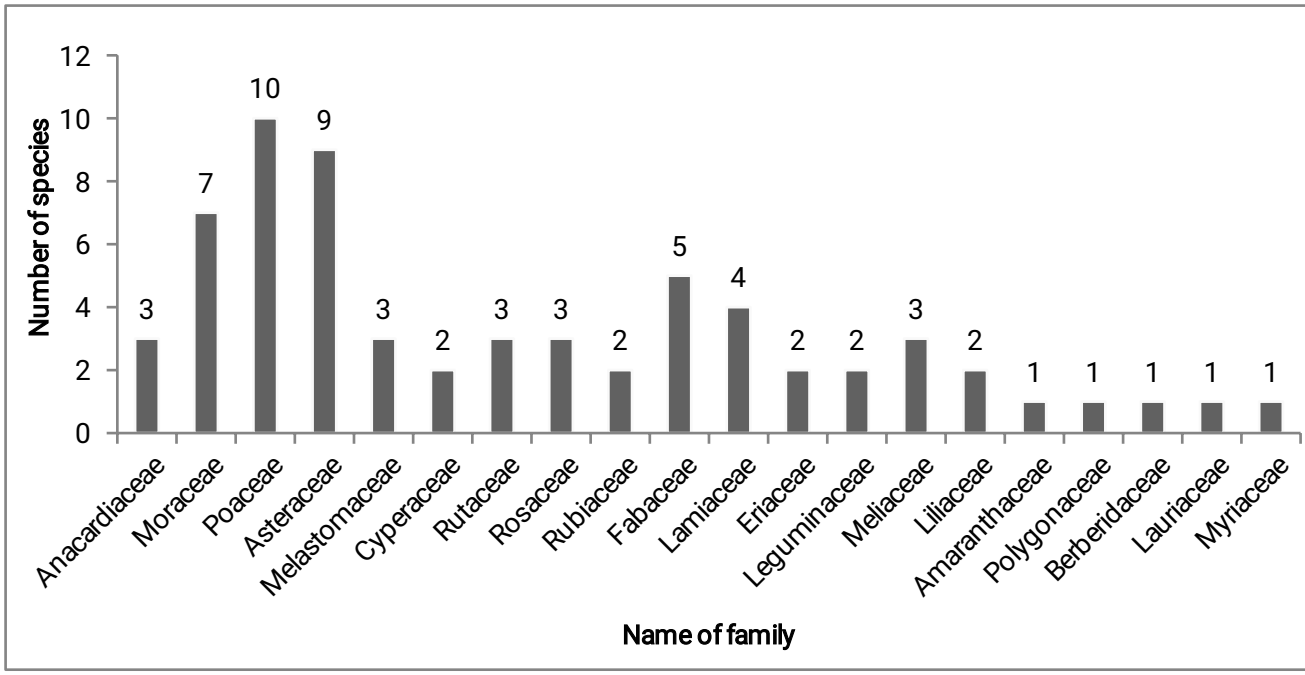


Figure 3: Species composition of the study area

4.2Ecological status of *Choerospondias axillaris* and its associated species in the study area

The bio-physical data of *C. axillaris* and its associated plants were studied by measuring frequency, relative frequency, density, relative density, coverage, relative coverage and Importance Value Index. Area wise distribution is mentioned below.

4.2.1. Density of *C. axillaris* in four different sites

The highest density of *C. axillaris* was recorded from Bhangara area (119.32 individual ha^{-1}) and lowest density was recorded from Thanamaula area (85.3

individual ha^{-1}), whereas density of *C. axillaris* in Shankarpokhari and Thapathana were 114.55 individual ha^{-1} and 118.79 individual ha^{-1} respectively (Figure 4).

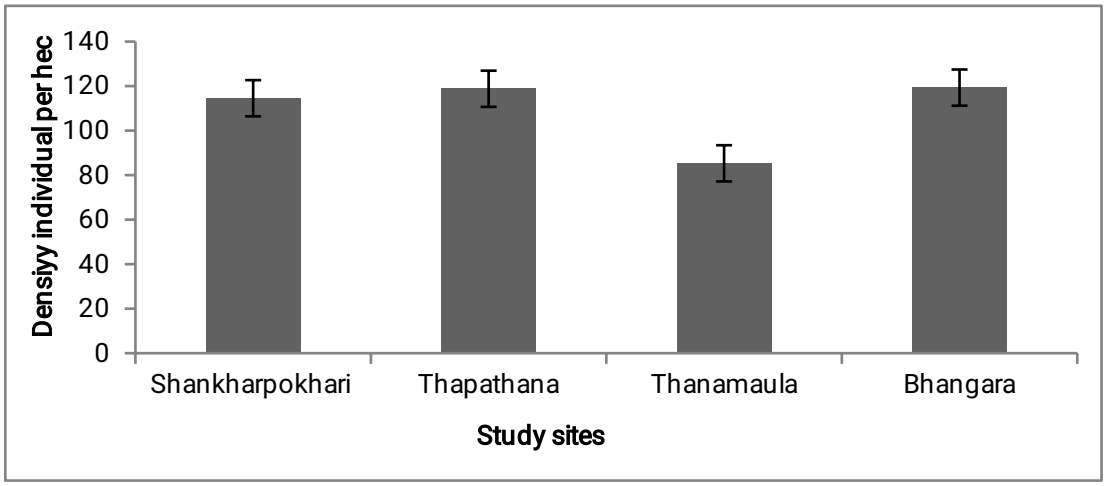


Figure 4: Density of *C. axillaris* in different study areas. Different letter showed highly significantly different between sites tested by Tukey multiple range test ($p<0.05$). Error bar showed SD (N=15-22).

4.2.2. Comparative analysis of density of *C. axillaris* in study area

The comparative density/ha of *C. axillaris* in the study sites was observed applying one-way ANOVA test. The highest and lowest average density was found 8.49 individual ha^{-1} and 4.14 individual ha^{-1} in Shankarpokhari and Thanamaula respectively. The difference of average density in the study areas was statistically significant (F=7.32,$p=0.00$) (Table 1).

Table 1: Comparative density/ha of *C. axillaris* in the study areas

Study Areas	N	Average Density/ha (±SD)	F	Sig.
Shankarpokhari	15	8.49 (±4.09)	7.32	.000
Bhangara	20	5.96 (±2.82)		
Thanamaula	22	4.14 (±1.43)		
Thapathana	15	7.92 (±4.12)		

Again from Tukey analysis, the differences of average density/ha was found statistically significant between Shankarpokhari and Thanamaula ($p=0.00$) and Thapathana and Thanamaula ($p=0.00$) (Table 2).

Table 2: Multiple comparisons (Tukey HSD) of comparative density/ha

Study Area		Mean Difference	Sig.
Shankaशाrpokhari	Bhangara	2.52	.09
	Thanamaula	**4.34***	**.00**
	Thapathana	.56	.96
Bhangara	Shankarpokhari	-2.52	.09
	Thanamaula	1.82	.24
	Thapathana	-1.95	.26
Thanamaula	Shankarpokhari	-4.34*	.00
	Bhangara	-1.82	.24
	Thapathana	-3.77*	.00
Thapathana	Shankarpokhari	-.56	.96
	Bhangara	1.95	.26
	Thanamaula	**3.77***	**.003**

* Statistically significant at $p < 0.05$ level of significance

4.3Frequency and IVI of species according to study area

4.3.1. Shankarpokhari

The major associated tree species of *C. axillaris* in study area of Shankarpokhari include *Schima wallichi* and *Englehardia spicata, Fraxinus floribunda, w* hereas *Rhus javonica*, G*aruga pinnata* and *Artocarpus lacucha* were also occasionally present in the study site. The shrubs canopy was quite sparse and was dominated by *Melastoma melabathricum* and *Rubus ellipticu* s and herbs canopy was densely dominated by *Ageratina adenophora* and *Ageratum conyzoides.* Among the tree species the study showed that *C. axillaris* has highest frequency (86%), where as *Picrasma javonica* (6%) has lowest frequency (Figure 5, Annex I).

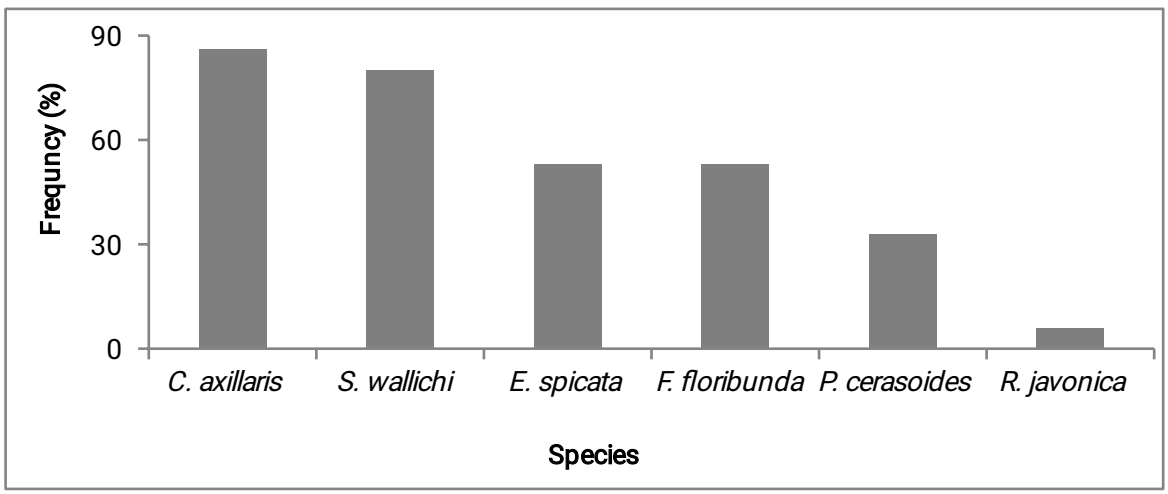


Figure 5: Frequency of tree species in Shankarpokhari

Similarly the frequency of Shrubs species ranged between 53% (*Berberis aristata*) to 6% (*Desmodium elegans*) (Annex IX) and herbs ranged between 93% (*Ageratina adenophora*) to 6% (*Smilax aspera*) (Annex V).

The highest Importance Value Index (IVI) among the tree species was occupied by *C. axillaris* (IVI=58.2) and it was followed by *Schima wallichi* (IVI=43.21) and *Englehardia spicata* (IVI=24) (Figure 6, Annex I). *Vitex negundo* has highest IVI (34.19) among shrubs (Annex IX) and *Ageratina adenophora* (89.09) has the highest IVI among herbs species (Annex V).

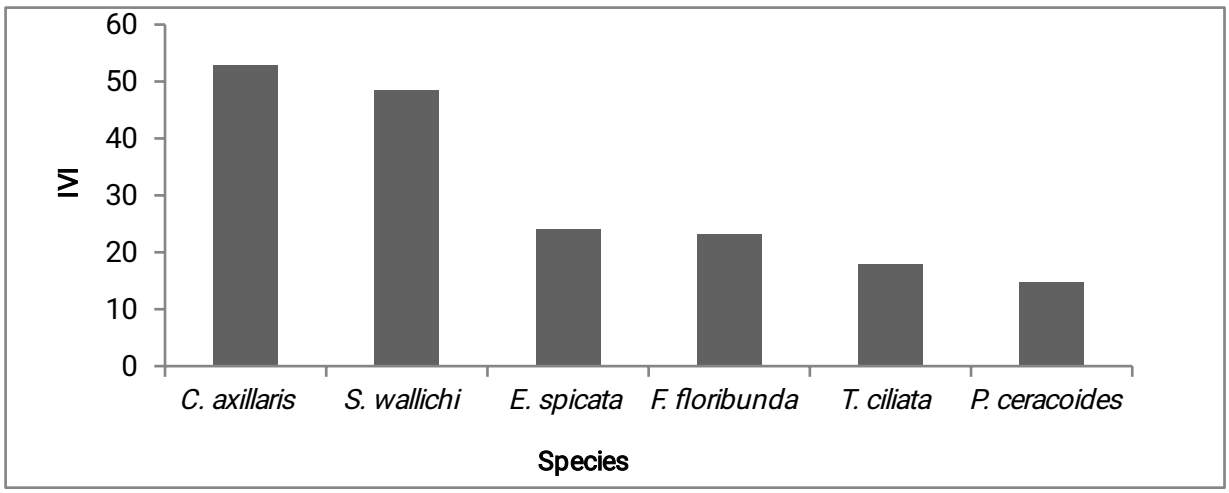


Figure 6: Importance Value Index (IVI) of trees of Shankarpokhari

4.2.1 Bhangara

From the study it was found that *Schima wallichi*, *Ficus semicordata* and *Ficus nerifolia* are major associated tree species along with *C. axillaris* where *Ficus benghalennsis* and *Zanthoxyllum armatum* were also occasionally present. The major dominated shrubs species includes *Berberis aristata*, *Rubus ellipticus* and *Randia aculeta* where herbs canopy was dominated by *Ageratina adenophora* and *Sesbania graniflora.* The frequency of tree species ranged between 100% (*C. axillaris*) to 5% (*F. benghalensis*) (Figure 7, Annex II).

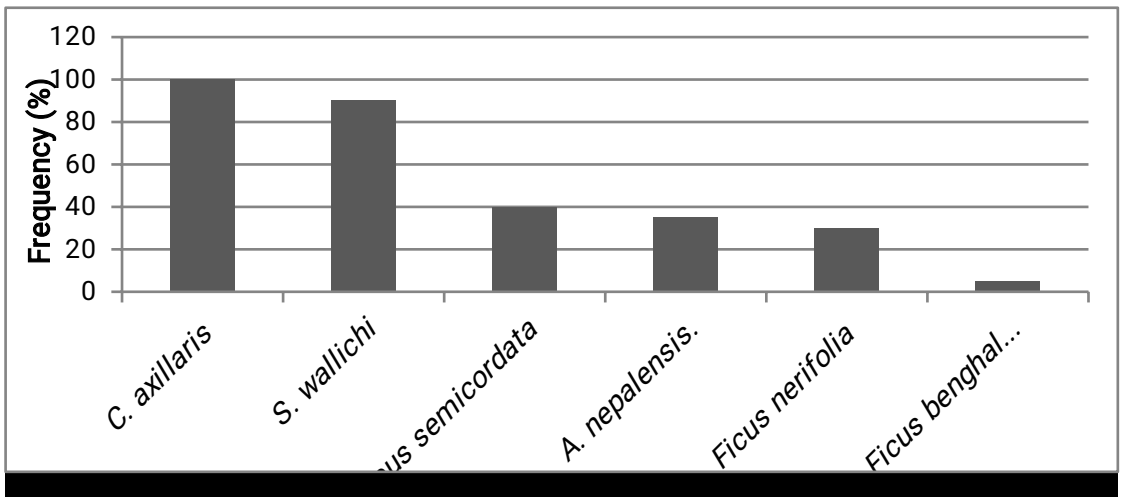


Figure 7: Frequency of tree species in Bhangara

The frequency of Shrubs species ranged between 60% (*Berberis aristata*) to 10% (*Colebrookea oppositofolia*) (Annex X). Similarly frequency of herbs in Bhangara ranged between 73% (*Ageratina adenophora*) to 6.7% (*Begonia picta*) (Annex VI).

The highest Importance Value Index among these tree species was occupied by *C. axillaris* (IVI=54.55) and was followed by *Schima wallichi* (IVI=43) and *Alnus nepalensis* (IVI=16) (Figure 8, Annex II). *Berberis aristata* and *Ageratina adenophora* were recorded for highest IVI among shrubs (Annex X) and herbs species with value 49.14 and 66.56 respectively (Annex VI).

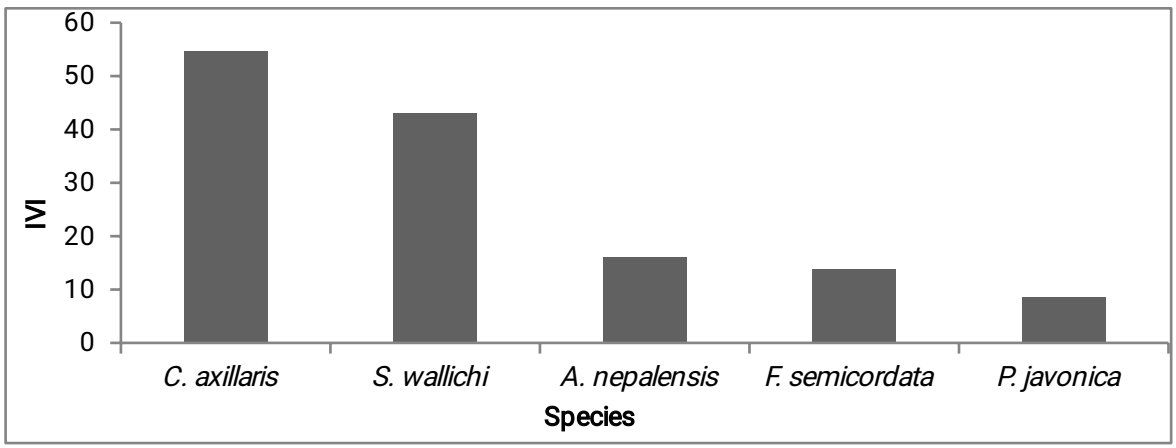


Figure 8: Importance Value Index (IVI) of trees of Bhangara

4.3.3. Thapathana

Major associated tree species of *C. axillaris* in Thapathana VDC includes *Schima wallichi, Fraxinus floribunda*, *Toona ciliata* and *Sapium insigne.* The shrubs dominated species were *Rubus elipticus*, *Berberis aristata*, *Rubus rosifolus*,

Randia aculeate and understory dominant vegetations includes *Ageratina adenophora* ,*Artemesia vulgaris* ,*Bidens pilosa* and *Reinwardtia indica.* The study showed that *C. axillaris* (80%) has highest and *Ficus nerifolia* (6%) has lowest frequency among tree species (Figure 9, Annex III).

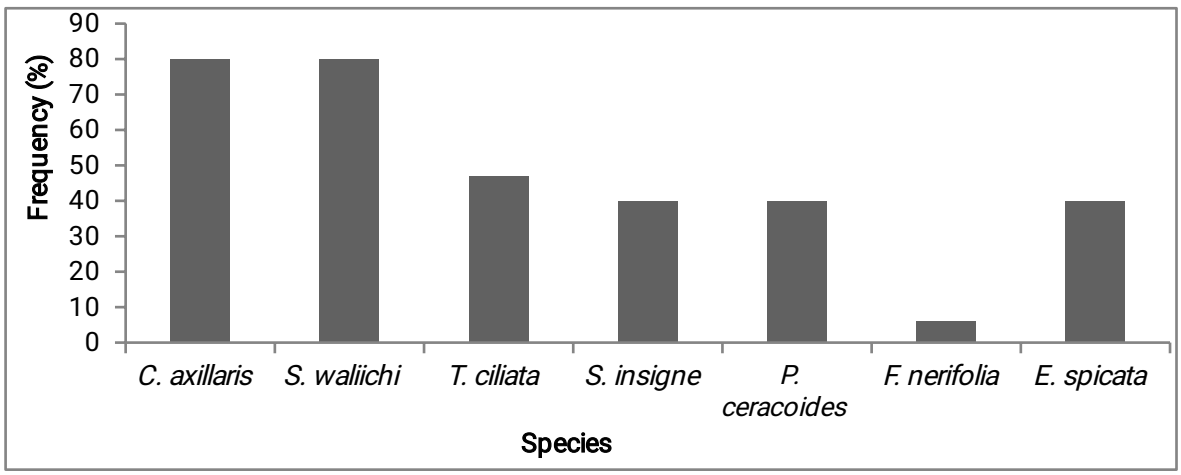


Figure 9: Frequency of tree associated species of *C. axillaris* in Thapathana

The frequency of Shrubs species ranged between 60% (*Rubus ellipticus*) to 6% (*Calotropis gigantea*) (Annex XI) and that of herbs ranged between 80% (*Ageratina adenophora*) to 6.7% (*Solanaum heterophyllum*) (Annex VII).

Choerospondias axillaris has highest Importance Value Index with value 48.83 among tree species and was followed by *S. wallichi* (IVI=47.16) and *Alnus nepalensis* (IVI=20.09) (Figure 10). Similarly *Rubus ellipticus* occupied highest IVI value of 43.4 among shrubs species (Annex XI) and highest IVI for herbs was recorded for *Triumfetta pilos* a with value 24.10 (Annex VII).

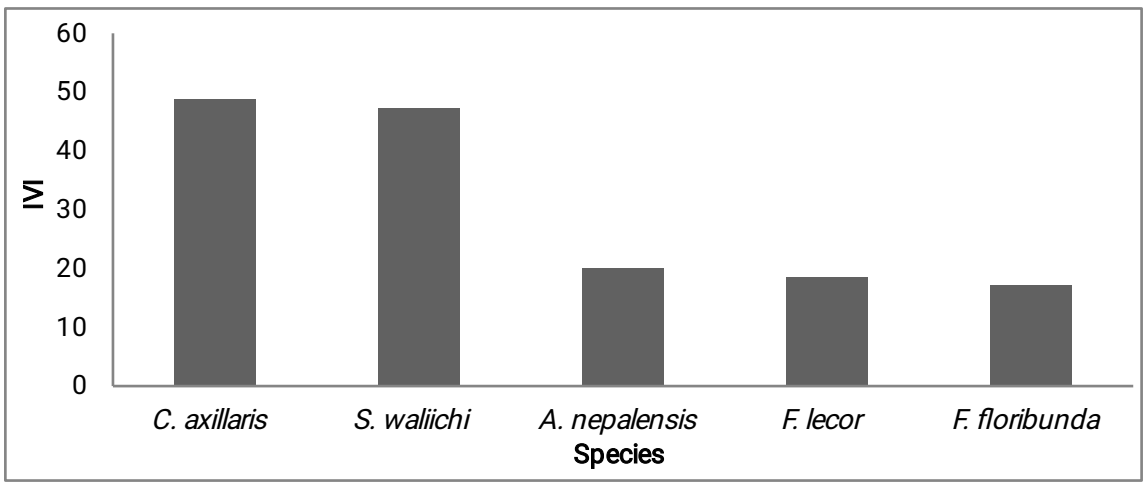


Figure 10: Importance Value Index (IVI) of the trees of Thapathana

4.3.4. Thanamaula

Major associated tree species of *C. axillaris* in Thapathana VDC includes *Schima wallichi*, *Sapium insigne, Castonpsis indica*, *Fraxinus floribunda* and *Prunus cerasoides*. The shrubs dominated species were *Artemesia indica*, *Rubus elipticus*, *Berberis aristata*, *Justica adathoda*, *Randia aculeate* and understory dominant vegetations includes *Bidens* pilosa, *Ageratum conyzoides*, *Drypteris intermedia* and *Ageratina adenophora.* The frequency of tree species ranged between 100% (*C. axillaris*) to 4% (*Shorea robusta*) (Figure 11).

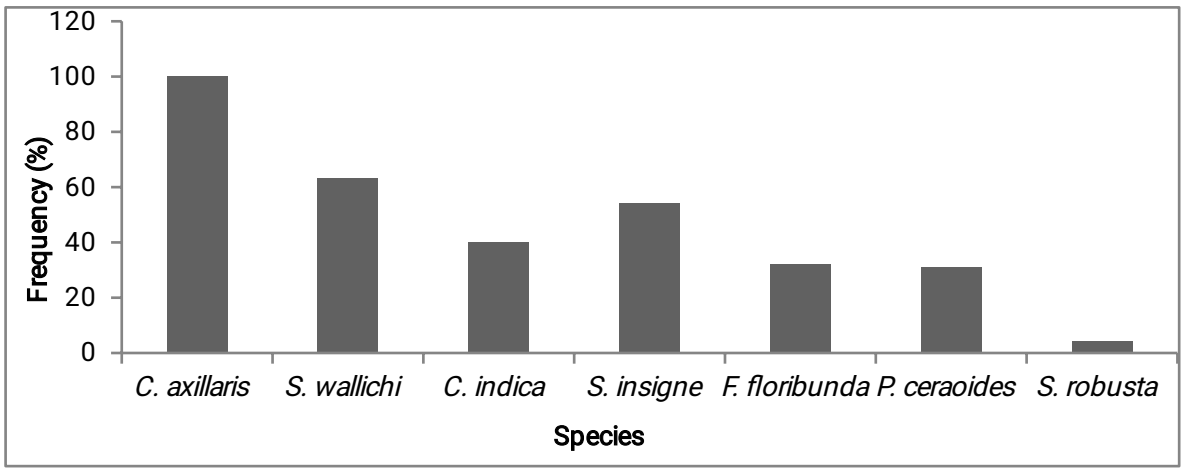


Figure 11: Frequency of associated tree species of *C. axillaris* in Thanamaula

The frequency of Shrubs species ranged between 54% (*Rubus ellipticus* and *Berberis aristata*) to 9% (*Desmodium microphyllum*) (Annex XII). Similarly herbs frequency ranged between 45% (*Bidens pilosa*) to 9% (*Alpuda mutica*) (Annex VIII).

Among tree species *C. axillaris* has highest Importance Value Index (IVI) with value 49 and was followed by *Schima wallichi* (IVI=35.2) and *Ficus benajmina* (IVI=25.8) (Figure 12, Annex IV) and *Artemesia indica* and *Ageratina adenophora* was recorded for highest IVI for shrubs (Annex XII) and herbs species with value 46.01 and 35.51 respectively (Annex VIII).

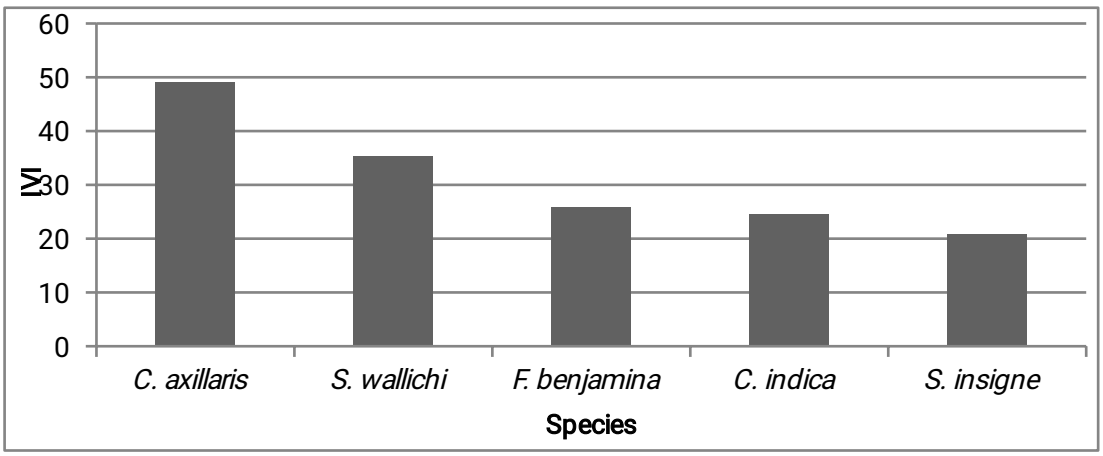


Figure 12: Importance Value Index (IVI) of the trees of Thanamaula study area

4.4Biodiversity Index

Highest Shannon-Wiener index (H) values were calculated from Thanamaula (2.53), Thapathana (2.45) and Bhangara (2.35) (Table 3). The overall values are greater than 2 and less than 3. Similarly Simpson's Diversity Index (D) value was also highest in these areas with the value of 0.91 in Thanamaula, 0.87 in Thapathana and 0.85 in Bhangara areas respectively. Lowest values of Shannon-wiener index (2.3) and Simpson diversity index (0.84) were recorded from Shankarpokhari area. Similarly, the evenness was observed highest in Thapathana and lowest in Shankarpokhari with the value 0.81 and 0.74 respectively (Table 3) whereas it was recorded 0.78 in Thanamaula and 0.77 in Bhangara areas (Table 3).

Table 3: Simpson, Shannon index of diversity and evenness of associated tree species

Study sites	Simpson index of diversity	Shannon-Wiener's index	Evenness
Shankarpokhari	0.84	2.31	0.74
Thapathana	0.87	2.45	0.81
Thanamaula	0.91	2.53	0.78
Bhangara	0.85	2.35	0.77

4.5 Regeneration of *C. axillaris*

In Shankarpokhari area, density of *C. axillaris* trees were 114 individual ha^{-1}, density of *C. axillaris* saplings were 8 individual ha^{-1} and seedling were 12

individual ha^{-1}, where in Thapathana area density of *C. axillaris* trees were 118 individual ha^{-1}, saplings were 12 individual ha-1 and seedling were 14 individual ha^{-1} (Figure 13). Similarly Bhangara area has highest number of tree density (119 individual ha^{-1}) and seedlings (24 individual ha^{-1}) likewise Thanamaula area was recorded for highest number of sapling density (19 individual ha^{-1}) and lowest number of seedlings density (9 individual ha $^{-1)}$ and tree density was 85 individual ha^{-1} respectively (Figure 13).

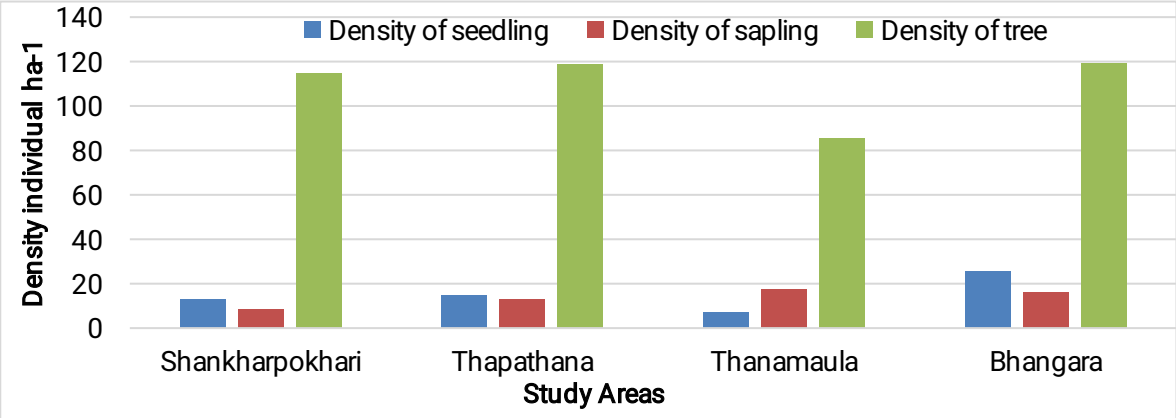
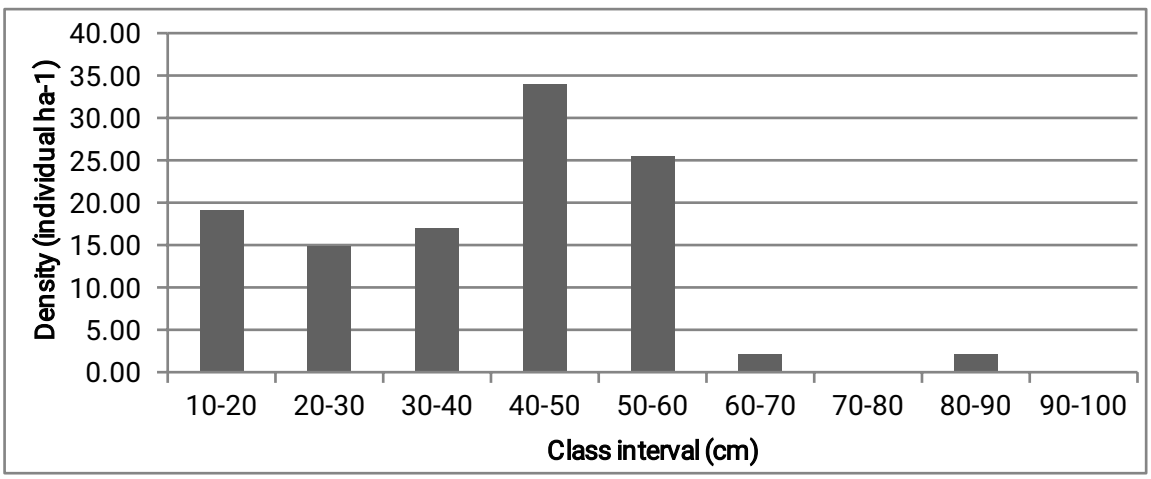


Figure 13: Regeneration status of *C. axillaris* in the study area

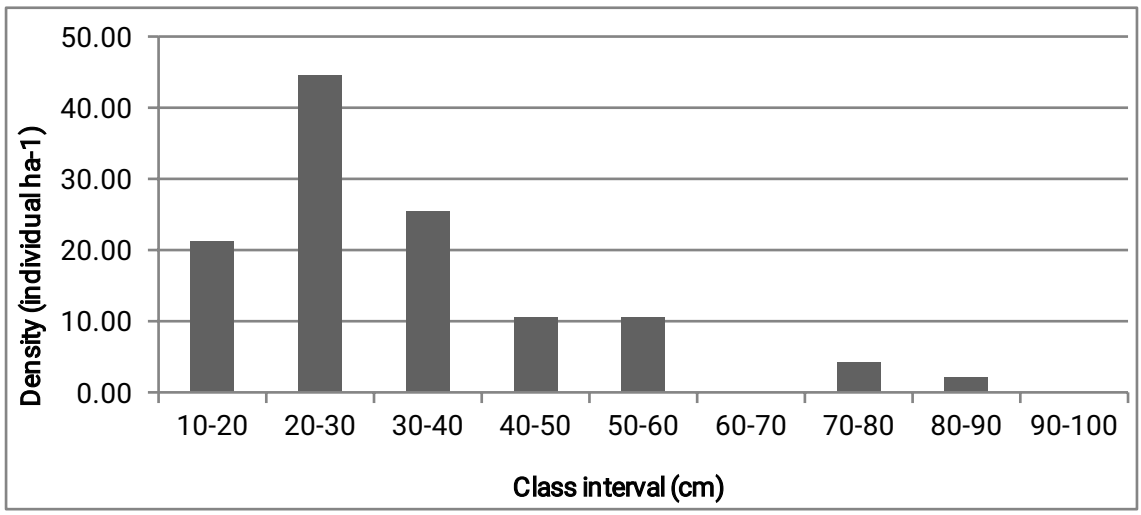
4.6 Diameter and height class distributions

4.6.1. Diameter class distributions

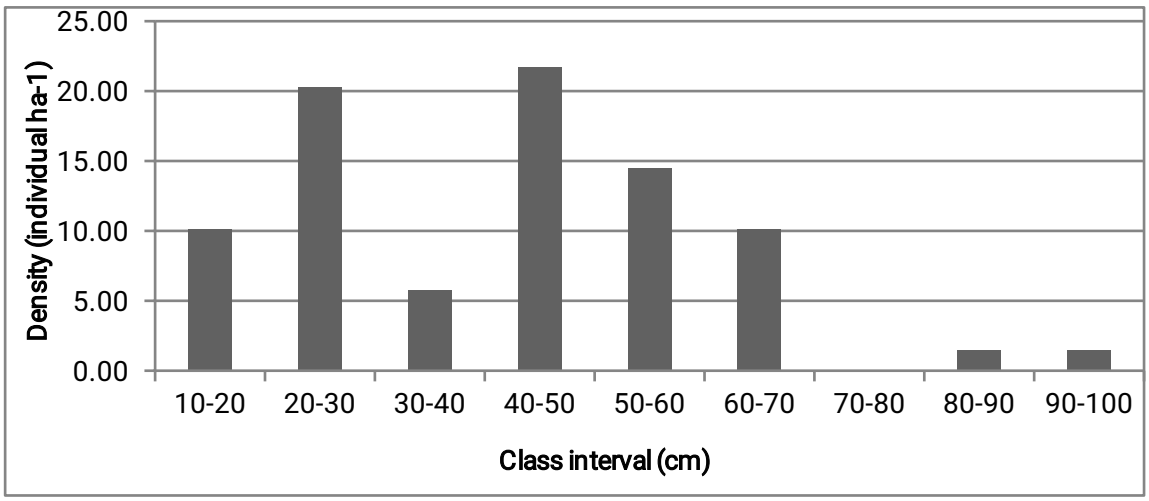
The diameter class distributions of *C. axillaris* based on the sampled trees of the individual plots of our four study sites are shown in the following figures 14 (A, B, C, D) respectively.



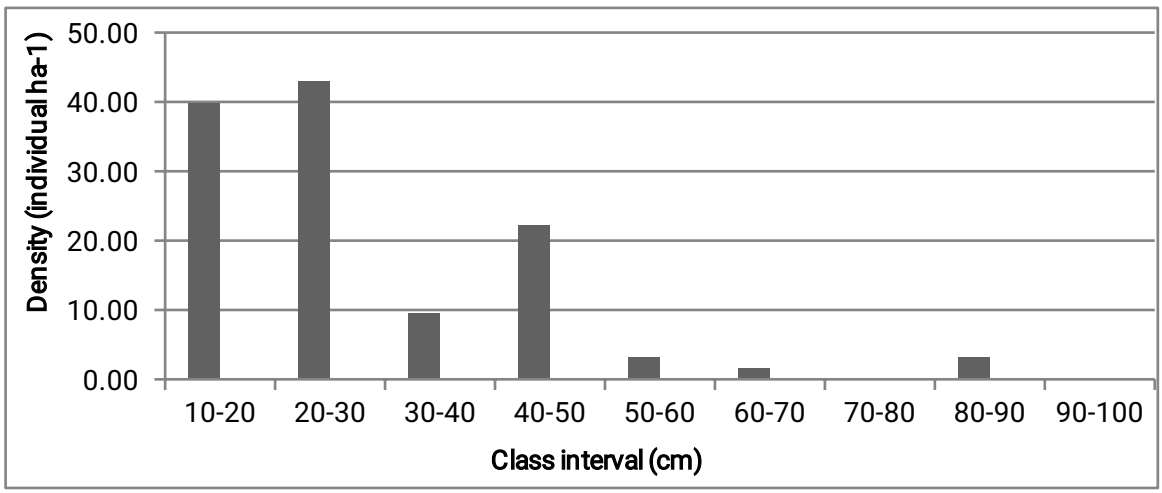
A. Shankarpokhari



B. Thapathana



C. Thanamaula



D. Bhangara

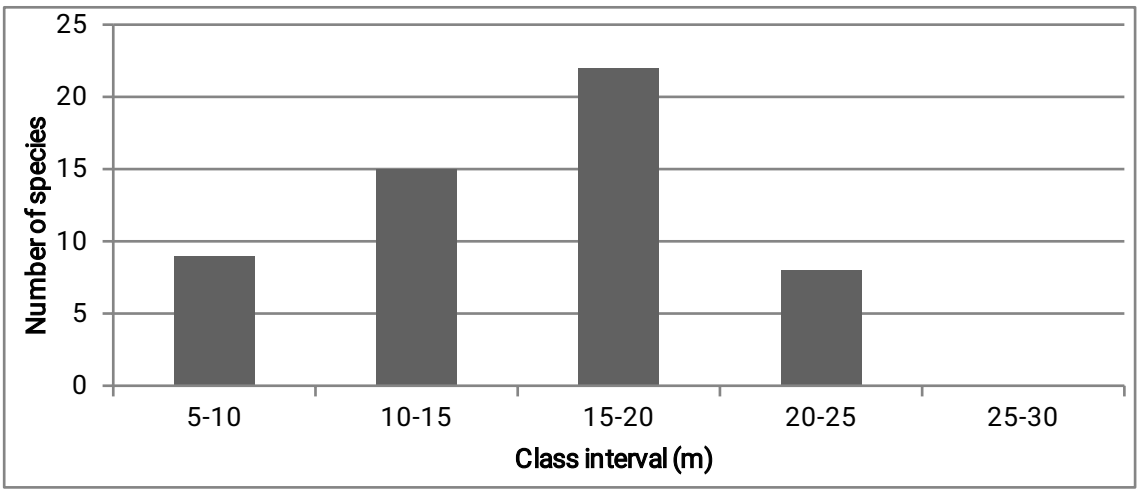
Figure 14 (A, B, C, D): Diameter class distribution of *C. axillaris* in the study areas

DBH class distribution in all four study sites depict irregular distribution of *C. axillaris.* In Shankarpokhari the highest stand density of *C. axillaris* was recorded in DBH class 40-50 cm i.e. 33 individual ha^{-1} followed by DBH class 50-60 cm (25 individual ha^{-1}) and DBH class 10-20 cm (19.09 individual ha^{-1}). The lowest density was calculated in DBH class 60-70 cm (2.12 individual ha^{-1}). Likewise in Thapathana the highest stand density of *C. axillaris* was calculated in DBH class 20-30 cm (44.55 individual ha^{-1}) and lowest density of *C. axillaris* was recorded in DBH class 80-90 cm (2.12 individual ha^{-1}).

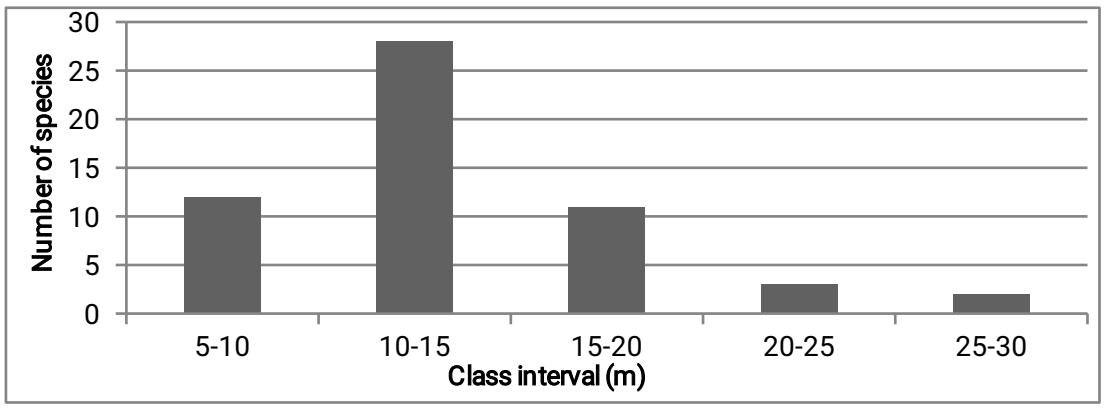
Similarly in Thanamaula DBH class of 40-50 cm was recorded for highest density of *C. axillaris* (21 individual ha^{-1}) and is followed by DBH class 20-30 cm i.e.20 individual ha^{-1}. The lowest density was recorded in DBH classes 80-90 cm and 90-100 cm with value 1.45 individual ha^{-1}. Likewise in Bhangara the highest stand density of *C. axillaris* was recorded in DBH class 20-30 cm (42.9 individual ha^{1}) and lowest density was recorded in DBH class 60-70 (1.59individual ha^{-1}). Single class of 70-80 cm was present only in Thapathana area. The maximum diameter of *C. axillaris* in all study sites did not exceeded 90 cm in all study sites.

4.6.2. Height class distributions

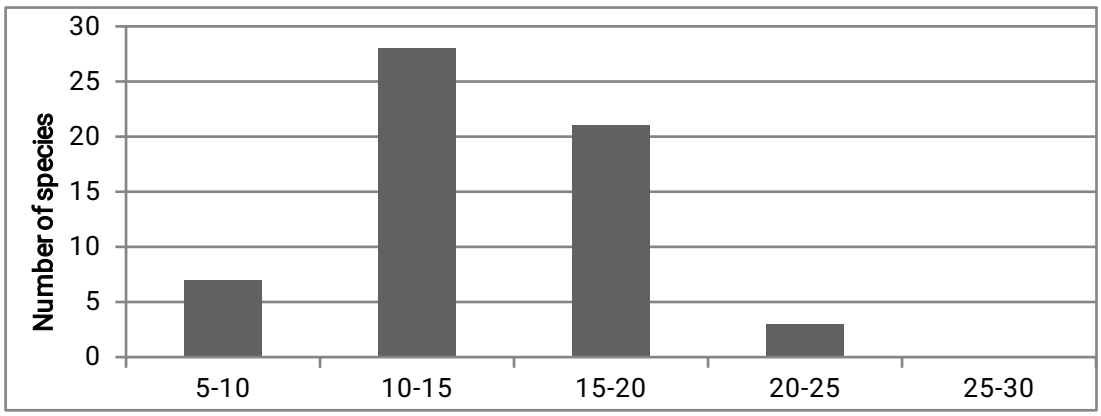
The height class distribution of *C. axillaris* in the study areas are presented in the following figures (15 A, B, C, D).



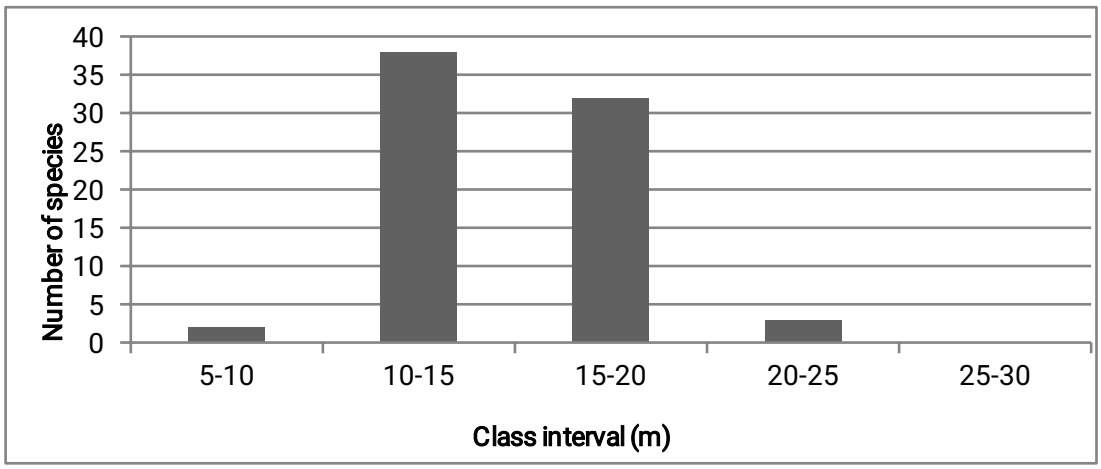
A. Shankarpokhari



B. Thapathana



C. Thanamaula



D. Bhangara

Figure 15 (A, B, C, D): The height class distribution of *C. axillaris* in study area

The height class distribution of *C. axillaris* was quite irregular. In Shankarpokhari highest numbers of *C. axillaris* trees were calculated in height class 10-15 m (22) and height class 25-30 m was recorded for lowest number of individual of *C. axillaris.* Likewise in Thapathana height class 15-20 m was recorded for

possessing highest number of individual of *C. axillaris* i.e.28 and lowest number was found to be in height class 25-30 m.

Similarly in Thanamaula height class 10-15 m was calculated for highest number of *C. axillaris* trees (28) and followed by height class 15-20 m (21). Whereas lowest number was calculated in height class 20-25 m with only 3 number of *C. axillaris* species. Likewise in Bhangara area height class 10-15 m was calculated for having highest number *C. axillaris* trees (38) whereas lowest density was calculated for class 20-25 m with only 3 numbers of *C. axillaris* species. The dominance class interval in all study sites were 10-15 m and 15-20 m while in other classes group the dominancy of *C. axillaris* was very poor. Class 25-30 m was present only in Thapathana where in other areas it was absent. Height of *C. axillaris* did not exceed 30 m in present study sites.

4.7Relationship among the various vegetation attributes

4.7.1. Relationship among the DBH and height of *C. axillaris*

There exists a lower level of positive correlation between DBH and height of *C. axillaris* and this correlation was statistically insignificant (r=0.30,*p=0.10*). From the analysis, the regression between DBH and height, the estimation line was also observed (Figure 16).

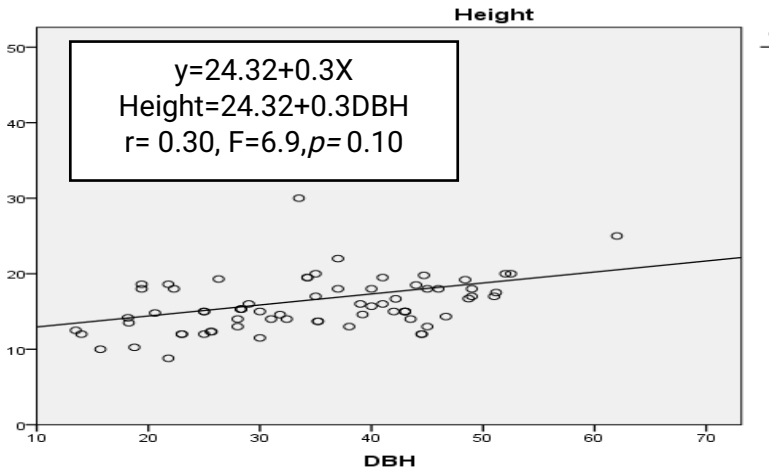


Figure 16: Curve estimation between DBH and height of *C. axillaris*

4.8Comparative study of species richness (One-way ANOVA test)

Analyzing the species richness, comparative study has been made in trees,

shrubs and herbs. In tree species it was observed a slight difference in the average species richness as per study areas however it was statistically insignificant (F= 2.32, *p=* 0.08). The average of herbs species richness in different study areas were different, which was statistically significant (F= 5.06, *p=0.003*). Similarly, there found statistically insignificant difference in shrubs species richness (F=1.62, *p=* 0.19). Likewise there exist slight differences in the average of total species richness and this difference was statistically significant (F=6.89, *p=0.00*) (Table 4).

Table 4: One-way ANOVA of species richness in different study sites

Species Richness	Study Areas	N	Mean (±S.D.)	F	Sig. value (p)
Tree Species Richness	Shankarpokhari	15	6.13 (±1.81)	2.32	0.083
	Thapathana	15	6.53 (±1.19)		
	Thanamaula	22	5.64(±1.33)		
	Bhangara	20	5.40(±1.19)		
Herbs Species Richness	Shankarpokhari	15	5.53(±1.85)	5.06	**0.003**
	Thapathana	15	4.73(±1.28)		
	Thanamaula	22	3.91(±0.97)		
	Bhangara	20	4.05(±1.39)		
Shrubs Species Richness	Shankarpokhari	15	5.07(±1.71)	1.62	0.19
	Thapathana	15	4.07(±1.28)		
	Thanamaula	22	4.50(±1.37)		
	Bhangara	20	4.05(±1.64)		
Total Species Richness	Shankarpokhari	15	16.80(±2.08)	6.89	**0.00**
	Thapathana	15	15.33(±2.47)		
	Thanamaula	22	14.09(±2.27)		
	Bhangara	20	13.50(±2.35)		

4.9Socio-economic benefits of *C. axillaris*

4.9.1. Demographic status of the respondents

Purposive selection of 61 households was made in four study areas (viz. 4 wards of Phalewash Municipality, Parbat District) and accordingly 61 respondents (at least 15 from each ward) were interviewed which includes *C. axillaris* producers. All 61 respondents were permanent residents of the study area (Figure 17).

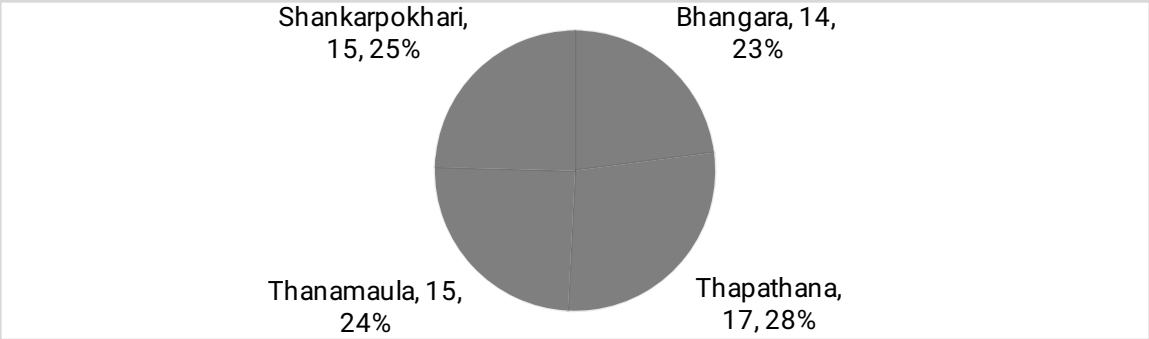


Figure 17: Number of respondents according to the study area

According to the gender of the total respondents, 58% were male and 41% female (Figure 18). Similarly, according to the respondents' age category, 14% were below 30 years, 65.6% were in between 30 to 50 years and the rest 19% were above 50 years.

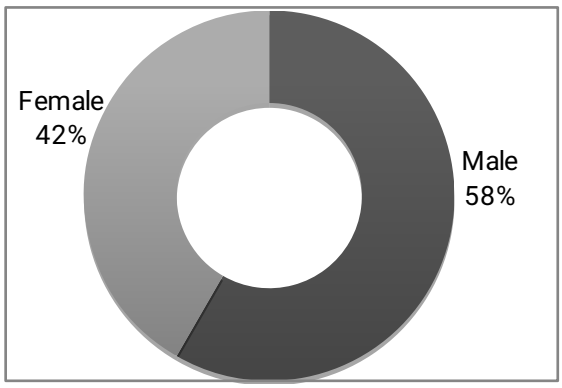


Figure 18: Gender of respondents

On the basis of literacy, 33% of the respondents have got basic level education (1-8 classes). Similarly, 46.7% have got secondary level education and only 20% of the total respondents were able to get higher level education. Among all the respondents, according to their family size, 18.6% have less than 4 members, 68.7% have between 4-6 members and the rest 13.6% have more than 6

members (Table 5).

Table 5: Demographic status of the respondents

Respondent's Demography		Frequency	Percent
Age Category	Below 30	9	14.75
	30 to 50	40	65.57
	Above 50	12	19.67
	Total	**61**	**100.00**
Education	Basic School (1-8 class)	20	32.79
	Secondary School (9-12)	29	47.54
	Higher Education	13	21.31
	Total	**61**	**100.00**
Family Size	Less than 4	12	19.67
	4 to 6	41	67.21
	More than 6	8	13.11
	Total	**61**	**100.00**

(*Source: Field Survey, 2020)*

4.9.2. Socio economic importance of *C. axillaris*

Choerospondias axillaris is recognized as having great potential as a cash generating commodity in Parbat. Local farmers sell *C. axillaris* and earn money annually in raw form mainly. Some of the local producers prepare Candy, Mada, Achar etc. from *C. axillaris* and sell them to market. The market price of *C. axillaris* was found to be around Rs. 11 per kg but the fluctuation in price has been seen according to cultivators/collectors.

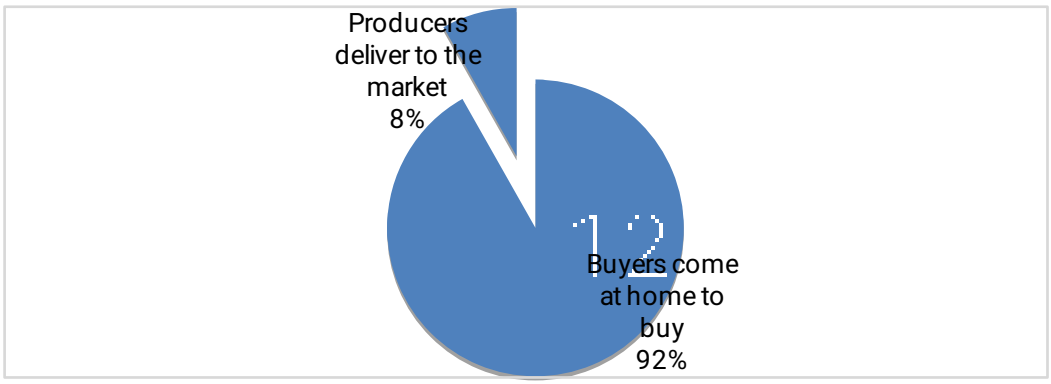


Figure 19: Two main ways of finding customers of *C. axillaris*

Similarly, among the two main ways of finding customers, buyers come at home to buy viz. 92% of the total respondents. And rest of the respondents only 8% answered that producer's visit market to find customers and deliver *C. axillaris* (Figure 19).

According to the survey, the major customers of *C. axillaris* in that area were

entrepreneurs outside the village (80%), Local entrepreneurs (13.1%), and only 6 % were others viz. visitors, local people etc. Similarly, 27.9% of the total respondents were directly or indirectly assisted by government or any other NGOs for *C. axillaris* farming whereas most of the respondent's viz. 72.1% did not get any support from anyone (Table 6).

Table 6: Economic benefits of *C. axillaris*

Respondent's Demography		**No. of Respondents**	**Percent**
Major customers	Local entrepreneurs	8	13.1
	Entrepreneur outside the village	49	80.3
	Others	4	6.6
	Total	61	100.0
Is anyone assisting?	Yes	17	27.9
	No	44	72.1
	Total	61	100.0

(*Source: Field Survey, 2020)*

According to the survey, the total average land used of households is 1.94 ropani (max=2.73, min=1.13), total average production is 273 kg per household (max=450, min=50), and that of annual income in average is Rs 29336 per household (max=49,500, min=5,000) (Table 7).

Table 7: Economic benefits of *C. axillaris*

Description		**Mean**	**S.D.**	**Minimum**	**Maximum**
Land Used Ropani (Average of 61 respondents)	Bhangara	1.89	0.54	1.13	2.75
	Thapathana	1.96	0.41	1.25	2.50
	Thanamaula	1.83	0.47	1.19	2.75
	Shankarpokhari	2.10	0.56	1.25	3.25
Last Year Production (in KG)	Bhangara	245	115	50	400
	Thapathana	290	92	175	450
	Thanamaula	302	54	200	375
	Shankarpokhari	252	108	75	425
Last Year Annual Income (in NRs.)	Bhangara	25143	11568	5000	40000
	Thapathana	31956	10699	19250	49500
	Thanamaula	32817	6691	22000	42000
	Shankarpokhari	26800	11885	7500	42500

(*Source: Field Survey, 2020)*

4.9.3. Comparative study on economic benefits of *C. axillaris* in the study

Average land used by the producers, last year's production and last year's annual income from *C. axillaris* of the different study areas was found slightly different in each other's. However this difference was statistically insignificant (land used in Ropani, F=0.88, *p=0.46* , last year production, F=1.29, *p=0.29* and last year's income from *C. axillaris,* F=1.97,*p=0.13*) (Table 8).

Table 8: Comparative One-way ANOVA test of the economic benefits of *C. axillaris*

Descriptive	df	Mean Square	F	Sig.
Land Used Ropani	3.00	0.21	0.88	0.46
Last Year Production (in KG)	3.00	11.60	1.29	0.29
Last Year Annual Income (in NRs.)	3.00	213.98	1.97	0.13

(*Source: Field Survey, 2020)*

4.9.4. Other socio-economic importance of *C. axillaris*

Besides its economic values, *C. axillaris* has socio-cultural importance and medicinal value as well. According to the producers, small enterprises and some other stakeholders, *C. axillaris* has an important value in social and cultural practices. It has been used and consumed since the ancient times during the various religious ceremonies for its symbolic significance. *C. axillaris* fruits have been used in Hindu rituals, Newari feasts, festivals and celebrations.

4.10 Trend analysis of productive area, production and productivity of *C. axillaris* in Parbat district

A ten year secondary data of *C. axillaris* of overall Parbat district was collected from District Agriculture Knowledge Center, Parbat. The data comprises of productive area, total annual production and productivity of the last one decade. Trend of these variables and their correlation has been analyzed.

4.10.1. Trend of Productive Area

It was found that the total productive area of *C. axillaris* of Parbat district was slightly decreasing over the period of 10 years. During year 067/068 total productive area was 75 ha after that it was gradually decreasing until 073/074 (70 ha). However the overall trend of productive area of *C. axillaris* over the last one decade has been decreasing trend (Figure20).

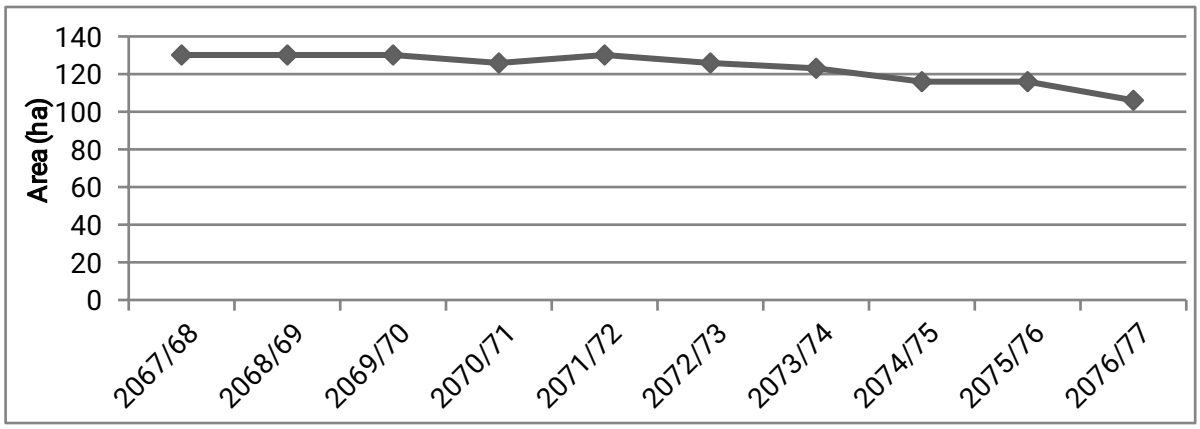


Figure 20: Trend of total productive area under cultivation of *C. axillaris* in Parbat district

(Source: Agriculture Knowledge Center, Parbat)

4.10.2. Trend of total production of *C. axillaris*

From the analysis, the total production of *C. axillaris* over period of last 10 years, it has been found a gradually decreasing trend from 800mt-680mt. The maximum value was observed in year 2070/71 (850mt) whereas the minimum in 2076/77 (680mt) (Figure 21).

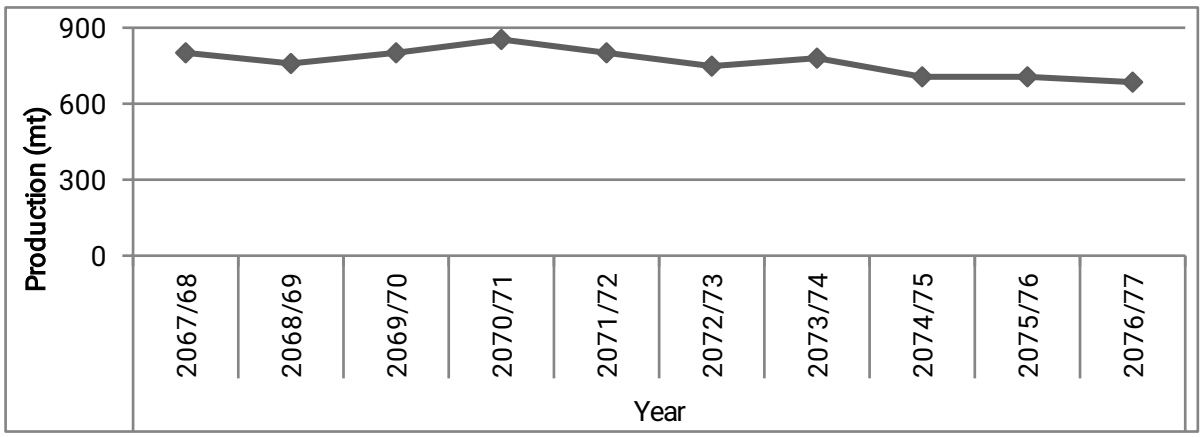


Figure 21: Total Yearly *C. axillaris* Production (mt)

(Source: Agriculture Knowledge Center, Parbat)

4.10.3. Trend Analysis of Productivity

From the analysis it was observed that the productivity of *C. axillaris* in Parbat district has been increasing gradually over the period of one decade. The lowest productivity was observed 10.27 (mt/ha) in year 2068/69 whereas the highest 12.36 (mt/ha) in 2076/77(Figure 22).

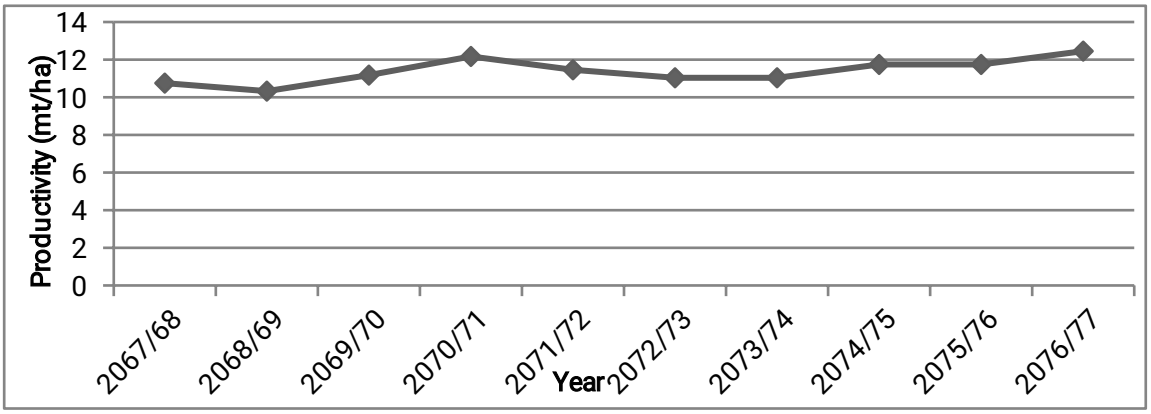


Figure 22: *C. axillaris* Productivity in Parbat District
(Source: Agriculture Knowledge Center, Parbat)

4.11 Correlation between productive area, production and productivity of *C. axillaris* in Parbat district

Analyzing the data of last one decade, we found that there exists a positive correlation between total *C. axillaris* production area and total *C. axillaris* production of Parbat district (r=0.855) and this correlation was statistically significant (*p=0.001*). Likewise, there exist statistically significant negative correlation between productive area and productivity (r=-0.75,*p=0.003*). However, there exists a negative correlations between production and productivity (r=0.36) which was statically insignificant (Table 10).

Table 9: Correlation analysis between productive area, production and productivity

Particulars		Productive Area (ha^{-1}) under cultivation	Productivity (mt/ha)	Production (mt)
Productive Area (ha)	Pearson Correlation	1	-0.795**	0.855**
	Sig. (2-tailed)	-	0.003	0.001
	N	11	11	11
Production (mt)	Pearson Correlation	0.855**	-0.368	1
	Sig. (2-tailed)	0.001	0.265	-

	N	11	11	11

** Correlation is significant at the *p<0.001* level.

CHAPTER V

DISCUSSION

5. Distribution *C. axillaris* in study sites

Choerospondias axillaris was recorded at the altitudes between 1400m to 1500masl hill, in this study. Previous authors studying "Chemical Composition of Lapsi from Nepal" also reported that *C. axillaris* was mostly found in between 850m-1900m in hilly areas of Nepal (Paudel and Parajuli, 1999; Paudel *et al.,* 2002). In our study the occurrence of *C. axillaris* was frequent to lower belt of private forest (the nearest areas of cultivation land), this might be due to human activities in seeding of *C. axillaris* /dispersal of seeds; transporting the seeds to nearby fertile areas by various means (through compost manure, by birds) or it might be due to littering the residue of *C. axillaris* (Madda/Achar) by local farmers while having their lunch working in their fields.

5.2Ecological status of *C. axillaris*

Among the four study sites, more or less similar tree density of *C. axillaris* were recorded from Bhangara area (119 individual ha^{-1}) and Shankarpokhari area (118 individual ha^{-1}) this might be due to high attention of community /locality toward the protection of this trees for socio economic benefits and the lowest density was recorded in Thanamaula 85 individual ha^{-1} which might due to various anthropogenic activities including deforestation, road construction or due to destruction of seedling and sapling of *C. axillaris* as they grown in cultivation land or due to dominant tree being *Schima wallichi* in association with *C. axillaris* . In our study sites the density of *Schima wallichi* ranged between 60-80 individual ha^{-1}likewise Chhetry *et al.,* (2021) also recorded the similar density (72 individual ha^{-1}) from Morang district Eastern Nepal as being dominant species. Similarly intermediate values were reported from Thapathana and Thanamaula. While comparing mean density of *C. axillaris* using one way ANOVA to test the significance of these differences in the densities, it was found that the density of the different study sites were statistically significant (F=7.32, *p=0.00*). This

implies that the density of *C. axillaris* in four different sites was highly significant different which might be due to different in soil type, altitudes and nutrition.

Frequency of *C. axillaris* accounted 80% in Shankarpokhari and Thapathana areas and 100% in Bhangara and Thanamaula areas respectively which indicates that number of plants species occurrence was high because present study areas were suitable for growth of this plants.

In all study sites *C. axillaris* has the highest IVI among tree species which were more or less similar in value as well (i.e. Shankarpokhari 52, Thapathana 48, Thanamaula 49 and Bhangara 54) and it was followed by *Schima wallichi* (Shankarpokhari 48, Thapathana 45, Thanamaula 35 and Bhangara 43) in all study sites which indicate major associated tree species was *Schima wallichi.* Shrestha *et al*., (2016) found slightly higher IVI value of *Schima wallichi* (81.4) while studying "are sacred groves of Kathmandu valley efficient in sequestering carbon? In Kathmandu Valley. The IVI value of *C. axillaris* and *Schima wallichi* was quite close. Then after *Engelhardia spicata* in Shankarpokhari, *Alnus nepalensis* in Bhangara and Thapathana, and *Ficus benjamina* in Thanamaula possess third highest IVI among tree species, this implies that *C. axillaris* and *S. wallichi* was the most important and dominant trees species in all four study sites with high density, frequency and basal area. Whereas, *Engelhardia spicata*, *Alnus nepalensis*, *Ficus benjamina* were medium. Whereas *Rhus javonica* in Shankarpokhari, *Zanthoxyllum armatum* in Bhangara, *G. pinnata* in Thanamaula and *F. nerifolia* in Thapathana recorded for the lowest IVI value. Similarly *R. javonica*, *Z. armatum*, *G. pinnata* and *F. nerifolia* were the lowest important plants species with lowest value of frequency, density and basal area.

Among herbs *Ageratina adenophora* has highest IVI in Shankarpokhari (89), Bhangara (66) and in Thanamaula (46) areas. While studying *Ageretina adenophora*: Its invasion and influence on the biodiversity of herbaceous vegetation in Girinagar range of Paonta forest division, district Sirmour Himachal Pardesh, Bhardwaj *et al*., (2017) also found the value of *A. adenophora* in between 40-100. Among shrubs, *Rubus ellipticus* has the highest IVI in Thapathana area whereas *Vitex negundo* occupied highest IVI in Shankarpokhari. The above results indicate that, *A. adenophora, D. intermedi* a, *R. ellip* ticus and *V.*

negundo were the most important and dominant herbs and shrubs species which can grow even in the area with high disturbance and can tolerate any types of environment, and they were the most associated herbs and shrubs species of *C. axillaris* .

In all four study sites similar species were associated with *C. axillaris* . The major associated species in all study sites were *Schima wallichi* , *Ficus nerifolia* , *Rubus ellipticus* , *Berberis aristata* , *Ageratina adenophora* and *Dryopteris intermedia,* which might be due to four study sites were situated in almost similar altitudes found same type of climate. Similar result was found by Paudel, (2012) while studying value chain analysis of *Choerospondias axillaries* "Lapsi"from three VDCs of Parbat District, Nepal.

5.3Biodiversity Indices

Biodiversity of species is generally measured by Shannon-Wiener's index (H) and Simpson index of diversity (D). The higher the value of H, the higher the diversity of species in a particular community and vice versa. Similarly Simpson index of diversity (D) range between 0 to 1. The index close to 1 indicates the highest diversity whereas close to 0 indicates the lowest diversity (Mishra, 1989). The present study indicates that our all four study sites were highly rich in diversity in term of tree species as value of H was found greater than 2 and value of D was found close to 1. An according to Barbour *et al* ., (1999) ecosystem with H' value greater than 2 and D value close to 1 has been regarded as medium to high diverse in terms of species. In similar study conducted in forest of Ethiopia, Fetene *et al.,* (2010) mentioned that Species diversity were highest at intermediate altitude around (1500-2750 m) indicating the influence of altitude in species distribution. Species evenness ranged from 0 to 1. Zero signifying no evenness and one denote a complete evenness (Shannon and Weaver, 1963) in all four study sites the value of evenness was recorded greater than 0.7 with highest value in Thapathana (0.81). The highest value of evenness indicates the tree species in all four study sites were quite constant i.e. similar species were dominant in all four sites.

5.4Regeneration status of *C. axillaris*

The highest seedling and sapling density were found in Bhangara area which was only 25.4 individual ha ^{1} (seedling) and 15.9 individual ha^{-1} (sapling) for 119 individual ha^{-1} of trees. And lowest density of seedling and sapling was recorded from Thanamaula. According to Community forest resource inventory guideline (2004) regeneration status of the forest was said to be good if the forest has seedling>5000 and sapling>2000 per hectare as cited by Pandey *et al* ., (2012). In accordance with above mentioned criteria it is expected that the regeneration pattern of *C. axillaris* was found very poor in our study sites. This might be due to destruction of forest due to high anthropogenic activities. People destroy seedling and sapling because the trees of *C. axillaris* were giant (in girth and height) which inhibit the growth of seedling and sapling in lower canopy and also affect the productivity of food crops as well. Some are destroy themselves during construction works (road), fruits collector etc. Similar results were also observed by Shrestha *et a* l., (2015) while studying regeneration pattern in sacred groups of Kathmandu valley. They found that there was poor regeneration of *C. axillaris* in Pashupati sacred groups and no regeneration in Bajrabarahi sacred groups. While in other places of Nepal regeneration of this species has not been mentioned yet.

5.5Diameter and height Class of *C. axillaris*

While analyzing DBH and height class of *C. axillaris* in all four study sites it was found that there was prevalence of irregular distribution of girth and height classes of *C. axillaris* in study sites. According to Chhetry *et al.,* (2021) irregular girth class distribution denote disturbance. Rahaman, (2009) while studying plant diversity and anthropogenic disturbances in *Shorea robusta* forest of Bangladesh also found irregular distribution in disturbed forest. Lower DBH classes were found with comparatively highest density which indicates forest of *C. axillaris* was in young staged. Whereas medium size classes had medium density but density of large DBH classes were fewer which indicates only few trees of *C. axillaris* were present in old forest (large, tall, mature trees were fewer) or might be due preservation of old trees as they yield larger production. Single DBH class of 70-80 cm was absent in some study sites which might be due to

cutting down of trees belonging to this class. To explored relation between height and DBH of *C. axillaris* correlation was done and it was found there exists a lower degree of positive correlation between DBH and height of *C. axillaris* and this correlation was statistically insignificant (r=0.30, *p=0.10*). Insignificant relation might be due to irregular distribution of *C. axillaris* trees.

5.6Socio-Economic aspects

A total of 61 respondents were interviewed to get socio economic data. Demographic study regarding *C. axillaris* production indicates male population involved in *C. axillaris* production was slightly higher than female population. correspondingly 46.7% *C. axillaris* producers got higher education which indicates educated people were also attracted toward *C. axillaris* production which might be due to its high socio economic benefits. Similarly 92% respondents told that the buyers came home directly to buy *C. axillaris* which indicates the demand of *C. axillaris* was very high in market. In study area almost all the people depends on agriculture to sustain their life. According to them they used *C. axillaris* in their daily life form in their food. They sell them in raw form and earn some money. They sell *C. axillaris* fruits with limited price to entrepreneurs which were very less to buy other needs of fundamental elements. Some producers receive maximum amount also buy selling their products as they transfer *C. axillaris* themselves to market. There was seen large gap regarding price between producers who sell their fruits to entrepreneurs and entrepreneurs who sell them into market. While studying value chain analysis of Parbat district Paudel (2012) also found that enterprises have the highest share from *C. axillaris* and producers have the lowest share in their total annual income.

Some producers want to grown *C. axillaris* in cultivated land also but according to them they were not grown like that of natural plants and their production was also very less. While studying trend analysis of production, productive area and productivity over period of 10 years (2067/68-2077/78) it was found that annual production and productive area was slightly decreasing while that of productivity was increasing which might be due to natural regeneration was very poor and artificially cultivated plants were not grown well due to edaphic and non-edaphic factors including climate, soil, precipitation, humidity and soon. Analyzing the

data of last one decade, it was found that there exists a positive correlation between total *C. axillaris* productive area and total *C. axillaris* production of Parbat district (r = 0.85) and this correlation was statistically significant (*p = 0.001*) which indicates increase in productive area increases production of *C. axillaris.*

CHAPTER VI
CONCLUSION

After assessing ecological status (frequency, density, coverage, IVI, diversity indexes. vegetation composition, structure, regeneration status) and socio-economic benefits of *C. axillaris* from four wards of Phalewas Municipality (Shankarpokhari, Thapathana, Thanamaula, and Bhangara) it was found that;

i. *Choerospondias axillaris* was dominant tree species in these areas and major associated species includes *Schima wallichi*, *Ficus nerifolia*, *Rubus ellipticus*, *Berberis aristata*, *Ageratina adenophora* and *Dryopteris intermedia.*
ii. The highest value of IVI among the trees was found for *C. axillaris* in all area and their other ecological parameters such as frequency, density, coverage were also higher.
iii. *Choerospondias axillaris* was most important and *S. wallichi* is dominant plant species in all four study sites.
iv. The seedling sapling density and regeneration of *C. axillaris* was very poor or about absent.
v. Diameter and height class distribution indicate irregular distribution of *C. axillaris*
vi. In Phalewas Municipality, *C. axillaris* found valuable species so local people could obtain socio economic benefits directly through it.

CHAPTER VII
RECOMMENDATION

Based on the literature, this study, analyses, major findings regarding the ecological status and socio-economic benefits of *C. axillaris* in Parbat district, the following recommendations can be made for the conservation, development, sustainability and optimum uses of *C. axillaris.*

i. *C. axillaris* species are native to Nepal, it has multidimensional importance. Its protection is our major requirement. A proper cooperation, coordination and partnership of government, private sector and local people concerned required for its protection.
ii. Regarding *C. a* xillaris very little study has been done so far. Extensive study should be necessary.

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ANNEXES

Annex I: Trees of Shankarpokhari

(Frequency, Relative Frequency, Basal Area, Relative Basal Area, Density, Relative Density and IVI)

S.N.	Scientific Name	Local Name	Family	F	RF	BA	RBA	D	RD	IVI
1	*Choerospondias axillaris* (Roxb.) B.L.Burtt & A.W.Hill	Lapsi	Anacardiaceae	86.67	13.68	0.12	16.66	114.55	22.59	52.94
2	*Picrasma javonica Bl.*	Teeju	Simbarbuaceae	26.67	4.21	0.04	5.57	23.33	4.60	14.39
3	*Schima wallichi* (DC.) Korth.	Chilauni	Theaceae	80.00	12.63	0.04	5.29	154.85	30.54	48.46
4	*Ficus Nerifolia Sm.*	Dhudhilo	Moraceae	26.67	4.21	0.02	3.07	12.73	2.51	9.79
5	*Prunus cerasoides* Buch.-Ham. ex D.Don	paiyu	Rosaceae	33.33	5.26	0.05	6.81	12.73	2.51	14.59
6	*Engelhardtia spicata* Lechen ex Blume	Mahuwa	Meliaceae	53.33	8.42	0.06	8.16	38.18	7.53	24.11
7	*Sapium insigne* (Royle) Benth. ex Hook. f.,	Khirro	Euphorbiaceae	26.67	4.21	0.03	4.46	8.49	1.67	10.35
8	*Castonopsis indica* (Roxb. ex Lindl.) A.DC.	Katus	Fragaceae	6.67	1.05	0.03	4.61	12.73	2.51	8.17
9	*Alnus nepalensis D. Don.*	Uttish	Betulaceae	6.67	1.05	0.02	2.39	2.12	0.42	3.86
10	*Bumbusa tuda*	Taama baans	Poaceae	33.33	5.26	0.01	1.59	16.97	3.35	10.20
11	*Zanthoxyllum armatum* DC.	Timur	Rutaceae	20.00	3.16	0.01	1.89	6.36	1.26	6.30
12	*Fraxinus Floribunda* (Wall.) Sweet	Lakuri	Oleaceae	53.33	8.42	0.06	7.67	36.06	7.11	23.21
13	*Rhododendron arboreum* Sm.	Gurans	Eriaceae	13.33	2.11	0.01	1.45	6.36	1.26	4.81
14	*Myrica esculanta Buch.* -Ham. ex D. Don	Kafal	Myriaceae	13.33	2.11	0.01	1.58	10.61	2.09	5.78
15	*Artocarpus Lacucha* Buch.-Ham.	Badahar	Moraceae	20.00	3.16	0.01	1.98	6.36	1.26	6.40
16	*Erythrina stricta Roxb*	Phadelo	Leguminaseae	33.33	5.26	0.02	3.21	10.61	2.09	10.57
17	*Zanthoxyllum oxyphyllum Edgew*	Seltimur	Rutaceae	20.00	3.16	0.01	1.53	6.36	1.26	5.94
18	*Garuga pinnata Roxb.*	Dabdabe	Burseraceae	20.00	3.16	0.01	1.62	6.36	1.26	6.03
19	*Magnifera indica L.*	Aanp	Anacardiaceae	20.00	3.16	0.02	2.95	6.36	1.26	7.36
20	Betula alnoides Buch.-Ham. ex D.Don	Saur	Betulaceae	6.67	1.05	0.03	3.44	4.24	0.84	5.33
21	*Toona ciliata M.Roem.*	Tuni	Meliaceae	26.67	4.21	0.09	11.92	8.49	1.67	17.80
22	*Rhus javonica L.*	Bhalayo	Anacardiaceae	6.67	1.05	0.02	2.39	2.12	0.42	3.86
Total/				**633.33**		**0.74**		**506.98**		

Annex II: Trees of Bhangara

(Frequency, Relative Frequency, Basal Area, Relative Basal Area, Density, Relative Density and IVI)

S.N.	Scientific Name	Local Name	Family	BA	RBA	F	RF	D	RD	IVI
1	*Choerospondias axillaris* (Roxb.) B.L.Burtt & A.W.Hill	Lapsi	Anacardiaceae	0.07	5.86	100	18.69	119.32	30.00	54.55
2	*Schima wallichi (DC.) Korth.*	Chilauni	Theaceae.	0.05	4.57	90	16.82	85.91	21.60	43.00
3	*Picrasma javonica Bl.*	Teeju	Simarbuaceae	0.10	8.93	15	2.80	4.77	1.20	12.94
5	*Ficus Nerifolia Sm.*	Dhudhilo	Moraceae	0.04	3.47	30	5.61	11.14	2.80	11.87
6	*Ficus lacor*	Kavro	Moraceae	0.05	4.38	20	3.74	7.95	2.00	10.12
7	*Litsea monopelata(Roxb.) Pers.*	kutmiro	Lauriacea	0.03	3.04	15	2.80	7.95	2.00	7.84
8	*Ficus semicordata*	Khaniu	Moraceae	0.00	0.24	40	7.48	27.05	6.80	14.52
9	*Engelhardtia spicata Lechen ex Blume*	Mahuwa	Meliacea	0.05	4.80	10	1.87	15.91	4.00	10.67
10	*Castonopsis indica(Roxb. ex Lindl.) A.DC.*	Katush	fragaceae	0.04	3.83	20	3.74	11.14	2.80	10.37
11	*Fraxinus floribunda (Wall.) Sweet*	Lakuri	oleacea	0.04	3.51	25	4.67	14.32	3.60	11.78
12	*Zanthoyllum oxyphyllum Edgew*	Seltimur	Rutaceae	0.02	1.93	15	2.80	6.36	1.60	6.34
13	*Alnus nepalensisD. Don.*	Uttish	Betulacea	0.03	2.98	35	6.54	28.64	7.20	16.72
14	*Zanthoyllum armatum DC.*	Timur	Rutaceae	0.02	1.50	10	1.87	6.36	1.60	4.97
15	*Artocarpua lacucha Buch.-Ham.*	Badhar	Moraceae	0.03	2.40	25	4.67	9.55	2.40	9.47
16	*Erythrina stricta Roxb*	Phadelo	Leguminaece	0.02	1.47	20	3.74	7.95	2.00	7.21
17	*Brassaiopsis hainla*	Chuletro	Araliaceae	0.02	1.86	15	2.80	11.14	2.80	7.46
18	*Rhus javonica L.*	Bhalayo	Anacardiacea	0.03	2.76	15	2.80	7.95	2.00	7.56
19	*Toona ciliata M.Roem.*	Tuni	Anacardiaceae	0.06	5.33	15	2.80	7.95	2.00	10.13
20	*Prunus cerasoides Buch.-Ham. ex D.Don*	Paiyu	Rosaceae	0.06	5.53	15	2.80	4.77	1.20	9.54
21	*Ficus begalonsis*	Pipal	Moraceae	0.08	7.06	5	0.93	1.59	0.40	8.39

Total	1		535		398		

Annex III: Trees of Thapathana

(Frequency, Relative Frequency, Basal Area, Relative Basal Area, Density, Relative Density and IVI)

S.N.	Scientific Name	Local name	Family	BA	RBA	F	RF	D	RD	IVI
1	*Choerospondias axillaris(Roxb.) B.L.Burtt & A.W.Hill*	Lapsi	Anacardiacea	0.07	9.65	80.00	12.12	118.79	27.05	48.83
2	*Terminalia alata*	Saj	Combretaceae	0.04	6.22	33.33	5.05	14.85	3.38	14.66
3	*Schima waliichi (DC.) Korth.*	Chilauni	Theaceae.	0.11	16.20	80.00	12.12	82.73	18.84	47.16
4	*Prunus cerasoides Buch.-Ham. ex D.Don*	Painyu	Rosaceae	0.02	2.78	40.00	6.06	27.58	6.28	15.12
5	*Ficus lecor*	Kavro	Moraceae	0.07	10.52	33.33	5.05	12.73	2.90	18.47
6	*Alnus nepalensis D. Don.*	Uttish	Betulaceae	0.06	7.75	40.00	6.06	27.58	6.28	20.09
8	*Ficus nerifolia Sm.*	Dudhilo	Moraceae	0.00	0.44	6.67	1.01	6.36	1.45	2.90
9	*Toona ciliata M.Roem.*	Tuni	Meliaceae	0.03	3.95	46.67	7.07	19.09	4.35	15.37
10	*Sapium insigne (Royle) Benth. ex Hook. f.,*	Khirro	Euphorbiaceae	0.01	1.91	40.00	6.06	16.97	3.86	11.83
11	*Pinus roxburghii*	Sallo	Pinaceae	0.05	6.92	6.67	1.01	2.12	0.48	8.41
12	*Melia azederach*	Bakaino	Meliaceae	0.03	3.59	13.33	2.02	4.24	0.97	6.57
13	*Betula alnoides Buch.-Ham. ex D.Don*	Saur	Betulaceae	0.06	8.41	33.33	5.05	14.85	3.38	16.84
14	*Zanthoyllum oxyphyllum Edgew*	Seltimur	Rutaceae	0.01	2.11	33.33	5.05	10.61	2.42	9.57
15	*Myrica esculenta* Buch.-Ham. ex D. Don	Hade kafal	Myriaceae	0.03	3.54	33.33	5.05	19.09	4.35	12.94
16	*Rhododendron arborium Sm.*	guras	Eriaceae	0.01	1.93	20.00	3.03	10.61	2.42	7.37
17	*Engelhardtia spicata Lechen ex Blume*	Mahuwa	Meliaceae	0.01	1.43	40.00	6.06	16.97	3.86	11.36
18	*Rhus javonica L.*	Bhalayo	Anacardiacea	0.01	1.97	20.00	3.03	6.36	1.45	6.45

19	*Litsea monopelata(Roxb.) Pers.*	Kutmiro	Lauriacea	0.04	5.85	6.67	1.01	6.36	1.45	8.31
20	*Fraxinus floribunda (Wall.) Sweet*	Lakuri	Oleaceae	0.03	4.16	53.33	8.08	21.21	4.83	17.08
	Total			**0.71**		**660.00**		**439.10**		

Annex IV: Trees of Thanamaula

(Frequency, Relative Frequency, Basal Area, Relative Basal Area, Density, Relative Density and IVI)

S.N.	Scientific Name	Local Name	Family	BA	RBA	F	RF	D	RD	IVI
1	*Choerospondias axillaris(Roxb.) B.L.Burtt & A.W.Hill*	Lapsi	Anacardiaceae	0.09	10.06	100.00	17.74	85.30	21.38	49.17
2	*Schima wallichi (DC.) Korth.*	Chilauni	Theaceae.	0.04	4.78	63.64	11.29	76.63	19.20	35.27
3	Castonopsis indica (Roxb. ex Lindl.) A.DC.	Katush	fragaceae	0.07	7.88	40.91	7.26	37.59	9.42	24.56
4	*Sapium insigne (Royle) Benth. ex Hook. f.,*	Khirro	Euphorbiaceae	0.01	1.01	54.55	9.68	40.48	10.15	20.83
7	*Ficus benjamina*	Sami	Moraceae	0.16	19.32	22.73	4.03	10.12	2.54	25.89
8	*Toona ciliata M.Roem.*	Tuni	Meliaceae	0.05	5.78	22.73	4.03	14.46	3.62	13.43
9	*Garuga pinnata Roxb.*	Dabdabe	Burseraceae	0.02	1.94	9.09	1.61	2.89	0.72	4.28
10	*Rhododendron arboreum Sm.*	Laligurans	Eriaceae	0.02	2.72	22.73	4.03	8.68	2.17	8.93
11	*Rhus javonica L.*	Bhalayo	Anacardiaceae	0.02	2.31	27.27	4.84	15.90	3.99	11.14
12	*Engelhardtia spicata Lechen ex Blume*	Mahuwa	Meliaceae	0.06	7.38	18.18	3.23	5.78	1.45	12.05
13	*Brassaiopsis hainla*	Chuletro	Araliaceae	0.02	1.94	9.09	1.61	2.89	0.72	4.28
14	*Picrasma javonica Bl.*	Teeju	Simbarbuaceae	0.02	2.37	13.64	2.42	4.34	1.09	5.87
15	*Fraxinus Floribunda (Wall.) Sweet*	Lakuri	Oleaceae	0.03	3.72	31.82	5.65	20.24	5.07	14.44
17	*Prunus cerasoides Buch.-Ham. ex D.Don*	paiyu	Rosaceae	0.03	3.09	31.82	5.65	15.90	3.99	12.72
18	*Dalbergia sissoo*	Sisau	Leguminaceae	0.03	3.98	9.09	1.61	5.78	1.45	7.04
19	Ficus Semicordata	khaniyu	Moraceae	0.02	1.77	18.18	3.23	8.68	2.17	7.17
20	*Streblus asper*	Bedulo	Moraceae	0.03	3.70	9.09	1.61	5.78	1.45	6.76
21	*Litsea monopelata*	kutmiro	Lauriacea	0.02	2.16	18.18	3.23	10.12	2.54	7.92
22	*Ficus Nerifolia sm.*	Dhudhilo	Moraceae	0.01	1.19	9.09	1.61	4.34	1.09	3.89
24	*Melia azederach*	Bakaino	Meliaceae	0.02	2.52	9.09	1.61	2.89	0.72	4.85
25	*Shorea robusta*	Saal	Dipterocarpaecea	0.03	3.70	4.55	0.81	1.45	0.36	4.87
26	*Alnus nepalensis D. Don.*	Uttish	Betulaceae	0.06	6.74	18.18	3.23	18.80	4.71	14.67
	Total			**0.85**		**563.64**		**399.05**		

Annex V: Herbs of Shankarpokhari

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N.	Scientific Name	Local Name	Family	F	RF	D	RD	TC	C	RC	IVI
1	*Arisaema erubescens*	Sarpako Makai	Araceae	13.33	2.38	14.85	1.32	13	0.87	2.05	5.75
2	*Ageratina adenophora*	Banmara	Compositae	93.33	16.67	335.16	29.37	273	18.20	43.06	89.09
3	*Utrica dioca*	Sisnoo	Urticaceae	13.33	2.38	14.85	1.30	11	0.73	1.73	5.42
4	*Bidens pilosa*	Kuro	Asteraceae	40.00	7.14	70.00	6.13	46	3.07	7.25	20.53
5	*Achyranthes aspera*	Datiyon	Amaranthaceae	40.00	7.14	53.03	4.65	14	0.93	2.21	14.00
6	*Frageria nubicola*	Bhuie Aiselu	Rosaceae	20.00	3.57	14.85	1.30	29	1.93	4.57	9.45
7	*Ageratum conyzoides*	Boke ghas	Compositae	60.00	10.71	142.12	12.45	58	3.87	9.15	32.31
8	*Cyperus difformis*	Banso	Cyperaceae	20.00	3.57	36.06	3.16	13	0.87	2.05	8.78
9	*Saccharum spontaneum*	Kanns	Graminae	13.33	2.38	8.49	0.74	6	0.40	0.95	4.07
10	*Ageratum houstonium*	Nilo gandhe	Compositae	33.33	5.95	95.46	8.36	31	2.07	4.89	19.21
11	*Lycopodium*		Lycopodiaceae	26.67	4.76	67.88	5.95	22	1.47	3.47	14.18
12	*Smilax aspera*	Kukur dianyo	Liliaceae	6.67	1.19	2.12	0.19	2	0.13	0.32	1.69
13	*Begonia picta*	Makarkanchi	Begoniaceae	26.67	4.76	16.97	1.49	4	0.27	0.63	6.88
14	*Sesbania grandiflora*	Dansinki	fabaceae	20.00	3.57	42.43	3.72	13	0.87	2.05	9.34
15	*Cynodon dactylon*	Dubo	Graminae	33.33	5.95	89.09	7.81	35	2.33	5.52	19.28
16	*Centella asiatica*	Bholtapre	Compositae	13.33	2.38	8.49	0.74	2	0.13	0.32	3.44
17	*Oxalis corniculata*	Chari amilo	Oxalideacea	20.00	3.57	29.70	2.60	17	1.13	2.68	8.85
18	*Artemesia vulgaris*	Setopati	Asteraceae	26.67	4.76	42.43	3.72	28	1.87	4.42	12.90
19	*Reinwardtia indica*	Pyauli	Lineaceae	20.00	3.57	27.58	2.42	13	0.87	2.05	8.04
20	*Rumex crispus*	Halhale sag	Polygonaceae	20.00	3.57	14.85	1.30	4	0.27	0.59	5.46

Total	**560.00**		**1126.38**		**634.00**	**42.27**		

Annex VI: Herbs of Bhangara

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N.	Scientific Name	Local Name	F	RF	C	RC	D	RD	IVI
1	*Ageratina adenophora*	Banmara	73.33	13.41	30.07	32.56	284.25	20.58	66.56
2	*Cyperus difformis*	Banso	20.00	3.66	1.87	2.02	44.55	3.23	8.91
3	Dryopteris intermedia	Fern	13.33	2.44	6.87	7.44	42.43	3.07	12.95
4	*Cynodon dactylon*	Dubo	20.00	3.66	5.00	5.42	89.09	6.45	15.53
5	*Bidens pilosa*	Kuro	20.00	3.66	1.67	1.81	70.00	5.07	10.53
6	*Triumfetta pilosa*	Dalle kuro	20.00	3.66	1.60	1.73	38.18	2.76	8.16
7	*Artemesia vulgaris*	Setopati	26.67	4.88	4.80	5.20	38.18	2.76	12.84
8	*Ageratum conyzoides*	Boke ghas	26.67	4.88	1.47	1.59	53.03	3.84	10.31
9	*Saccharum spontaneum*	Kanns	6.67	1.22	0.73	0.79	8.49	0.61	2.63
10	*Sesbania grandiflora*	Dansinki	46.67	8.54	4.07	4.40	108.18	7.83	20.78
11	*Begonia picta*	Makarkanchi	6.67	1.22	0.80	0.87	4.24	0.31	2.39
12	*Rumex crispus*	Halhale Sag	6.67	1.22	0.87	0.94	4.24	0.31	2.47
15	*Reinwardtia indica*	Pyauli	13.33	2.44	1.27	1.37	16.97	1.23	5.04
16	*Utrica dioica*	Sisnoo	20.00	3.66	3.20	3.47	16.97	1.23	8.35
17	*Centella asiatica*	Bholtapre	33.33	6.10	2.13	2.31	50.91	3.69	12.09
19	*Themeda triandra*	Khaar	20.00	3.66	1.87	2.02	44.55	3.23	8.91
20	*Frageria nubicola*	bhueAiselu	26.67	4.88	2.73	2.96	72.12	5.22	13.06
21	*Eleusine indica*	Kode Jhar	26.67	4.88	7.87	8.52	114.55	8.29	21.69
22	*Digitaria ciliaris*	Banso	33.33	6.10	3.20	3.47	82.73	5.99	15.55
23	*Ageratum houstonium*	Nilo gandhe	26.67	4.88	3.87	4.19	80.61	5.84	14.90
24	*Trofolium sp*		40.00	7.32	3.53	3.83	101.82	7.37	18.52
25	*Nephrolepis cordifolia*	Pani amala	20.00	3.66	2.87	3.10	14.85	1.08	7.84
Total			**546.67**		**92.33**		**1380.93**		

Annex VII: Herbs of Thapathana

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N.	Scientific Name	F	RF	C	RC	D	RD	IVI
1	*Ageratina adenophora*	80	16.67	31.53	54.62	239.70	36.45	10.67
2	Cyperus difformis	20	4.17	1.33	2.31	27.58	4.19	14.53
3	Dryopteris intermedia	26.67	5.56	2.20	3.81	33.94	5.16	12.98
4	Cynodon dactylon	26.67	5.56	0.93	1.62	38.18	5.81	18.34
5	Bidens pilosa	40	8.33	1.87	3.23	44.55	6.77	4.97
6	Triumfetta pilosa	13.33	2.78	0.33	0.58	10.61	1.61	24.10
7	*Artemesia vulgaris*	26.67	5.56	5.87	10.16	55.15	8.39	10.14
8	*Ageratum conyzoides*	26.67	5.56	0.60	1.04	23.33	3.55	7.56
9	*Saccharum spontaneum*	20	4.17	0.47	0.81	16.97	2.58	7.53
10	*Sesbania grandiflora*	13.33	2.78	1.07	1.85	19.09	2.90	4.53
11	*Begonia picta*	13.33	2.78	0.27	0.46	8.49	1.29	8.85
12	*Rumex crispus*	20	4.17	1.40	2.43	14.85	2.26	8.07
14	*Tinospora cordifolia*	20	4.17	1.13	1.96	12.73	1.94	14.48
15	*Reinwardtia indica*	26.67	5.56	1.80	3.12	38.18	5.81	7.28
16	*Smilax aspera*	20	4.17	0.87	1.50	10.61	1.61	7.05
17	*Utrica dioica*	13.33	2.78	1.53	2.66	10.61	1.61	6.89
18	*Centella asiatica*	20	4.17	0.27	0.46	14.85	2.26	2.96
19	*Solena heterophylla*	6.67	1.39	0.53	0.92	4.24	0.65	8.02
20	*Themeda triandra*	20	4.17	0.73	1.27	16.97	2.58	13.33
21	*Rubus elipticus*	26.67	5.56	3.00	5.20	16.97	2.58	0.00
	Total	**480**		**57.7**		**657.59**		

Annex VIII: Herbs of Thanamaula

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N	Scientific Name	F	RF	C	RC	D	RD	IVI
1	Drypteris intermedia	36.36	9.30	4.82	12.50	67.98	10.93	32.73
2	Cyperus iria	27.27	6.98	1.50	3.89	41.94	6.74	17.61
3	*Ageratum conyzoides*	36.36	9.30	2.32	6.01	52.07	8.37	23.69
4	Tamariandrus Sps.	27.27	6.98	1.73	4.48	37.60	6.05	17.50
5	*Frageria nubicola*	18.18	4.65	1.18	3.07	14.46	2.33	10.04
6	*Ageratina adenophora*	36.36	9.30	8.77	22.76	86.78	13.95	46.01
7	*Lycopodium Sps.*	13.64	3.49	0.36	0.94	10.12	1.63	6.06
8	Triumfetta pilosa	9.09	2.33	0.05	0.12	4.34	0.70	3.14
9	*Cyperus difformis*	27.27	6.98	1.05	2.71	27.48	4.42	14.11
11	*Bidens pilosa*	45.45	11.63	2.50	6.49	83.89	13.49	31.60
12	*Alpuda mutica*	9.09	2.33	0.23	0.59	13.02	2.09	5.01
13	*Oxalis corniculata*	31.82	8.14	1.14	2.95	43.39	6.98	18.06
14	*Imperata cylindrical*	27.27	6.98	0.41	1.06	30.37	4.88	12.92
15	*Artemesia vulgaris*	31.82	8.14	12.00	31.13	83.89	13.49	52.76
16	*Saccharum spontaneum*	13.64	3.49	0.50	1.30	24.59	3.95	8.74
	Total	**390.91**		**38.55**		**621.91**		

Annex IX: Shrubs of Shankarpokhari

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N	Scientific Name	Local name	Family	F	RF	D	RD	C	RC	IVI
1	*Melastoma melabathricum*	Chulesi	Melastomaceae	40	7.89	38.18	10.71	2.33	5.85	24.46
2	*Randia aculeate*	Kanike	Rubiaceae	46.67	9.21	31.82	8.93	3.60	9.03	27.17
3	*Rubus ellipticus*	Ainselu	Rosaceae	46.67	9.21	31.82	8.93	3.67	9.20	27.34
4	*Berberis aristata*	Chuttro	Berberidaceae	53.33	10.53	25.46	7.14	3.13	7.86	25.53
5	*Justica adathoda*	Aasuro	Acanthaceae	26.67	5.26	12.73	3.57	1.07	2.68	11.51
6	*Calotro gigantea*	Aank	Apocynaceae	13.33	2.63	8.49	2.38	0.67	1.67	6.68
7	*Colebrookea oppositofolia*	Dhursulo	Lamiaceae	46.67	9.21	23.33	6.55	6.60	16.55	32.31
8	*Vitex negundo*	Simali	Lamiaceae	40	7.89	27.58	7.74	7.40	18.56	34.19
9	*Turmeric Plants*	Aduwa	Zingiberaceae	20	3.95	12.73	3.57	0.40	1.00	8.52
10	*Oxyspora paniculata*	Chulesi jhar	Melastomataceae	13.33	2.63	21.21	5.95	0.60	1.50	10.09
11	*Desmodium microphyllym*	Bakhre ghas	Fabaceae	33.33	6.58	31.82	8.93	1.73	4.35	19.85
12	*Artemesia indica*	Setopati	Asteraceae	46.67	9.21	38.18	10.71	2.40	6.02	25.94
13	*Osbekia nepalensis*	Seto chulsi	Melastomataceae	13.33	2.63	6.36	1.79	0.47	1.17	5.59
14	*Rubus rosifolius*	Baan Aiselu	Rosaceae	13.33	2.63	12.73	3.57	0.53	1.34	7.54
15	*Desmodium elegans*		Fabaceae	6.67	1.32	4.24	1.19	0.33	0.84	3.34
16	*Buddleja asiatica*	Bhimesen pati	Scrophulariaceae	20.00	3.95	16.97	4.76	3.33	8.36	17.07
17	*Gultheria hookei*	Patpate	Ericaceae	13.33	2.63	6.36	1.79	0.60	1.50	5.92
18	*Drepanostachyum intermedium*	nigalo	Poaceae	13.33	2.63	6.36	1.79	1.00	2.51	6.93

	Total	**506.67**		**356.37**		**39.87**		

Annex X: Shrubs of Bhangara

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N	Scientific Name	Local name	Family	F	RF	D	RD	C	RC	IVI
1	*Randia aculeta.l*	Kanike	Rubiaceae	30	7.89	22.27	8.92	45	10	26.81
2	*Berberis aristata*	Chutro	Berberidaceae	60	15.79	35.00	14.01	87	19.33	49.14
3	*Thysanolaena maxima*	Amriso	Poaceae	10	2.63	4.77	1.91	20	4.44	8.99
4	*Melastoma melabathricum*	chulesi	Melastomataceae	20	5.26	15.91	6.37	22	4.89	16.52
5	*Rubus ellipticus*	Aaiselu	Rosaceae	55	14.47	50.91	20.38	64	14.22	49.08
6	*Drepanostachyum intermedium*	Nigalo	Poaceae	15	3.95	9.55	3.82	9	2	9.77
7	*Rubia manjith*		Rubiaceae	30	7.89	15.91	6.37	13	2.89	17.15
8	*Osbekia nepalensis*	Seto chulsi	Melastomataceae	15	3.95	6.36	2.55	8	1.78	8.27
9	*Gultheria hookei*	patapate	Ericaceae	20	5.26	7.95	3.18	16	3.56	12.00
10	*Rubus rosifolius*	Baan aiselu	Rosaceae	40	10.53	33.41	13.38	37	8.22	32.12
11	*Bauhinia purpureaq*	Tanki	Fabaceae	15	3.95	9.55	3.82	32	7.11	14.88
12	*Vitex negundo*	Simali	Lamiacaceae	15	3.95	6.36	2.55	19	4.22	10.72
13	*Justicia adhathoda*	Aasuro	Acanthaceae	15	3.95	11.14	4.46	16	3.56	11.96
14	*Citrus maxima*		Rutaceae	10	2.63	4.77	1.91	6	1.33	5.88
15	*Colebrookea oppositofolia*	Dhusulo	Lamiacaceae	10	2.63	4.77	1.91	40	8.89	13.43
16	*Desmodium microphyllum*	Bakhre ghas	Fabaceae	10	2.63	6.36	2.55	7	1.56	6.73
17	*Buddleja asiatica*	Bhimsen pati	Scrophulariaceae	10	2.63	4.77	1.91	9	2	6.54
	Total			**380**		**249.8**		**450**		

Annex XI: Shrubs of Thapathana

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N.	Scientific Name	Local name	Family	F	RF	D	RD	C	RC	IVI
1	*Rubus ellipticus*	Aiselu	Rosaceae	60	14.75	27.58	13.13	3.20	15.69	43.57
2	*Vitex negundo*	Simali	Lamiaceae	13.33	3.28	6.36	3.03	0.93	4.58	10.88
3	*Justica adathoda*	Aasuro	Acanthaceae	13.33	3.28	4.24	2.02	0.67	3.27	8.57
4	*Berberis aristata*	Chutro	Berberidaceae	53.33	13.11	29.70	14.14	2.67	13.07	40.33
5	*Drepanostachyum intermedium*	Nigalo	Poaceae	26.67	6.56	12.73	6.06	0.87	4.25	16.87
6	*Randia aculeata*	Kanike	Rubiaceae	26.67	6.56	10.61	5.05	0.93	4.58	16.18
7	*Calotro gigantea*	Aank	Apocynaceae	6.67	1.64	2.12	1.01	0.27	1.31	3.96
8	*Rubus rosifolius*	Baan aiselu	Rosaceae	40	9.84	19.09	9.09	1.07	5.23	24.16
9	*Hedra nepalensis*		Araliaceae	26.67	6.56	10.61	5.05	0.80	3.92	15.53
10	*Rubia manjith*		Rubiaceae	26.67	6.56	10.61	5.05	1.00	4.90	16.51
11	*Thysanolema maxima*	Aamriso	Poaceae	13.33	3.28	25.46	12.12	3.33	16.34	31.74
12	*Bauhina purpurea*	Tanki	Fabaceae	6.67	1.64	4.24	2.02	0.27	1.31	4.97
13	*permna integrifolia*	Gidari	Lamiaceae	13.33	3.28	6.36	3.03	0.40	1.96	8.27
14	*Turmeric species*	Aaduwa	Zingiberaceae	20.00	4.92	8.49	4.04	0.53	2.61	11.57
15	*Desmodium elegans*		Fabaceae	13.33	3.28	4.24	2.02	0.33	1.63	6.93
16	*Buddleja asiatica*	Bhimsen pati	Scrophulariaceae	20	4.92	10.61	5.05	0.67	3.27	13.24
17	*Solanum species*	Kantakari	Solanaceae	26.67	6.56	16.97	8.08	2.47	12.09	26.73
	Total			**406.67**		**210.00**		**20.40**		

Annex XII: Shrubs of Thanamaula

(Frequency, Relative Frequency, Density, Relative Density, Coverage, Relative Coverage and IVI)

S.N	Scientific Name	F	RF	D	RD	C	RC	IVI
1	*Rubus ellipticus*	54.55	12.12	39.05	10.59	3.82	15.76	38.47
2	*Rubus rosifolius*	22.73	5.05	18.80	5.10	0.95	3.94	14.09
3	*Vitex negundo*	9.09	2.02	13.02	3.53	1.59	6.57	12.12
4	*Melastoma melabathricum*	18.18	4.04	8.68	2.35	0.64	2.63	9.02
5	*Justica adathoda*	13.64	3.03	20.25	5.49	0.50	2.06	10.58
6	*Artemesia indica*	45.45	10.10	54.96	14.90	2.55	10.51	35.51
7	*Berberis aristata*	54.55	12.12	54.96	14.90	3.36	13.88	40.91
8	*Solanum dimidatum*	22.73	5.05	8.68	2.35	1.18	4.88	12.28
9	*Colebrookea oppositofolia*	50.00	11.11	44.84	12.16	2.73	11.26	34.52
10	*Drepanostachyum intermedium*	9.09	2.02	7.23	1.96	0.27	1.13	5.11
11	*Randia aculeate*	13.64	3.03	10.12	2.75	0.45	1.88	7.65
12	*Buddleja asiatica*	31.82	7.07	17.36	4.71	1.00	4.13	15.90
13	*Phyllanthus parvifolium*	13.64	3.03	8.68	2.35	0.45	1.88	7.26
14	*Desmodium microphyllum*	9.09	2.02	4.34	1.18	0.23	0.94	4.13
15	*Osbekia nepalensis*	13.64	3.03	7.23	1.96	0.23	0.94	5.93
16	*Herdera nepalensis*	18.18	4.04	10.12	2.75	0.45	1.88	8.66
17	*Oxyspora paniculata*	9.09	2.02	8.68	2.35	0.59	2.44	6.81
18	*Thysanolaena maxima*	13.64	3.03	15.91	4.31	1.00	4.13	11.47
19	*Citrus maxima*	18.18	4.04	8.68	2.35	1.09	4.50	10.90
20	*Turmeric species*	9.09	2.02	7.23	1.96	1.14	4.69	8.67
		450.00		**368.81**		**24.23**		

Annex XIII: Data Sheet of Trees

Date:…… Name of the recorder…….

District:…….Locality:…….Altitude (m):…….Aspect:……

Slope:……..Latitude:……Longitude:……

Forest type:…….Disturbance, Grazing (0 – 3):……..

Plot No: Quadrate No: Quadrate size:

S. N.	Scientific Name (Plant Species)	Local Name	DBH (cm)	Height (m)	Remarks

Annex XIV: Data Sheet of Herbs and Shrubs

Date:…….. Name of the recorder……..

District:…….Locality:…….Altitude (m):……..Aspect:……..

Slope:……..Latitude:……Longitude:…….

Forest type:…..…… Disturbance, Grazing (0 – 3):……....

Plot No.: Quadrate No.: Quadrate size:

S.N.	Plant species	Local name	No. of species	Coverage	Remarks

Annex XIV: Research Questionnaires; Local Producer (Farmers)

Dear sir/madam,
I am investigating the ecological status and socio-economic benefits of Lapsi in Parbat district. Please answer the following questions as fairly as possible.
Thank you.

A. Demography

Name (Optional): **Gender:** M / F **Age:** Below 30, 30-50 above 50

Address: a. Bhangara b. Thapathana c.Thanamaula d. Shankarpokhari e.Other

Education: a. Basic School (1-8) b. Secondary School (9-10) c. High Education

B. Lapsi Farming Status

Family Size: a. Less than 4 b. 4-6 c. More than 6

Members Engaged in Lapsi Farming: a. Less than 4 b. 4-6 c. More than 6

Engaged years in Lapsi Farming: a. Less than 3 years b. 3-5 c. More than 5

Amount of land used for Lapsi Farming: ……. Ropani……Ana (…….Sq Meter)

C. Economic Benefits of Lapsi Farming (Trade Status)

1. What is approximate amount of Lapsi production in a year?
2. What is your annual income (approximately) in NRs?
3. What is approximate annual income from *Lapsi* farming, from a Ropani area in NRs?
4. What is approximate annual expense for *Lapsi* farming, for a Ropani area in NRs?
5. Who are your major customers?
6. How do you find customers?
7. Is anybody viz. government and NGOs assisting you for *Lapsi* farming? If yes how and how much? (seeds, technology, cash or other)?

D. Non-economic (Social) Status

1. What are the secondary products of *Lapsi?*
2. Is there any medicinal or cultural value of *Lapsi?* if yes, please mention……..

Annex XV: Photo Collection

Photo 1: Lading quadrate to collect the ecological data

Photo 2: Seedling of *C. axillaris*

Photo 3: Seedling of *C. axillaris*

Photo 3: Tree of *C. axillaris*

Photo 4, 5 & 6: Data collection of *C. axillaris* and Associated species

Photo 7: Interviewing with the Local Producer of *C. axillaris*

Photo 8: Interviewing with the Local Producer and Trader of *C. axillaris*