

**AGRICULTURAL LAND USE CHANGE IN TARAI OF
NAWALPARASI DISTRICT:
A TEMPORAL AND SPATIAL ANALYSIS**

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By

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LETTER OF RECOMMENDATION

We certify that this dissertation entitled **“AGRICULTURAL LAND USE CHANGE IN TARAI OF NAWALPARASI DISTRICT: A TEMPORAL AND SPATIAL ANALYSIS”** was prepared by **Mr. Bhola Nath Dhakal** under our guidance. We hereby recommend this dissertation for final examinations by Research Committee of the Faculty of Humanities and Social Sciences, Tribhuvan University in fulfillment of the requirements for the Degree of **DOCTOR OF PHILOSOPHY in GEOGRAPHY**.

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Date: May 2019

APPROVAL LETTER

DECLARATION

I, hereby, declare that this Dissertation is my own work and that it contains no materials previously published. I have not used its materials for the award of any kind and any other degree. Where other authors' sources of information have been used, they have been acknowledged.

Bhola Nath Dhakal

Date: May 2019

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ABSTRACT

This study entitled “Agricultural Land Use Change in Tarai of Nawalparasi District: A Temporal and Spatial Analysis” has set three objectives: i) analyze the trends of agricultural land use change in terms of its pathways, magnitude and pace, ii) identify the main drivers of agricultural land use change, and iii) assess the state of input use in agricultural land management.

Primary and secondary sources of data have been used in this study. Primary data were collected through household survey, Focus Group Discussion, Key Informant Interview and field observation in three VDCs of Nawalparasi district. Those are Jahada VDC (ward number 3), Palhi VDC (ward number 9) and Ramnagar VDC (ward number 5). Secondary information was obtained from published articles, unpublished documents and government records, maps and satellite images. Both qualitative and quantitative techniques have been used for the data generation, compilation and analysis.

First, land use is highly dynamic and changes by space and time. Cultivated land has gained its coverage from forest in the beginning, while it transformed to built-up area later. It is clear that agricultural land use change through different stage from extensive to intensive utilization and finally converted to built-up area in the situation of availability of market and demographic pressure. Agricultural land has increased between 1958 to 1994, but it has decreased from 1994 to 2009 in all study sites. Similarly, built-up area has the highest Change Intensity Index (T_i), Rate of Change (A_i) and Dynamic Index (K_i) in all study sites. The overall landholding size owned by agricultural holders in study sites has however decreased.

There are different pathways and magnitude of agricultural land use change in study sites. It has been found that area under crop land changed to built-up area by 18.6 percent in Jahada, 31.5 percent in Palhi and 10.9 percent in Ramnagar during the ten years of study period. There has been noticed the variation in the productivity of major crops in the study sites. The productivity index is higher in Palhi and Ramnagar than Jahada. It has been found that cropping intensity increased with the increasing in irrigation facilities. The value of cropping intensity has been ranging from 141 to 226 in the study sites. In addition, the change in crop calendar has been also observed in the study area during the study period.

Second, population change, off-farm employment, infrastructural development, use of modern inputs and technology and land ownership status are major drivers of agricultural land use change. In-migration and population growth are the main reasons for agricultural land use change in study sites during the study period. Similarly, farmers' involvement in off-farm activities, such as business, services, foreign employment are the important drivers of agricultural land use change. It is found that number of households increased by one-third (32.2 percent) and population density has increased by 14.8 percent in study sites during the ten years of study period. Land tenure status and availability of agricultural land has also played a major role in the use of inputs in the study sites.

Third and finally, use of labour force, manure, chemical fertilizers and pesticides, use of machineries, development of irrigation facilities, land intensification and crop diversification are the major land management practices observed in the study sites. The use of manure is increasing in all study sites. Labour input has increased in major crops such as, wheat, pulses and oilseeds by different land holdings size. The labour input is higher in small size of land holding in major crops such as, paddy and wheat cultivation. Hired and exchange of labours also are used in addition to family members in their farmlands. Labour input intensity is highest in potato cultivation in Jahada and Palhi. Similarly, it is the highest in paddy cultivation in Ramnagar. The changing trend of productivity is higher in large size of land holding in Jahada whereas productivity is higher in small size of land holding in Palhi and Ramnagar. However, the highest productivity is found in paddy in all study sites. Similarly, highest output intensity is found from paddy production in Jahada and Ramnagar whereas it is highest in vegetables in Palhi. In addition to labour and manure inputs, chemical fertilizer has also been used in paddy, wheat and oilseeds in all study sites. Farmers have used pesticides only in paddy cultivation in all study sites. The productivity of paddy and wheat has increased, whereas productivity of maize has decreased by different land holding sizes. Productivity of paddy has increased in Palhi and Ramnagar with the use of local and improved seeds, whereas it has decreased in Jahada with the use of local seeds. Furthermore, decisive role of farmer by land tenure status and education level have also affected on agricultural production. Farmers have adopted intensification and crop diversification practices in study sites through the changes in crops from one type of crop to another and also

changed in the varieties of seeds within the particular type of crop. Farmers have been using intensive farming in the parcels close to residence/house than some farther locations.

Crop Diversity Index (CDI) values are higher than 0.5 which seems closer to 1.0 in the study sites (0.71 in Jahada, 0.64 in Palhi and 0.76 in Ramnagar). The CDI values are also increased during the study period. The higher Crop Diversity Index (CDI) value indicates that farmers have adopted crop diversification practices in agricultural land management in the study sites.

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ABBREVIATIONS/ACRONYMS

ADB	Agricultural Development Bank
ADS	Agricultural Development Strategy
APP	Agricultural Perspective Plan
CBS	Central Bureau of Statistics
DADO	District Agricultural Development Office
DDC	District Development Committee
DHM	Department of Hydrology and Meteorology
DoS	Department of Survey
FAO	Food and Agriculture Organization for United Nations
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GIS	Geographic Information System/Science
GPS	Global Positioning System
GoN	Government of Nepal
KII	Key Informant Interview
LRMP	Land Resource Mapping Project
MoA	Ministry of Agriculture
MoAD	Ministry of Agricultural Development
MoFALD	Ministry of Federal Affairs and Local Development
MSS	Multi Spectral Scanner
NPC	National Planning Commission
SI	International System of Units
SLC	School Leaving Certificates
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNEP	United Nations Environment Program
VDC	Village Development Committee

CHAPTER 1

INTRODUCTION

1.1 Background

Land is an essential natural resource, both for the survival and prosperity of humanity and for the maintenance of ecosystems (FAO, 2007). Land is any delineable area of the Earth's terrestrial surface, involving all attributes of the biosphere immediately above and below the surface (European Commission, 2001). It is the basic, fixed and limited natural resource which plays the key role in the fulfillment of human needs, and it determines the economic, social and cultural development. Land is used for different purposes: it is dynamic and changes with time and space. Hence, land use is being shaped under the influence of two sets of forces - human needs and environmental features and processes (Briassoulis, 2000).

Land use is the surface utilization of all developed and vacant land on a specific point at given time and space (Mandal, 1982). Land use is defined by the purposes for which humans make use of land cover. There is a high variability in time and space in biophysical environments, socioeconomic activities, and cultural contexts that are associated with land use change (Ojima, Galvin, & Turner, 1994). Land use is a product of interactions between a society's cultural background and its physical needs on the one hand, and the natural potential of land on the other (Ram & Kolarkar, 1993). Besides, land use is a primary indicator of the extent and degree to which man has modified the land resources (Vink, 1975).

Land use is a projection of people's life style and activities onto the land surface, which reflects deeply on various environmental conditions, such as nature, economy, history and culture (Verburg, Erb, Mertz, & Espindola, 2013). As a result, research on land use has been the most traditional and fundamental subject to study in geography. More specifically, agricultural land use has been a main topic of interest among geographers, as it directly represents the relationship between people and their environment (Binns, 1995). The research about agricultural land use can be divided into two categories: one is a static analysis of actual agricultural land use to identify its spatial distribution and patterns, while the other is a dynamic analysis of temporal variations of agricultural land use from the past to present (Ogale, 2014).

Based on this, agricultural land use is the result of inter-action between human and environment. The term agricultural land use denotes the extent of the gross cropped area during the agricultural year under various crops (Vaidya, 1997). It is generally classified into two

categories: the crop land and the ponds. Crop land is further classified into three categories, namely: arable land, land under permanent crops and land under permanent meadows and pastures (CBS, 2002).

Agricultural land use is changing globally both in terms of area and productivity. Agricultural area has increased by 11.36 percent in the World from 1960 to 2014 (World Bank, 2014). Agricultural land use in Nepal is also changing. Though total agricultural area has increased by 35.8 percent during 1961/62 to 2011/12, per capita cultivated land has decreased due to rapid growth in population (CBS, 2013b). Agricultural land use change takes place over time with the change in population, technological intervention, livelihood strategies, perception, political economy and institutions and biophysical environment. The drivers of such change may be external forces and or endogenous factors (Lambin, Geist, & Lepers, 2003).

Associated with it are different physical drivers, like flood, landslides, drought, etc., biological drivers like pest, diseases, alien species, weeds etc. and socio-economic drivers, like population, and infrastructure development, government policies, livelihood strategies, and use of technology etc. They are responsible in changes in land uses in different parts of the world (MoAD, 2017).

Land management is the process of managing the use and development of land resources (Foley et al., 2005). It is the process of land resources use for good effect which includes agricultural activities, the formation and implementation of land use policies, environmental impact assessment, and the monitoring of all activities on land that affect the best use of that land (UN, 1996).

Agricultural land management has the main objective of an economic or production target, focusing on the optimization, in enhancing sustainable maximization of outputs. Good management requires that good practices be maintained in time and prepared to adapt to changing conditions (Verheye, 2009). Agricultural land management is the product of available biophysical condition on the one hand and the use of inputs in terms of labor, new technology, improved seeds, fertilizers, pesticides, irrigation etc. to obtain optimum level of production on another (Sheahan & Barrett, 2017).

If the agricultural land is not managed properly, it tends to degrade and production is lost. Agricultural land is managed through different strategies, like physical land management practices (traditional terraces, modern terraces, soil bund, contour plough etc.), biological land

management practices (like agro forestry, grass strips etc.) and agronomic practices (like fallowing, inter cropping, crop rotation, use of improved crop seeds, crop diversification etc.) (Malik, 1998).

Agricultural land is managed through the increase in use of chemical fertilizers and farm yard manure, inter-cropping and crop rotation, agro forestry, mulching, legume cultivation and crop residue, stone and earthen bunds, grass strips, alley cropping and contour-plowing (Thapa & Yila, 2012). Moreover, it is managed by labor-saving input, use of improved seeds, chemical fertilizer, pesticide and increase in machinery input, capital intensity, intensification and crop diversification, government policies (Carswell, 2002; MacLeod & Moller, 2006; Kumar & Singh, 2012; Li, Yu, & Gong, 2013). Agricultural land can be managed through construction of traditional ditches, waterways, check dam and stone bund, mixed cropping, crop rotation (Miheretu & Yimer, 2017), and increasing use of chemical fertilizers, pesticides, increased access with irrigation and market for input and output, constructing terraces and soil nutrients through manuring and runoff (Khanal, 2002). Through intensification and diversification, practice of new crops, shifting from cereal crops to livestock husbandry, structural and biological measures to control soil erosion, landslides, gully expansion and soil nutrient loss are the strategies of agricultural land management (Poudel, 2002).

Agriculture land use is an important indicator for an appropriate use or misuse of land. Information on agricultural land use and land management practices are essential for the better management and economic development of natural resources. Information regarding the current state of resources and how they are being managed is required to predict future condition. It is in this context that proper understanding of the agricultural land uses, in terms of the area and management is necessary in order to develop agricultural strategies for the increase of the level of production and improve food security in the country.

1.2 Statement of the Problem

Nepal has three major agro-ecological zones i. e. Tarai, Midhill and Mountain, which have diverse geological, climatic and hydrological characteristics. These are responsible for country's distinct and varied agricultural land uses (CBS, 2002). Tarai region known as the food granary, it comprises 23 percent of the nation's land area, a flat and fertile zone, ranging from 59-700 meters in the Mahabharata foothills. Over 40 percent of the available agricultural land in the Tarai is cultivated which can be irrigated throughout the year. This region has a great

potential for greater productivity as well as increased access to irrigation when technology permits, than do the nation's other regions. The Tarai produces a variety of crops including rice, wheat, maize, sugarcane, jute and vegetables (MoI, 2017).

Agricultural land use is changing in Nepal. The total agricultural area has increased but per capita cultivated land has decreased due to rapid growth in population (CBS, 2013b). Natural growth rate of population and migration are two major components for this change in the size of population of any area. The census result indicates that about 15 percent of population movement from Mountain and Mid-Hills to Tarai is mainly for agriculture purposes. Nepal's regional pattern of migration also shows a large volume of migration from Mountain and Mid-Hills to Tarai (CBS, 2014a).

People from less developed areas started migrating to more developed areas, especially to areas where there was better infrastructure and economic opportunities such as expansion of roads and transport, development of agriculture, health, education, and industrial development (CBS, 2014a).

The internal migration emerged in the mid-50s with the implementation of the state sponsored resettlement programme of hill people to Tarai for land colonization and increased agricultural production (Suwal, 2014). Nepal Resettlement Company (NRC) settled 1,504 families in Nawalparasi and there were more than 10,000 spontaneous settlements (Shrestha, 1990, cited in Suwal, 2014, p.242). Likewise, as of early 1988, the NRC settled 4,026 migrants under the Dhanewa project in Nawalparasi district (Suwal, 2014). This constant flow of people has certainly affected on existing land use and agricultural situation and this input to examine its nature and extent.

There is population growth rate is 1.34 percent during the census 2001 to 2011 in Nawalparasi district (CBS, 2014c), whereas net migration rate is 13.9 percent of total population (CBS, 2014b). Nawalparasi district has around 79,149 hectares of arable land (DADO, 2015). Of this, only 70,149 hectares of land is being used for agricultural purpose largely because of shortage of human resources to operate farming. About five hundred thirteen thousand migrants have left Nepal in 2014/15 which has been a growing trend for the past 15 years (NRB, 2016). However, there is no study on trend at micro level on the process and extent of agricultural land use change.

Keeping in view of the contribution, the government has given top priority for the agriculture sector after the fifth National Development Plan (NDP) (1975-1980). The government has implemented a twenty-year Agricultural Perspective Plan (APP) with the goal of increase production and incomes of households by encouraging farmers to use green revolution technologies, such as irrigation, fertilizers, and high-yielding varieties (HYVs) of plant seeds (APROSC, 1995). The Government developed the Agricultural Development Strategy (ADS) in 2015 AD after the lesson learned from APP to guide the agricultural sectors of Nepal over the next 20 years. In spite of progress compared to the past, agriculture sector in Nepal is still in a low development stage, relatively to the progress made by its neighbors (MoAD, 2015).

Knowledge of recent changes in agricultural land use, driving forces and implication of changes within the context of agricultural development is limited. Better understandings of past changing processes of agricultural land use have enabled the improvement of future planning strategies (Hazell & Wood, 2007). Identifying the causes of land use change requires an understanding of how people make land use decisions and how various factors interact with specific contexts to influence decision making on land use (Ojima et al., 1994).

Development of trade and off-farm employment opportunities (Virgo & Subba, 1994), and development of new irrigation facilities, distance to farm from the village/farmer, access to market centers, government policies and use of technology are the driving factors of agricultural land use change (Khanal, 2002). Besides, the shortage of agricultural labour and population structure, livelihood strategies, the access of the market economy, growth of market towns and urban centers, and the opening of the country to the international job market and government policies (Khanal & Watanabe, 2006), and rapid out migration and involvement to non-agricultural activities are the causes of land abandonment (Chapagain, 2008). Introduction of market-oriented vegetable-based production, socio-economic conditions and access to road and markets (Dahal, Nyborg, Sitaula, & Bajracharya, 2009), and limited irrigation facilities, limited access to agricultural inputs, depletion of natural resources, seasonal variability of rainfall, and climate change are the major drivers of crop land change (Malla, 2009). Sociopolitical instability and ceasing on farming as a viable occupation (Paudel, Tamang, & Shrestha, 2014), and topography (elevation, slope, and soil types), socioeconomics (population and foreign labor migration), climate (annual mean temperature and precipitation), and neighborhood factors

(roads, rivers, and settlements) (Paudel, Gao, Zhang, Wu, Li, & Yan, 2016) are the major drivers in agricultural land use change.

On this backdrop, Nepal is facing problem of food deficit due to the rapid growing population on the one hand and not improving in the level of production of agricultural crops on the other. There are two alternative to increase the level of production- either through extensification (increase in cropping area) or intensification (increase in productivity) (Khanal, 2002). So proper understanding of the possibilities of both the extensification and intensification is necessary. It also necessary to understand various aspect of agricultural land management: the use of modern technologies such as machinery, high yield varieties of seeds, chemical fertilizers, and pesticides also play an important role in the improvement of productivity. Further, the provision of agricultural infrastructures, such as irrigation facilities, market centers, road networks, cold storages etc. are considered important factors for improving the agriculture sector.

The use of inputs such as manure, chemical fertilizers, pesticides, farm machines, including tractors and pump-sets, helped farmers cope with complexity of agricultural development in Morang district of Nepal (Nepal & Thapa, 2009). Farmers have started to use higher quantity of agricultural inputs such as fertilizer, hybrid seeds, insecticides, pesticides as well as modern agriculture tools such as tractor, power tillers and threshers. Agricultural practices have changed from monoculture to multiple cropping due to of irrigation input in the cropping area in Kanchanpur district (Paudyal, 2010). The production per hectare is found higher in mechanization (i.e. use of tractor) than using bullock to plough the field, whereas and use of manure has helped to increase in wheat yields than chemical fertilizer in Tarai region of Nepal (Devkota & Phuyal, 2015). The use of inputs like modern farm technologies such as tractors, chemical fertilizers, irrigation and hybrid seeds have increased agricultural development in Chitwan (Bhandari & Ghimire, 2016). However, there is no study on state of input use for agricultural land management in Nawalparasi.

For better management of land resources, decision makers and planners are required to have informed knowledge on biophysical as well as socio-economic information and human use patterns of land resources in addition to their proper accounting system. The most pressing problem faced by the management is the lack of reliable information. For effective planning in order to overcome the problems, tools are required for analyzing and updating spatial

information quickly and efficiently. In order to avoid the negative impact of agricultural land use change at various scales and sectors, it is necessary to understand the trends, drivers and processes of agricultural land management practices by focusing on agricultural input use.

In order to achieve the progress of agriculture sector, it is necessary to develop and implement policies and strategies in understanding of ecological niches for agricultural use with proper assessment of land, soil and climate on the one hand and use of technologies and service infrastructure on the other. Such understandings at different spatial scales are scanty. There are very limited and almost no in the case of study area of agricultural performance at micro level (parcel level). So, this study is proposed aiming to answer the following research questions:

- What is the trend of agricultural land use change in terms of its pathways and magnitude?
- What are the main drivers of such changes?
- How is the input use managed in agricultural land?

1.3 Objective of the Study

The main aim of this study is to analyze spatial and temporal changes in agricultural land use in Nawalparasi district. The specific objectives are to:

1. Analyze the trends of agricultural land use change in terms of its pathways, magnitude and pace;
2. Examine the main drivers of agricultural land use change, and
3. Assess the state of input use in agricultural land management.

1.4 Significance of the Study

Nawalparasi district has 643,508 populations (CBS, 2014c) with man-land ratio of 11.5 persons/ha. Altogether 78.7 percent of total population of Nawalparasi district depends on agriculture. Out of total agricultural holders 60.1 percent populations are employed in agriculture sector (CBS, 2013c).

Development of agriculture is important for food security and income generation. It is also the main source of employment and raw materials for industries. But such study is lacking in Nawalparasi district which will contribute in understanding of existing condition of agricultural land use, its drivers and level of agricultural input use as essential components for the development of agriculture. Similarly, this study will contribute to the formulation of strategy and policy feedback, especially for local governments and regional level as well. In addition, the

findings of this study could provide the basis for comparative study in the low lands of other areas for researchers.

1.5 Limitations of the Study

This is comparative study in three sites in the Tarai region of Nawalparasi district. This study is limited only in a decadal period (2005/06 to 2015/16) of changes so it does not cover on historical time series of information. The information during the period of 2015/16 was taken directly from the field where as base information for the period of 2005/06 was obtained and discussed with respondents and recorded as a form of recalled data. This study covers only input of labour, manure, improved seeds, chemical fertilizers, pesticides and irrigation in agricultural land management practices. Land parcels located within the ward boundary of selected study sites were only taken to plot on cadastral maps for analysis. Similarly identified parcel numbers during the field survey were only used for the change pattern analysis. The study considers the major crops such as paddy, wheat, maize, vegetables, potato, oilseeds and pulses. Further, this study includes agricultural land area to analyze the trends and drivers of change, whereas only cropped land area is considered for others.

1.6 Working Definition of the Terms

The working definitions of the terms used in the present study are given below:

Land use refers to the land, which is used for agricultural purposes with management practices in this study. The change of land use is the change in areal extent or change by crops or management practices or the use pattern.

Agricultural land use denotes the extent of area under cultivation of different crops during the last agricultural year.

Structure is used in this study for ‘agricultural land use structure’ which is defined as the combination of the crops in total cropping area.

Magnitude is used in this study for the extent or the amount of change.

Pace refers to the rates of change.

Pathway (s) refers to the way/direction of change from one category of agricultural land use to another.

Driver (s) refers to the internal and external conditions and control which determines the pathways, magnitude and pace. Drivers in this study include all underlying factors responsible for change in agricultural land use. These include both the exogenous and endogenous agents of

agricultural land use change.

Input use refers to use of labour, manure, seeds, chemical fertilizers, pesticides, irrigation and machineries.

Conversion refers to the change from one cover or use type to another use type.

Modification refers to the change through the processes of intensification or extensification and diversification or abandonment by different crops or activities in this study.

1.7 Organization of the Study

This study is divided into eight chapters. Chapter one includes general background of the study, statement of the problem, research questions with objectives, significance of the study, limitation of the study and organization of the study. Chapter two includes the review of literature with conceptual framework adopted for the study. Similarly, chapter three presents the research methodology. This consists of brief description on the sources of information, methods of data collection, data processing and analysis. Gradually, chapter four provides bio-physical and socioeconomic settings of the study area. Changing trend of agricultural land use is dealt in chapter five. An evaluation of the available agricultural land use data and the pathways, magnitude and pace of land use change at different spatial and temporal scale is discussed in this chapter. Furthermore, the drivers of agricultural land use change are analyzed in chapter six. The characteristics of agricultural land management in terms of input use intensity and productivity, and land ownership are presented in chapter seven respectively. Finally, the summaries of findings and conclusions are discussed in chapter eight.

CHAPTER 2

LITERATURE REVIEW

2.1 Theoretical Review

Review of literature is an early step for conducting research. It enables to avoid the duplication of research work and broadens the understanding of research problem. Moreover, it provides the basis to develop methodological and analytical frameworks on the one hand and compare the results and findings between conductive study and similar types of studies carried out in other areas. The relevant theoretical and empirical research works at global and national levels are reviewed in this section.

Dethier and Effenberger (2012) argue that agriculture contributes to both income growth and poverty reduction by generating income and employment in rural areas thereby providing food to urban areas. There are two challenges related to agriculture. The first is the need to increase food productivity and production in developing countries, especially with smallholder farmers. For this, a number of problems need to be addressed such as property rights, research and development for input use like seeds and irrigation, fertilizer, machinery use, agricultural extension, credit, rural infrastructure, storage, and connection to markets to achieve the solution. The second problem is, however, the instability of food prices, market mechanism because of events outside the control of poor countries.

According to location theory of agriculture coined by Von Thunen (1826), agricultural land use is determined by relative location and the accessibility to the market and service centers. The use of land is diverse with the distance from the market. In this, farmers give priorities on high value and perishable crop production surrounding the market centers. Their concern prevails on the maximum economic return. The fertility of land has maintained by using the means of manuring. The intensity of production of a particular crop declines with the distance from the market. Intensity of production is a measure of the amount of inputs per unit area of land. For example, the greater the amount of money, labour and fertilizers, etc., that are used, the greater the intensity of agricultural production. Different land users like vegetable producers, dairy farming, mixed crop and livestock, cereal crops, and cattle-ranching use the farmlands near the market with a divergence intensity of cultivation. As the distance from the market is increased, the intensity of production is decreased with a consequent reduction in yields.

According to the land extensification theory of Malthus (1798), there is an important

relationship between population and agricultural land use change. He examined the relationship between population growth and agricultural production in his theory with the principle of population will grow exponentially whereas food production will grow linearly, much more slowly. This would make population surpass food production and leading to the conflict that can only be resolved by occurrences of natural disasters to significantly reduce population or controls on population growth or forced to land extensification. In order to fulfill the increasing demand for food, agriculture is expanded into increasingly inferior lands over time resulting in decline in average land productivity.

Intensification theory of Boserup (1965) explores the interrelationship between population growth and food production. According to her theory, there are two different ways of approaching the problem of growing population. On the one hand, how changes in agricultural conditions affect demographic situation, and on the other hand, how the population changes involve in agricultural situation. A major basis is that 'necessity is the mother of invention'. Her attempt tried to probe into the causes of agricultural development. Agricultural development is due to some kind of compulsion (Boserup, 1965). This compulsion relates to rising trend of population. It means that the basic force behind agricultural development is the pressure of population. Therefore, the development of patterns and techniques of cultivation is governed by the population growth. Boserup developed her ideas in connection with traditional farming system in South East Asia, but her ideas have been applied to global agricultural patterns. She supported this contention through an examination of agricultural development of some African and Latin American countries as well.

Resource exploitation model of Hubbert assumes that the surplus of land and labour capacity enable small farmers to expand production rapidly under the stimulus of new markets even if they have poor technology. The major challenges of this model as underutilized resources are exhausted, it is difficult to generate growth in land and labour productivity. It also does not work in areas where there is no surplus land suitable for agriculture. In such cases, sustainable growth of agriculture in the long run is not achievable. It is applicable only in areas where surplus land suitable for agriculture is available (Bardi & Lavacchi, 2009). An increase in agriculture production occurs as a result of expansion in cultivated area. And, land expansion is used to continue the exploitation of a profitable and growing resource. The production depends upon land, farmer's effort on agriculture and upon the biotic resource (Foudi, 2002).

Farmers do not always play the same strategy inside each situation. Expectations of the farmer are other determinant of the strategy on the level of resource exploitation. In contrast, when they expect that the resource stock is declining, the farmer can choose a different strategy because of farming orientations. Indeed, in the normal case, farmers can choose to make more effort when they hold property rights on the resource. The perception of farmer is also driving in a dynamic setting of investment in the land, and farmer will invest more in a land if they expect that the value of the land in the future will be positive (Skonhoft, 1999).

Expansion of the cultivated area is the dominant source of increase in agricultural production. Intensification of land use in existing agricultural land is also another strategy of raising production level. Under the conditions of rapid population growth, the limits to the resource exploitation model are often quickly realized. Crop yields remains typically low measured in terms of output per unit of seed rather than per unit of crop area. Output per hectare and per man-hour tended seems to decline (Ruttan, 1988). The conservation model is based on the propositions made by Malthus, Ricardo and John Stuart Mill. It is based on two assumptions. These are i) lands for agriculture production are limited and ii) soil exhaustion is possible to prevent decreases in yield or to increase land productivity. As land scarcity is increased, poorer land is used for the marginal productivity. It needs more investment to improve soil productivity. It therefore, demands for integrated crop-livestock husbandry (Hubacek & Bergh, 2002). The conservation model emphasized evolution of a sequence of increasingly complex land and labor-intensive cropping systems. The production and use of organic manures, and labor-intensive capital formation in the form of physical facilities to more effectively utilize land and water resources (Ruttan & Hayami, 1971). Conservation agriculture (CA) is an innovative approach for improving resource use in sustainable production. Its benefits include reduced inputs, more stable yields, improved soil nutrient exchange and enhanced long-run profitability. Conscious of the possible divergence between private and social interests, it highlights the importance of farmers' objectives and motives, the collective dimension and the role of policy (FAO, 2001).

Ruttan (1985) noted that conservation agriculture to involve the introduction and more intensive use of new forage and green manure in crops and an increase in the availability and use of animal manures. The use of the plant nutrients, animal power, land improvements, physical capital, and agricultural labour force are produced or supplied by the agricultural sector itself in conservation system of farming. Tagar and Shah (2012) pointed the important element of

conservational model to be increasing soil fertility through the use of green manure, crop residues and animal manure to increase the agricultural output per unit of land. It is also facilitated by better use of water resources, labour, animal power and equipment. This model assists to explore the cropping pattern and crop intensity as well as input of manure and agricultural labours.

The location model of Von Thunen explains the geographical variation in the location and intensity of agricultural production. This model assumes that the market determines location of production of agricultural commodities and influences techniques and intensity of cultivation. The rationale for this model was developed in terms of more effective input and product markets in areas of rapid urban-industrial development. It motivated agricultural development by expanding demand for farm products, supplying the industrial inputs needed to improve agricultural productivity, and drawing away surplus labour from agriculture. The empirical tests of the location model have confirmed repeatedly that a strong non-farm labour market is a prerequisite for labour productivity in agriculture to improve the incomes for rural people (Katzman, 1974). The location model presents a main development strategy through historical experience. It suggests that the increased agricultural production largely depends on opening up and use of new and fertile tracts of land with little change in the existing technologies of the day. It further suggests that the increasing population pressure on the present agricultural lands stresses the need for more land is brought into cultivation around the village or part of the population move to virgin lands (Tagar & Shah, 2012).

The spatial development of many diffusion patterns is characterized by the addition of new adopters around the original basis of introduction of the innovation (Hagerstrand, 1976). His model of diffusion discovered that innovations of all kinds to have a tendency to diffuse from their points of origin in a similar four stage wave. In the primary stage an innovation occurs and gains acceptance at its point of origin. In the second stage, its dispersal begins to widen rapidly. In the tertiary stage adoption begins to slow. Finally, in the saturation stage, the innovation approaches its maximum diffusion and its rate of acceptance declines or stops altogether. The simplicity of the Hager-strand model allows its terms to be precisely specified, simulated mathematically, and measured empirically. His studies this way confirmed that the diffusion and adoption of an innovation over time tends from slow initial acceptance to rapid dispersal to increase. Udemezue and Osegbue (2018) argue that diffusion model was developed emphasizing

the relationship between diffusion rates and the personality, characteristics and educational accomplishments of farm operators. This model suggests that the diffusion of better crop and livestock varieties has been the major source of productivity in agriculture. So the effective dissemination of technical knowledge provides intellectual foundation for research and extension efforts in farm management and production economics. The diffusion approach to agricultural development rests on the empirical observation of substantial differences in land and labor productivity among farmers and regions. Diffusion of innovations is therefore a theory that seeks to explain how, why, and at what rate new ideas and technology spread. It is due to this agriculture technology is advancing rapidly, and researchers started to examine how independent farmers are adopting hybrid seeds, equipment, and techniques (Valente & Rogers, 1995). The diffusion model argues that significant increases in agricultural productivity can be obtained by increasing the flow of information about new agricultural technology and new institutional arrangements to farmers (Eboh, 2003). The high-payoff input model of Schultz (1964) emphasizes that agricultural growth depends on the availability and price of modern agricultural factors. He argues that small farmers get less progress from the agriculture due to the limited technical and economic opportunities. The model supports for the investments in agricultural research; investments in capabilities for the production, supply and distribution of modern inputs, and investments in human capital. The high pay off input model is focused on the creation and provision of new high-payoff technology to the farmers and increases the productivity. It assumes that economic growth from agriculture sector depends predominantly upon the availability of modern high-payoff inputs. The provision of agricultural inputs, such as fertilizer, higher yielding seeds, technology, human resources in lower cost makes agriculture profitable (Rutton, 1977).

Technology adoption in general is positively related to a farmer's schooling, wealth and the adoption of the same technology by neighbours (Foster & Rosenzweig, 2010a). It suggests that low education, missing credit markets, and externalities could be major barriers to technology adoption. Higher levels of education increase the return to experience with a new technology, making a technology profitable after a shorter period of time for more educated farmers. The potential to learn about new technologies also depends on the available information about new technologies and their profitability. Another barrier for adoption of new technologies is the lack of well-functioning credit markets. If new technologies require initial investment, farmers

lacking with sufficient funds cannot obtain loans. They might be unable to adopt the technology even if it is highly profitable to them. Farmers' lack of collateral may be the cause of their restricted access to loans. Property rights for land may therefore be an important determinant of adoption. In addition, property rights are also important for farmers' incentives to plant new varieties (Croppenstedt, Demeke, & Meschi, 2003).

The high-payoff input model assumes inverse relation between farm size and land productivity, even after controlling for other productivity determinants, such as land quality. However, in the presence of market failures, large farms may have an advantage over small farms. Increasing farm size is the key to improve incomes in agriculture because it allows for the use of modern machineries and involve increasing returns at higher profitability per hectare (Foster & Rosenzweig, 2010b). In addition to farm size, property and user rights are also determinants of agricultural productivity. Tenants either pay a fixed rent for land use or engage in sharecropping, transferring part of their harvest to the landlord. Efficiency of arrangements leads to a less distorted agricultural land use distribution and increase productivity. The extent to which fixed rent or sharecropping is preferred depends on the degree of asymmetric information between farmer and landlord (Binswanger, Deininger, & Feder, 1995). This model assists to explore the size of land holdings, land ownership and decision making status of farmers in their farm.

On the theory of economic growth, Lewis (1954) has suggested on how to progress the economy of developing countries. The economy starts with two sectors in the developing countries from traditional to modern. The traditional sector is dominated by agriculture with marginal productivity of farmer with low capital and low wage. This is the reason why the surplus labor can be extracted from this sector to the modern sector. With the modern sector, there is a high probability of industrialization and capital accumulation which demands more labors/workers. There is unlimited supply of labor from the rural sector to the urban sector to promote the economic growth of developing countries. According to economic model, farmers mention a variety of factors to explain their choices of production. Farmers are rational and choose options to get the highest level of well being and gain with the available resources and technology, and their ability to absorb risk. For any given level of input they prefer to obtain as much output as they can (Norton, Heong, Johnson, & Savary, 2010). However, in practice, farmers often fail to take optimal decisions which could increase output due to several reasons:

that is due to lack of knowledge, risk attitude and uncertainty, different objectives, differences in resource quality, market imperfections, inappropriate institutions, etc. In this connection, Norton et al. (2010) argue that maximum return can happen through a change in market opportunities and relative price. This leads farmers to add inputs using existing technologies, an innovation that allows production of more output at a given level of inputs. They distinguished three ways to get increased output per unit of input: increases in scale or specialization; increase in efficiency; and technological change. Mellor (1995) argues that economic growth requires transforming of country's basic production resources in more efficient ways. With limited natural resources and an efficient utilization of resources like land, capital, and labour constitutes to be important factor contributing to rapid economic growth. In addition to farm size, property and user rights are also determinants of agricultural productivity. Tenants either pay a fixed rent for land use or engage in sharecropping, transferring part of their harvest to the landlord. Efficiency of arrangements leads to a less distorted agricultural land use distribution and increase productivity (Binswanger et al., 1995).

Based upon these theories and models of agricultural development, this study tries to examine the trends and pathways of agricultural land use change through extensification or intensification, and deintensification or abandonment of agricultural land; to identify major drivers of agricultural land use change and assess the state of agricultural inputs use from the available literature.

2.2 Empirical Studies

This section includes literature available from within and outside of Nepal which are arranged into global and national level.

2.2.1 Global Context

A lot of works have been done by various researchers in the field of agricultural land use change in the world mostly in 20th century. The outline of brief history of the land use studies was initiated in Great Britain. The first land use survey and mapping was carried by Patrick Geddis but the practical work on land use study was carried by Stamp (1930) in Britain. Whittelsey (1936) has divided the world into major agricultural regions. Enyedi (1964) has described geographical types of agriculture in Hungary.

2.2.1.1 Trends of Agricultural Land Use Change

Rahman and Saha (2009) have made a spatio-temporal analysis of cropland and cropping pattern change in the Bogra district of Bangladesh over the last 16 years. They found mono crop cultivation (rice) in summer season, whereas potato and mustard were cultivated in the winter season, and the grain area of cropland during the study period was higher in winter than in summer. The analysis also showed that mainly current fallow land was changed to cropland (rice, potato and mustard) in both summer and winter seasons. Analysis of changes of cropland occurred mainly in the north, northwest and southwest parts of the area. On the other hand, the cropping pattern analysis showed that five major cropping patterns were identified in the study area. The rice-current fallow, rice-potato and rice-mustard patterns were the important cropping patterns in the area. The change analysis showed that the highest area change was found in the rice-potato pattern. Gulgun, Yoruk, Turkyilmaz, Bolca, and Gunes (2009) have found decreased in agricultural land and increased in residential area of Akhisar district, Turkey. Kodiwo and Okere (2012) have conducted a study on spatial and temporal variations of agricultural land use intensity in Nyakach District, Kenya. They found increased in cultivated area, spatial and temporal variations in agricultural land use intensity and land degradation. Gibson (2012) has found a decrease in cultivated area in Iraq. Espindola, Aguiar, Pebesma, Camara, and Fonseca (2012) have studied agricultural land use dynamics in the Brazilian Amazon and found an overall expansion of the total agricultural area.

Li, Yu, and Gong (2013) have analyzed the intensity change in cultivated land use in Shandong province and found that the multiple-cropping index and labour intensity were declining while capital intensity was increasing rapidly. In addition, they have found that the average level of land productivity was higher in economic crops than grain crops while the average level of labour productivity was higher in grain crops than economic crops.

Mewett, Paplinska, Kelley, Lesslie, Pritchard, and Atyeo (2013) have studied the trends in agricultural land use change in Australia and found an increased in cropping land and decreased in the area of grazing land. In addition, they have found the decreased in farm size. Similarly, Salvati (2013) has assessed change in agricultural land in Latium (one of the twenty Italian regions) and found that trends in the crop intensity index increasing in lowlands due to the intensive crop management and the favorable territorial and climatic conditions. Whereas, crop intensity index showed decreasing trend in mountain areas due to traditional farming systems

featured by small-sized farms holding. Fu, Zhang, and He (2014) have found an increase in agricultural land in Northwest China. Within the cropland, the rice planting area was decreased, while wheat and corn planting areas was increased.

Geographic Information System (GIS) and Remote Sensing (RS) are used commonly in the study of land use and land cover change including agricultural land (Allotey, 2000; Sharma, Prawasi, Babu, Pal, & Hooda, 2015; Utami & Ahamed, 2018).

2.2.1.2 Drivers of Agricultural Land Use Change

Bilsborrow and Ogendo (1992) have found population growth and government policies responsible factors for the agricultural land use changes in Latin America and Sub-Saharan Africa. Sikor and Truong (2002) have found agricultural policy, use of technology and markets as the main factors of agricultural land use change in Vietnam. Lambin, Geist, and Lepers (2003) have found economic, environmental and social drivers, as well as government policy to be the dominant factors influencing agricultural land use change in Australia.

Wood, Tappana, and Hadjb (2004) have studied the drivers of agricultural land use change in South-Central Senegal and concluded with eight categories of drivers. These were sustainable intensification of agriculture, climate, population pressure, development projects, goods production, forestry practices, fallow cycles, and land tenure. Further, Mottet, Ladet, Coque, and Gibon (2006) have found the application of agri-environmental policies, roles of bio-physical factors and farm socio-economic factors (age, education, land ownership and willingness) as the main drivers agricultural land use change in the peripheral area of the Pyrenees National Park of France. Schmit and Rounsevell (2006) have analyzed agricultural parcel and farm location data in central Belgium to analyze whether and, to what extent, farmer imitation leaves an observable footprint on an agricultural landscape. They found that imitation is not an important determinant of agricultural land use patterns. Further they noticed that neighboring parcels cultivated by farmers who live in close proximity are only slightly more similar than neighboring parcels cultivated by farmers who live further away from one another. Amanor and Pabi (2007) have found technical and institutional development, movements of labour, infrastructure development and agricultural development policies on farming systems as the main drivers of change in farming systems in the Brong Ahafo Region in Ghana.

Alexander (2007) has found that government policies and economic factors to play an important role in the uptake of new technologies and changes to farming systems in Lao Peoples'

Democratic Republic and governance issues of land allocation, land availability and trading to be significantly affected on production decisions. Rahman (2009) has found the agricultural land to decrease due to the utilization of crop lands for settlements, growth of industries, construction of roads and canals in Dera Ismail Khan District, Pakistan. The positive changes occurred in Kharif crops like rice, sugarcane, pulses, orchards and vegetables and the negative changes were registered in sorghum, millet, oilseed, barley and maize. Liu, Li, Sun, and Yang (2009) have found government policies and growth of population to be responsible factors for change in crop land in the Zuli river basin of China. Wu, Cheng, Xiao, Wang, Yang, and Ellis (2009) have found that population growth, changes in agricultural policy and market-oriented land management strategies significant drivers in long-term agricultural landscape changes.

Braimoh (2009) has noticed population growth and increased demand for food and intensified labour use as determinant factors in cropland expansion in Ghana. Rudnicki and Dubownik (2010) have found government policy of land pooling as the main driver of changes in land use structure of agricultural holdings in Kujavia-Pomerania region of Poland. Rapid population growth and urbanization to be the main driver affecting agricultural land conversion worldwide (Azadi, Ho, & Hasfiati, 2011). Brown and Schulte (2011) have found that development of agricultural technology, economic development and federal farm policies as the drivers of the agricultural land changes in Iowa, USA. Zhao, Xiubin, Xin, and Hao (2012) have noticed that the off-farm employment of rural labour force, commercialization of agricultural product and regional comparative advantage were the main driving forces of geographic concentration of agricultural land use in China. In the same way, Kumar and Singh (2012) have pointed that the urbanization, occupational status, educational level of household head, household or family size, farm size, soil type and status of land ownership as being driving factors of agricultural land use change in the eastern and northeastern regions of India. Olaniyi, Abdulla, Ramli, and Sood (2013) have found industrialization and urbanization as the determinant factors of negative impacts on agricultural land use changes in Malaysia. Orimoogunje, Ndidi, and Ekanade (2013) have noticed that growth in population, increased soil fertility, availability of roads, encroachment into plantation and conversion of forest into farmland and settlement and expansion of crop land as the main responsible factors influencing spatial agricultural land use change in the Southern part of Nigeria. The government policies for processes of greening, forestation and construction of water bodies (lakes and reservoirs) were

the main determinant factors in decreasing agricultural land in Slovakia (Tarasovicova, Saksa, Blazik, & Faltan, 2013).

Feike, Mamitimin, Li, and Doluschitz (2014) have found that the population growth, increased in agricultural labour, positive price developments for fruits and cotton, strong increase in agricultural profitability, opportunity for further land reclamation, establishment of orchards and government policies on insufficient restriction of agricultural land expansion as the drivers of changes in agricultural land use in China. Assefa and Bork (2014) have found that demographic pressure, government policy, land tenure, and the nature of subsistence agriculture as the determinant factors in agricultural land use changes in Southern Ethiopia. Forbord, Bjorkhaug, and Burton (2014) have analyzed the pattern of farmland control in Norway and found that change was due to three key factors: techno-economic development, social norms, and policy and legal instruments. Further, Munteanu et al. (2014) have identified institutional (accessibility and development of urban centers) and socio-economic factors (migration and population pressure) as influential in agricultural expansion and socio-demographics (out-migration and shortage of agricultural labour) and institutional shifts (construction of roads and buildings) as the key drivers of land abandonment across the Carpathian Basin. Diack, Loum, Guisse, and Sane (2017) have found that the population growth, urbanization and industrialization processes have reduced the farmlands through uncontrolled construction of buildings and companies in Niayes region of West Senegal. Miheretu and Yimer (2017) have found education, family size, tenure security, training, access to farm credit and extension services as the main determinants on increased of agricultural activities in Ethiopia.

2.2.1.3 Agricultural Land Management

Kristensen (1999) has conducted a study on agricultural land use and landscape changes in Rostrup, Denmark through the process of intensification and extensification and found that both full-time and part-time farmers being involved in extensification of land use. However, full-time farmers were only involved in afforestation, whereas part-time farmers were involved in more diverse types of extensification. Sen et al. (2002) have found that increased in use of manure input by 50 percent in Pranmati watershed in Indian Himalaya has improved in traditional soil fertility management practices.

Carswell (2002) has found that farmers have successfully managed their land and maintained productivity by adding manure, fertilizers and machinery use in the area of Kigezi,

Uganda. Semwal et al. (2004) have found the changes in spatial patterns of agricultural land use through crop diversification, increased manure input for high yield, managed soil loss and runoff from cropland in a small watershed in Central Himalaya, India. MacLeod and Moller (2006) have identified agricultural land management through conversion to more intensive forms of agriculture, and diversification into forestry and deer farming, increased farm fertilizer and pesticide inputs in New Zealand.

Wu et al. (2009) have found agricultural land management through intensification (changing in cropping pattern from two crops to three/four crops, inter-cropping) of land in Yixing, China. Burgess and Morris (2009) have explored that farmer using agricultural machineries (tractors and thresher), hybrid seeds and chemical fertilizers to increase the output of crop and animal products per unit of land in the United Kingdom. Thapa and Yila (2012) have found application of chemical fertilizers and farm yard manure, intercropping and crop rotation as major land management practices in Jos Plateau in Nigeria. Bhat (2013) has assessed the agricultural land use pattern at micro level in Pulwama district of Kashmir Valley and found that the horizontal expansion of agriculture and utilization of land by adopting more remunerative cropping pattern, scientific rotation of crops and multiple cropping patterns to have helped in growing more food and raw material problems in the region. Miheretu and Yimer (2017) have found that adoption of traditional ditches, waterways, mixed cropping, crop rotation, use of manure and chemical fertilizer, tree planting, check dam and stone bund construction as the land management practices in Ethiopia.

2.2.2 Nepalese Context

Studies have depicted the use of agricultural land and state of agricultural development from the various parts of Nepal. It is noticed as an agricultural diversification in Central (Shrestha & Katuwal, 1992), Central West (Adhikari, 1996, Khanal, 2002; Poudel, 2002; Chapagain, 2008) and Eastern part of Nepal (Sharma, 1997; Chapagain, 2003; Paudel et al., 2016). These studies reflect the general pattern of farming system such as stagnant verses transformation, mainly from the low land to highland.

2.2.2.1 Trends of Agricultural Land Use Change

Virgo and Subba (1994) have found no significant changes in agricultural land use in the middle mountain zone in Dhankuta district. Pariyar and Singh (1995) have found agricultural land area was decreased in Chitwan district of Nepal. Khanal (2002) has found a slight increase

in the area under paddy, wheat, potato, pulses and decrease in the area under maize and millet in Nepal Himalaya. Balla, Awasthi, Shrestha, and Sherchan (2003) have found significant increase in area under agriculture. Further, they have found that area under shifting cultivation being converted into permanent agriculture land in Chitwan district, whereas forestland was converted into shifting cultivation and permanent agriculture during the same period in Tanahu district. Khanal and Watanabe (2006) have found the changes in agricultural land in the spatial context; they found that the cropping land was abandoned in the Nepal Himalaya. Further, they have noticed that abandoned plots subjected to different forms of geomorphic damage like landslides and floods. In addition, they have indicated that amount of geomorphic damage on plots abandoned earlier greater than that on plots abandoned recently. Bhujju, Yonzon, and Baidya (2007) have found that agricultural land to have increased by double at the expense of forest cover in Eastern Churiya hills of Nepal Himalaya. Both the forests and agriculture land cover have changed diversely in similar pattern in their altitudinal distribution which were high in lower elevation (< 300 m) and decreased gradually in the higher elevation. Chapagain (2008) has noticed change in agricultural land and found the negative agricultural development in the Upper Manang Valley, Mountain region of Nepal. Besides, Baidya, Bhujju, and Kandel (2009) have found increased in agricultural land in the buffer zone of Chitwan National Park.

Agricultural land has been increased in Khageri watershed, Chitwan (Dhakal, 2010). Cropping systems have been highly intensified in Chitwan and changed from dominant of rice-wheat-maize system to the rice-vegetable-maize system (Paudel, Acharya, Ghimire, Dahal, & Bista, 2014). Paudel, Tamang, and Shrestha (2014) have found continuous land abandonment across the mid hills and expanded faster. Similarly, Pandey (2015) has found the crop diversity in Jutpani Village Development Committee in Central Nepal. He has noticed that home gardens have the highest crop diversity compared to upland and lowland, the total number of crops grown (crop diversity) on a farm was significantly higher in the *Indo-Aryan* ethnic group compared to the *Tibeto-Burman* group. Poor farmers with small land holdings were found to be associated with higher crop diversity compared to rich farmers with large land holdings. Paudel et al. (2016) have found change in cropland area with rapid increases from 1978 onward at different magnitudes in the Koshi River Basin of Nepal.

2.2.2.2 Drivers of Agricultural Land Use Change

Amatya (1976) has mentioned several factors, such as traditional marketing system, price

fluctuation, lack of information, low productivity, lack of transportation network, lack of irrigation and other inputs (manure, fertilizers and pesticides) as the major obstacles for development of cash crops in the country. Virgo and Subba (1994) have mentioned that development of trade and off-farm employment opportunities to be the driving factors of change in agricultural land use in Dhankuta. Adhikari (1996) has pointed out change in livelihood strategy, changes in the adaptation strategies and the availability of off-farm sources of income as the dominant factors of changes in traditional subsistence practices of farming in the Western and Central Nepal. Khanal (2002) has found the development of new irrigation facilities, distance to farm from the village/farmer, access to market centers, government policies regarding the ownership and use right, land tax, use of labour, trade, transport and use of technology in combination have significant implications for agricultural land use change in Mid-Hills of Nepal. Khanal and Watanabe (2006) have mentioned that population structure, livelihood strategies with improved accessibility, the penetration of the market economy, the consequent growth of market towns and urban centers, and the opening of the country to the international job market, particularly after the 1970s, as the major drivers of the increasing trend towards land abandonment. In addition to this, they also claimed that government policies regulating ownership and rights of use, taxation, and rent also have a direct and an indirect bearing on abandonment in Middle Mountain areas of Nepal. Bhandari (2006) has studied about shortage of agriculture labour, opportunities of off farm occupation, changes in small sizes of cultivated land, land ownership status, technology use in agriculture, education of the household head, ethnicity, neighborhood characteristics and access to cultivated land has significantly contributed to move out of farming in the western Chitwan Valley of Nepal.

Chapagain (2008) has found the rapid out migration and involvement to non-agricultural activities to have negatively affected the local farming system in Manang Valley, Mountain region of Nepal. Shrestha (2009) has found expansion of urbanization, introduction of advanced technology in the agriculture systems and low returns in traditional farming systems, farmers to be compelled to change the traditional farming systems to modern systems in hills and plains of central development region of Nepal. Further, he has noticed that causal factors, such as plot size, distance from market centre, family size, profit, and market opportunities to be significant effects, while other two factors, like education and irrigation to be insignificant effects on the changes in cropping patterns in the region. Nepal and Thapa (2009) have found the access to

urban centers, shortage of fertilizer, labour and irrigation water as the main determinants of agricultural commercialization in Morang district, Nepal. Limited irrigation facilities, limited access to agricultural inputs, depletion of natural resources, seasonal variability of rainfall, including climate change as the major drivers of crop land change found in Nepal (Malla, 2009). Increased access to resources, infrastructures and technologies (access to inputs, access to extension services, access to markets and roads, better access to agriculture fields from homes) are important drivers for the intensification of the agriculture in Nepal (ADB, 2009).

Resettlement programme by government, migration from mid-hills of the country to this area, natural growth of population, construction of east-west highway and development of irrigation canal were the main drivers of agricultural land use change (Dhakal, 2010). There are various factors (HH size, age of HH head, total income from non-agricultural sources, possession of HH assets, migration status, and HH food sufficiency) which determine the land holding size and land use pattern in Nepal (Gartaula, Chaudhary, & Khadka, 2014). Paudel et al. (2014) have noticed three key determinant factors for the agricultural land use change: first, sociopolitical instability, which forced people to move out; second, the decreased agricultural production and availability of more attractive alternative opportunities; and third, farming ceasing to be a viable occupation for many farmers to maintain sustainable household economy in Mid-Hills of Nepal.

Paudel et al. (2016) have found topography (elevation, slope, and soil types), socioeconomics (population and foreign labour migration), climate (annual mean temperature and precipitation), and neighborhood factors (roads, rivers, and settlements) as main driving factors that changed cropland area in the Koshi River Basin. Technological innovations, such as mechanization, high-yielding crop varieties, improved animal breeds, chemical fertilizers and pesticides and development of new markets have changed the rural agriculture land in Nepal (Majumdar, 2001; World Bank, 2008; cited in Bhandari & Ghimire, 2016, p.1).

2.2.2.3 Agricultural Land Management

Amatya (1976) has suggested that cultivation of cereal grains and cash crops to be the best combination that the cereals satisfy the subsistence need of farmers and the cash crops provide extra income. Poudel (2002) has found that farmers being gradually intensified land use and cultivated new crops to increase farm production and income in the Western Hills of Nepal. There was a constant shifting from cereal crops to livestock husbandry, particularly along the road, vegetables and other cash crops in the accessible foothills. Khanal (2002) has noticed

human modification of micro-topography by constructing terraces and soil nutrients through manuring and runoff management, and soil moisture by developing irrigation which made it possible to enhance the capability of land for specific use. Besides, he has found a significance change on the use of manure, chemical fertilizers, and high yield varieties of seeds and irrigation for land management and increase production level of different crops in Mid-Hills of Nepal. Dahal et al. (2009) have found that intensification of land by input use of chemical fertilizers, pesticides, high yield varieties of seeds and use of machineries as an important strategy in agricultural commercialization and uplifting economic conditions of rural farmers of Nepal. Nepal and Thapa (2009) have noticed that the use of inputs such as manure, chemical fertilizers, pesticides, farm machines, including tractors and pump-sets, help farmers cope with complexity of agricultural development in Morang district of Nepal. The application of use of adequate amounts of fertilizers and use of farm machines at an extensive scale is possible only when farmers become able to sell the major proportions of their products at satisfactory prices.

The agriculture productivity has found positive change compared to that of before and after development of irrigation facilities in Kanchanpur district. The increase in production resulted higher food sufficiency status. As a result, farmers have started to use higher quantity of agriculture inputs such as fertilizer, hybrid seeds, insecticides, pesticides as well as modern agriculture tools such as tractor, power tillers and threshers. They are attracted to grow varieties of crop and vegetable production for additional income with the accessibility development and availability of markets. Agricultural practices therefore have changed from monoculture to multiple cropping due to the development of irrigation input in the cropping area (Paudyal, 2010).

The production per hectare is found higher in mechanization (i.e. use of tractor) than using bullock to plough the field, whereas the use of manure is helping increase in wheat yields than chemical fertilizer in Tarai region of Nepal. It indicates that organic farming seems more profitable in terms of fertility of land as well as production (Devkota & Phuyal, 2015).

The use of inputs like modern farm technologies, such as tractors, chemical fertilizers, irrigation and hybrid seeds are also increasing for agricultural development in Chitwan (Adhikari, 2013; Bhandari & Ghimire, 2013; cited in Bhandari & Ghimire, 2016, p.7).

Agricultural land use change is the result of both the natural processes and human activities at different levels in order to fulfill their multiple goals. It is obvious from the above reviews of

documents that the processes, drivers, state of input use in land management are very complex with space and time.

2.2.2.4 Agricultural Development Policies

Government of Nepal has been given a high priority for agricultural development through formation of agricultural development plans and land use policies in different periods for increasing production and productivity of agriculture. Nepal Agriculture Perspective Plan (APP, 1995-2015) was important in the context of agriculture development. The APP has encouraged farmers to use inputs such as irrigation, fertilizers, improved varieties of seeds and pesticides. In addition, it has also emphasized to accelerate the growth rate in agriculture through increased productivity on the technology-based green revolution in agriculture (NPC and ADB, 1995). The National Agriculture Policy (2004) has given special priority to a pocket of high-value agricultural products. Further, the policy has also emphasized to achieve high and sustainable economic growth through organic farming and commercial agriculture system contributing to food security and poverty reduction (MoAC, 2004). The Land Use Policy (2012) has given emphasize on the control of land fragmentation and management of land through zoning. It aims for sustainable, social, economic and environmental development through the optimal utilization of land (MoLRM, 2012). Ministry of Agricultural Development prepared Agricultural Development Strategy (ADS, 2014) for sustainable, competitive, and inclusive agricultural sector to drive economic growth and contribute to improve livelihoods and food and nutrition security (MoAD, 2015).

2.4 Research Gaps

Based on the available literature reviewed in the global as well as Nepalese context, it has been found that notable studies in the agricultural land use change done by international as well as national researchers are tools to see into research gaps. The agricultural land has been changed in spatial and temporal dynamics with various natures, different responsible drivers are found by localities. In addition to this, diverse land management practices are adopted to cope with scarcity of production and manage food insecurity to have resulted with diversities in socio-economic consequences. It reveals that there are limited empirical studies done in other sectors (such as forestry, land use zoning, industry, health, education and so on) based on primary and secondary data related to low lands of Nepal, particularly in Nawalparasi district. Moreover, there are no studies particularly on agricultural land use change at micro level (parcel level), its

drivers and state of input use in agricultural land management. Therefore this study is conducted to identify whether the changing pattern, drivers and state of input use are similar in nature or different in lowlands of Nepal, particularly in Tarai region.

A conceptual framework for the present study has been developed and discussed in the proceeding chapter with the research methodology.

CHAPTER 3

CONCEPTUAL FRAMEWORK AND RESEARCH METHODOLOGY

3.1 Conceptual Framework

The conceptual framework explains the path and gives a life to a research (Imenda, 2014). The conceptual framework employed here is to study agricultural land use change draws heavily from the theory of induced innovation (Boserup, 1965; Ruthenberg, 1980; Ruttan & Hayami, 1984; cited in Mullar, 2004, p. 7). Two main processes of agricultural land use change can be distinguished as a source for increasing agricultural production: First, agricultural expansion into previously uncultivated areas and second, agricultural intensification on already cultivated land. Intensification involves the substitution of labor and capital inputs for land intensive production techniques by means of technological changes, such as irrigation facilities or use of improved crop varieties, fertilizers and use of pesticides.

Agricultural expansion and intensification might coexist and occur simultaneously (Muller, 2004). If agricultural production becomes more profitable, e.g. through increases in agricultural output prices, farmers have an incentive to expand the area under cultivation, given the availability of suitable land and labour. Changes in the relation between agricultural output prices might have a similar effect, as different crops exert different pressures on farmers to expand their area under cultivation (Kaimowitz & Angelsen, 1998; cited in Mullar, 2004, p. 8). Profitability of agriculture is also influenced by changing input prices. An increase in prices of seeds, fertilizers and pesticides makes farming less profitable and, thus, can reduce the land area devoted to agricultural production. The profit incentive is therefore corresponding to agricultural diversification that also helps in yielding of land use.

It is obvious from the above review that the process of agricultural land use change is very complex and the pathways, magnitude, pace and drivers of change vary with space and time. The conceptual framework in figure 3.1 sketches the driving forces at the farm level, which induce a pressure for change on agricultural land use. In this research area, the means of agricultural land use change are primarily individual farmers. To meet the objectives stated in section 1.3, the outcome (agricultural land use change) is controlled as a function of various socio-economic driving forces and local endowments. On the empirical grounds, agricultural land use change is considered either the processes of intensification or extensification and

disintensification or land abandonment. The responsible drivers of such changes are demographic drivers (migration, population density, off-farm employment), infrastructural development (accessibility and development of market centers) and technological development (adoption of agricultural technology and crop management strategy).

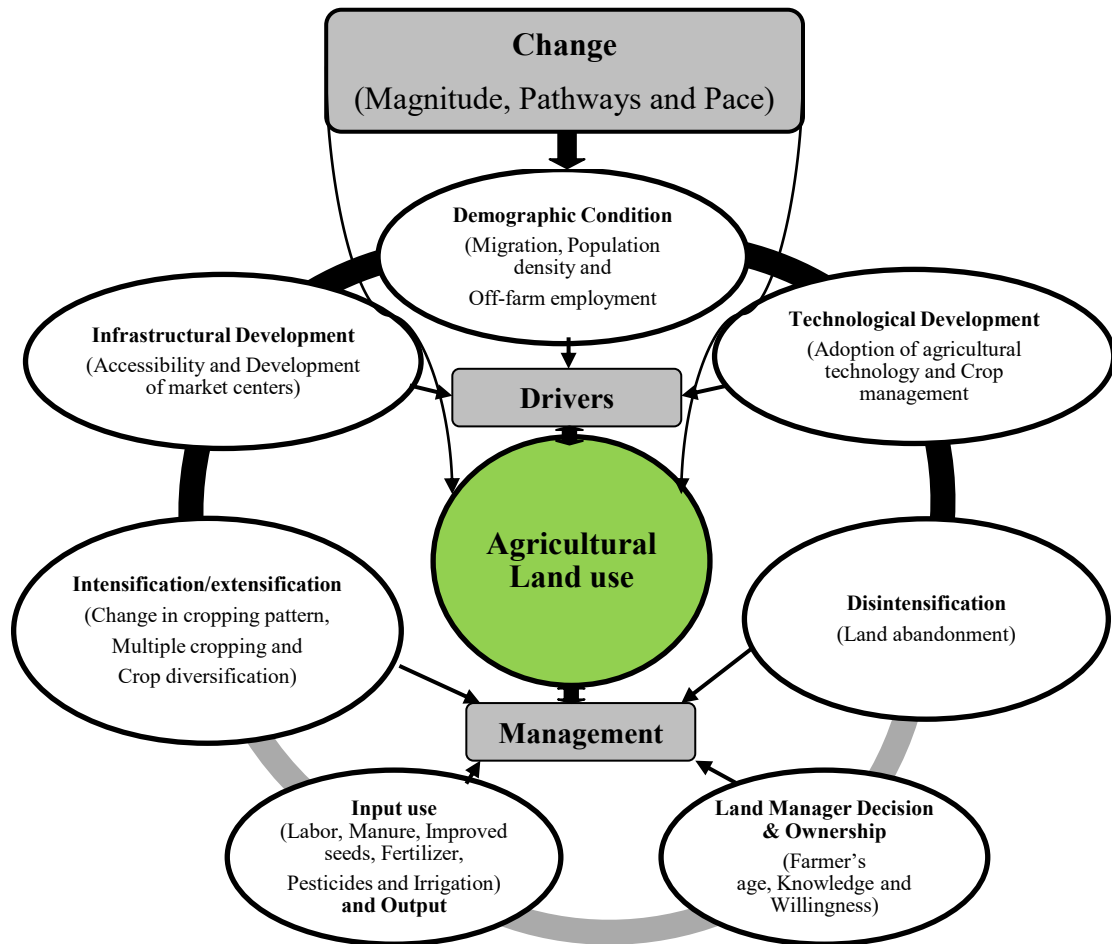


Figure 3.1: Conceptual Framework to the Study

Understanding of changes in agricultural land use is essential for the development of the agricultural land management plan and strategies. It is the process by which the resources of agricultural land are used for better purposes covering all activities concerned with the management of land as a resource both from an environmental and from an economic perspective. Not all agricultural land is capable or suitable for producing all agricultural products, regardless of the level of management applied. Besides, it is influence by land managers' decision and ownership of land, age and educational level of farmers, their attitude

and willingness on input use like agricultural labor, farm yard manures, fertilizers, pesticides, high yield variety seeds, use of modern machineries and irrigation facilities.

3.2 Selection of the Study Area

Nawalparasi district is selected purposively for this study which is one of the important food granary districts located in the Tarai region. It is the first and one of the important district selected for resettlement program after 1950s by state sponsored Nepal Resettlement Company (Suwal, 2014). Researcher is familiar with this district since long back, and it is because of this reason it is selected for micro level study. It is a comparative study; so three study sites (three wards) are selected for detail field survey with different population migration and physical characteristics.

3.3 Philosophical and Theoretical Basis

“Research methodology is based on the philosophical framework that guides research activity in certain tradition from selecting research problems, setting objectives and data collection and analysis” (Van Manen, 1990; Fien & Hillcoat, 1996; cited in Chapagain, 2008, p.34). A research method is a way of collecting and analyzing data. Both human and physical geographers engage in research to deal with the fundamental philosophical or theoretical questions concerning the nature of reality (ontology) and how to understand it (epistemology). In research, methodology is how knowledge is gathered and analyze in a systematic way; it is the theory of inquiry (Arora, 2017). Harvey (1969) emphasized that methodology without philosophy is meaningless, so geographer must take both methodology and philosophy into account (cited in Koirala, 2007, p.17). Elden (2009) in this concludes that many of the issues of concern to geographers have also been analyzed by philosophers. Taking this into consideration, my theoretical basis of the research is of two dimensional: one, it tries to see the theoretical link, and another is to find pragmatic ground to support this.

Agricultural land use change is the result of both the natural processes and human activities at different levels in order to fulfill their multiple goals. All scales have extent and resolution. Extent is the magnitude or the size of the spatial, temporal, quantitative or analytical dimensions whereas the resolution is the precision used in measurement. A pattern detected based on a scale with coarse resolution might disappear when a finer resolution is applied or vice versa. So, the findings derived from the analysis of one scale or level cannot be generalized to another scale or level (Gibson, Ostrom, & Ahn, 1998; cited in Khanal, 2002, p.42). The decisions of agricultural

land use change are made at different levels ranging from individual, household, community and levels of political/administrative institutional intervention in varying spatial scale ranging from plot to landscape and regional levels. For example, the selection of crops and use of input is decided by individual households. Similarly, the rules and regulations of state and community determine access to land, capital, technology and market. Infrastructural development, such as irrigation, roads and bridges depends on the decisions of village, community and local as well as national government institutions. Variables that appear to be drivers at one scale may seem constant at another and feedback effects are possible both in scales and driving forces (Khanal, 2002).

This study has applied the intensification theory of Boserup (1965) to explore interrelationship between population growth and food production. According to her theory, agricultural development is due to some kind of compulsion. She has highlighted that population growth results in agricultural development. Moreover, the intensification brings more investments in land improvement (e.g. irrigation, high yield variety of seeds, chemical fertilizers, pesticides etc.). Furthermore, she has extended interrelationship between demographic dynamics and technological development. Population change induces inventions with technological change to facilitate people doing different things. This theory is applied in the study for identification of farmers' agricultural activities to cope with increasing population pressure on agricultural land. The farmers adopt different strategies like intensification and diversification to increase the production of food by increasing workforce, machinery, HYV seeds, manure, fertilizers, irrigation etc.

Not only this, Boserup has highlighted that population growth results agricultural growth as anti-Malthusian theory. Her book '*The conditions of agricultural growth*' explores consequences of intensification - i.e. of the move from one stage to another caused by population growth. Each of them entails more labor per unit of (total) land, and thus the intensification increases the productivity of land and reduces that of labor. A household has to work more to keep the same level of income. The intensification brings about an improvement in tools (from the digging stick, to the hoe, to the plough) and in the long run; it also brings some investments in land improvement (e.g. irrigation, high yield variety of seeds, chemical fertilizers, pesticides etc.). Thus, the labour and agricultural land use pattern and diversification of the agricultural activities are linked with whether agricultural land use is the exceeding and receding pace.

In her another comprehensive book on '*Population and technological change: A study of long-term trends*' (Boserup, 1981), she has extended core interrelation between demographic dynamics and technological development. Inventions, or the acceptance of spreading inventions, have a strong demand component, and rapid population growth can generate such a demand. Thus, population change induces inventions and technological change to facilitate technological change: more people available make doing things differently possible. The agricultural changes which are now occurring in many underdeveloped countries seem to provide us with another example of rapid spread of the techniques of intensive agriculture owing to population pressure.

According to Malthusian theory, the size and growth of the population depends on the food supply and agricultural development. In Boserup's theory, agricultural development depends on the size of the population. In the Malthusian view, when food is not sufficient for everyone, the excess population naturally controls. However, Boserup argued that in those times of pressure, people would find ways to increase the production of food by increasing workforce, machinery, fertilizers, etc.

Economic condition of the farm household also influences the adaptation of innovation. Rich farmers are likely to be the first or principle adopters of new technology because their resources make them able to afford fixed costs and more likely to be able to survive even with the fluctuation of output. Not only the rich farmers but also the lower middle class people always do have greater desire for upward mobility. So, they take risks and adopt new technology. (Dewalt & Dewalt, 1980; Cancian, 1967 and 1980; cited in Khanal, 2002, p.11).

Out-migration of young people though helps balance population and resource use as a result of the reduction in demand for land, but sometimes it leads to deintensification and abandonment of agricultural land use due to the reduction in the use of inputs and other management practices. Increased population pressure provides abundant labour with which intensive use and management of land can be performed. If some of that labour is withdrawn due to increase in off-farm employment opportunities or emigration or demands on male labour generated by the state for *corvee* work or for war, the consequences can be the deintensification of land use (Blackie & Brookfield, 1987; cited in Khanal, 2002, p.10).

The philosophical approaches discussed above provided the basis to design research methodology, including the identification of variables and its linkages, selection of data collection methods and tools and development and adoption of analytical framework.

3.4 Research Design

The study was conducted in three different phases. In the beginning or during the pre-field work, various relevant literatures were reviewed from different reports and documents to identify the research questions and guide further activities. In addition, different materials like maps and satellites images of the study area was compiled and assessed to delineate research area. Then field survey was conducted to gather required information through quantitative method using household questionnaire and adopted qualitative method through observation, Focus Group Discussion (FGD) and Key Informant Interview (KII). Further, in the post survey phase, collected data were processed, managed, tabulated, compiled and analyzed. The schematic diagram of research design is presented below (Figure 3.2).

3.5 Methods of Study

Both qualitative and quantitative methods have been used though primarily focused on quantitative method in this research. The term quantitative research refers to the systematic scientific investigation of quantitative properties and phenomena and their relationships by using statistical methods. In addition, qualitative data such as perceptions, attitudes and priorities have also used to generate recalled and historical information through focus group discussion and key informant interview to triangulate with quantitative data. Limb and Dwyer (2001) argued that qualitative methodology is most suitable when exploring individuals' perceptions, attitudes and priorities.

The change in land cover discussion was based on time series maps so far available and field observation. The change in agricultural land cover area has been taken in VDC level due to different spatial scales of available maps and resolution of satellite images (Table 3.1). Other aspects of change are discussed with the help of cadastral maps and information obtained through household survey, and FGD and KII during the fieldwork in ward level.

The spatial distribution of overall cropping pattern and their temporal variation has been outlined and followed by the discussion of the area under different individual crops. The cropping pattern is the proportion of the area under various crops at the point of time. Agriculture land use, mainly the cropping pattern reflecting the development of the region depends upon natural and social environment. The data regarding the area and production of crops has been collected from household survey. Besides, the data has been converted into

percentage to the gross cropped area and production. The percentage of area and production of crop has been arranged into tables, diagrams and maps and have finally been displayed the spatial distribution. The study of temporal variation for the crops in the study area has been computed for 10 years period (2005/06 to 2015/16). Temporal variation is the change in proportion of area under different crops at two different times. This indicates the temporal variation at two different times. The changed area for every areal unit has been calculated for individual crop and the crops of leading increase and decrease which have been marked and mapped in all three sites for comparative view of the direction of change.

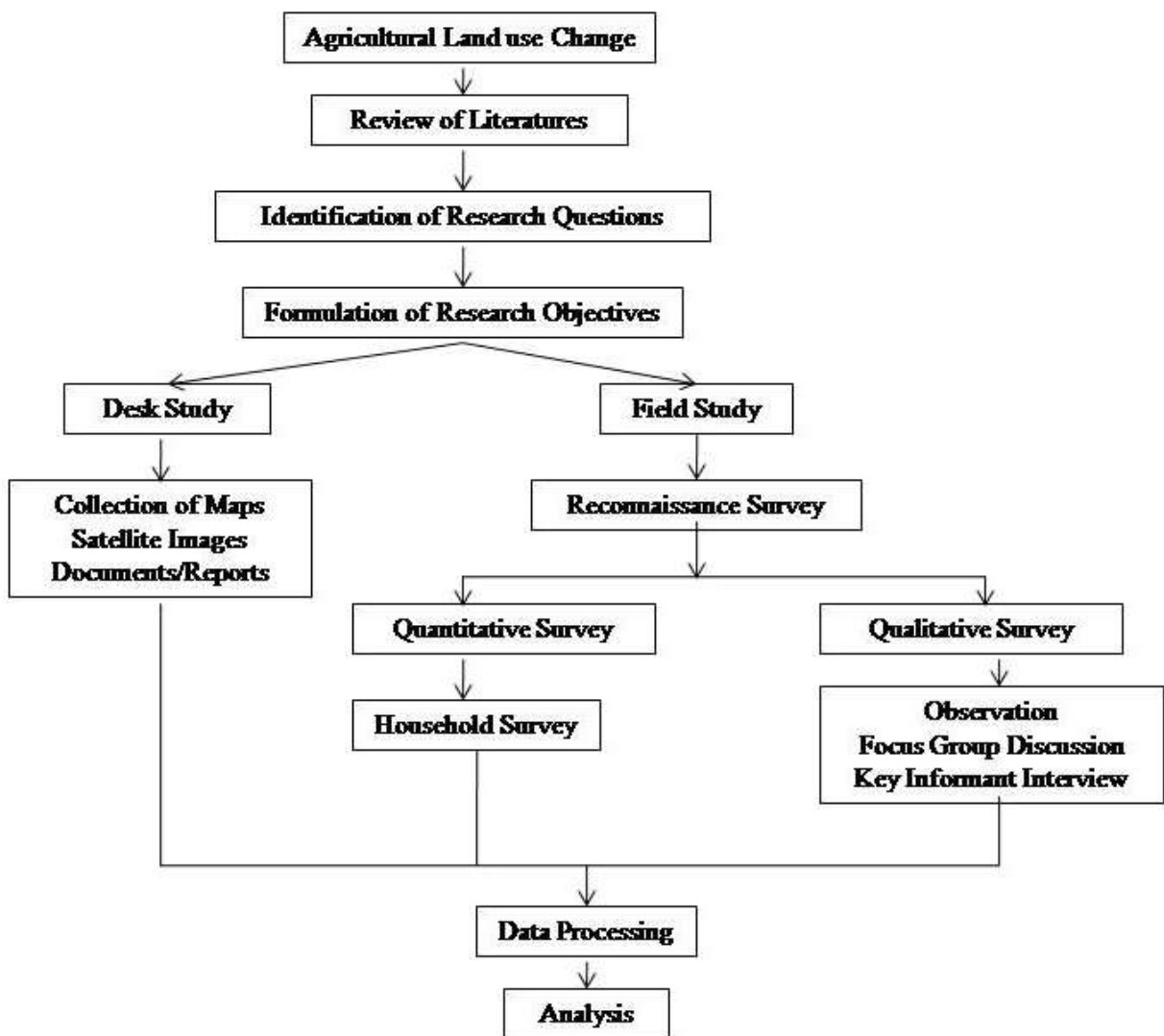


Figure 3.2 Schematic Diagram of the Research Design

3.6 Sources of Data

Primary and secondary sources of data were used.

3.6.1 Primary Data

Primary data was collected through different methods: Household Questionnaire Survey, Focus Group Discussion (FGD) and Key Informant Interview (KII). In addition, field verification of land use maps so far prepared from analogue maps, satellite images and Google earth images were carried out using Global Positioning System (GPS). Field observation and measurements were also carried out while doing field studies. A brief description of those methods is given below:

3.6.1.1 Household Survey

Household questionnaire survey is one of the important methods to collect primary data. It is one of the key components for the research like this because of its nature and research perspective. All together 93 households (31 households from each ward) were surveyed with semi structured questionnaire (Annex I). Information on demographic condition, land ownership, cropping area and production, driving factors of change in area and production, state of input use (labour, manure, fertilizers, pesticides and irrigation) by the households were collected through face to face household questionnaire survey. The sampling design for the household survey was as discussed below:

a) Sampling Design

Multistage sampling framework has been adopted. Tarai region of Nawalparasi district was selected purposively for this study. It is a comparative study. Only the Tarai area of the district was divided into three different regions based on land system (landform units, soil texture and drainage conditions) and socio-economic characteristics (sources of irrigation, ethnic composition and their history of migration) (Table 3.1). The region map was overlaid in VDC map. A list of VDCs in each region was prepared. From these three different regions, three VDCs, namely Ramnagar from upper part, Jahada from middle part and Palhi from lower part in the district were selected randomly. Again, a single ward from each VDC (ward number 5 from Ramnagar, ward number 3 from Jahada and ward number 9 from Palhi) were selected randomly for field survey (Figure 4.1). Ward level information was used for details of agricultural land use change in this study; however VDC level information was used for the presentation of land cover change only to examine the changing scenario of agricultural land to other categories.

Table 3.1: Physiographic and Population Characteristics of Study Sites

Characteristics Sites	Landform units*	Soil textures*	Drainage conditions*	Sources of irrigation facilities**	Originality of respondents**
Ramnagar (ward - 5) (Upper area)	Very gentle slope	Coarse	Moderately well	Surface irrigation	Ethnicity mainly of Hill origin
Jahada (Ward - 3) (Middle area)	Undulating	Silt	Well	Ground water	Ethnicity mixed of Tarai and Hill origin
Palhi (Ward - 9) (Lower area)	Depressional	Clay	Poor	Canal	Ethnicity mainly of Tarai origin

Source: * LRMP (1986) and ** Reconnaissance Survey, 2015/16

b) Sample Size

This is a comparative study. Comparative analysis was taken into consideration. Quota sampling of 31 households from each study site were determined keeping in view of the statistical norms for representation and data analysis. As per the Central Limit Theorem when the sample size is large, the mean computed from simple random sample is approximately normally distributed. Furthermore, one rule of thumb states that the sample size of 30 or more is considered as the minimum size for normal distribution (Daniel & Terrell, 1995; Sproull, 1988; Deviant, 2010). A list of household head within selected wards for household survey was obtained from Village Development Committee (VDC) offices and this was used as the sample frame for household survey. A random table was consulted, while selecting the household for interview in all study sites.

3.6.1.2 Focus Group Discussion (FGD)

Focus group discussions were carried out in nine places in various localities (Jayanagar, East Dhanewa and West Dhanewa in Jahada area, Brahmapur and Piparaiya in Palhi area, Upallo Jargaha, Bich Jargaha, Tallo Jargaha and Semrahanain in Ramnagar area). Information such as the number of households out migrated from the village was discussed during FGD. In addition, information on the overall change on agricultural land use and its trends and causes, distribution of public infrastructures and services, market centers, access to service centers, occurrence of major natural hazards including diseases and pests, chronology of the adoption of machineries in agriculture, prices of locally produced as well as imported commodities, wage rates, alternative sources of income, off-farm activities, status of permanent migration both in and out were

collected during FGD. These all components were taken into consideration with in-depth analysis.

The size of Focus Group Discussion (FGD) ranged from 9 to 14 people representing from community leaders, farmers group, senior citizens and school teachers during the consultation. All together, 126 peoples participated in discussion representing 61.1 percent male and 38.9 percent female, 53.2 percent from the 15-49 years age group, 42.1 percent from the 50-59 years age group and 4.8 percent from above 59 years of age group. Similarly, the participants belonged to different educational level. Of the total participants (126), 13.5 percent were illiterate, 15.9 percent with the primary level education, 37.3 percent with secondary level education and 24.6 percent with higher education level (SLC and above). At the time of FGD, participation from diverse occupations was ensured. However, all the participants were affiliated with agricultural activities either main source of income or alternate sources of income. Of the total participants, 38.9 percent were farmers, as dependent on agriculture only without other sources of income, and similarly 16.7 percent were from agriculture with business occupation, 31 percent were from agriculture with service occupation and rest 13.5 percent participated from other different occupations, like politicians, students, and freelancer and so on. The discussion was noted in the diary to categories with different issues and coding to analysis. FGD guidelines were prepared and used during the discussion (Annex II).

3.6.1.3 Key Informant Interview (KII)

Key Informants Interview (KII) is now-a-days a widely used in data collection procedure. In the present work, KII has been used to generate qualitative and quantitative information to explore knowledge on agricultural land management practiced in the study areas. KII interviews were taken to collect information from a wide range of people, including community leaders, professionals, senior citizens and local residents-who have firsthand knowledge about the community and agricultural activities. However, direct or indirect affiliation with agriculture was ensured with all respondents.

Key Informant Interview (KII) was conducted with fifteen persons (five in Jahada area, four in Palhi area and six in Ramnagar area) through face to face interview method, including ex-chairman and members of Village Development Committees (VDCs) and wards, schools teachers, senior citizens, members of farmer's cooperative and government officials from District Agriculture Development Office (DADO), Nawalparasi. The issues of discussion were

based on present and past agriculture condition, agricultural land use and production trends, cropping pattern, problems, drivers of agricultural land use change, issues on adopting modern agricultural inputs, strategies on agronomic agricultural land management practices, implication and use of technologies and socio-economic impacts and consequences, government policies, responsibilities of communities for the agriculture development. In addition, information on the trends and processes of change was obtained through informal discussion with key informants, consisting of senior citizen and knowledgeable persons. Based on the key informants' profile, experiences of agricultural activities and agricultural land use pattern, the research work is compatible to produce desired outcome in terms of its research paradigm.

The key informants participated from different socio-economic characteristics. Among them 73.3 percent were male and 26.7 percent were female representation. Similarly, 60 percent participants were from the 15-49 years age group, 26.7 percent from the 50-59 years age group and 13.3 percent from above 59 years of age group. Likewise, the participants were from different educational level. Of the total participants (15), 13.3 percent were illiterate, 26.7 percent with the primary level education, 13.3 percent with secondary level education and 26.7 percent from higher education level (SLC and above). At the time of KII, the participation from diverse occupations was ensured. However, all the participants were directly or indirectly affiliated with agricultural activities. Of the total, 53.3 percent were farmers, who depended on agriculture only without other sources of income, and similarly 20 percent had agriculture with business occupation, 13.3 percent had agriculture with service occupation and rest 13.3 percent participated from different other occupations like politicians and students. The discussion was noted for further analysis. A guideline of KII was developed to conduct the interview smoothly (Annex III). A demographic characteristic of respondents is presented in Annex V.

3.6.1.4 Field Observation

Agricultural land use of the study sites was observed and verified carefully and changed areas in agriculture were marked in the cadastral maps by parcels. Numbers of photographs were taken in the area under different crops production, intensification and diversification practices (Annex VIII). Changed areas in different localities in different periods were also verified with consultation of senior citizens and local government officials with long experience in agriculture and directly involved in agricultural activities. In addition, a consultation was also done with the officials from District Agriculture Development Office (DADO) and office of District

Development Committee (DDC), office of the Village Development Committees for the identification of extreme changed area and relevant weather and pest effect on crop previous years. Further, the direct observation was carried out in the farm during the field study.

3.6.2 Secondary Data

The major sources of secondary information on the pathways and extent of agricultural land use change consist of maps, government documents (district and VDC profiles, annual reports from DADO) and other published and unpublished reports, journals and books. Topographic maps (1958 and 1994) and cadastral maps and satellite images (2009) with different spatial resolution were other major sources of information on bio-physical and land use structure of the area (Table 3.2) and administrative boundary of study area from Department of Survey, Ministry of Land Reform, VDC/DDC offices, Ministry of Federal Affairs and Local Development (MoFALD), Government of Nepal were the institutions for major sources of spatial information.

Maps were prepared in digital format through digitization and overlay analysis done in Arc GIS 10.1 environment. Their pathways were analyzed as well. Emphasis was given to the hotspot areas where the change in land use was detected after interpretation of maps. Population censuses were other important sources of secondary information. Village Development Committee (VDC) and ward wise population data of 2001 and 2011 have been used. The data obtained from Population Monographs of Nepal and National Sample Census of Agriculture published by the Central Bureau of Statistics, National Planning Commission, and Government of Nepal was used for population, area and production related information in order to compare aggregate values obtained from the study area with national and regional averages.

Table 3.2: Sources and Resolution of Map and Satellite Data

Analogue maps and satellite image	Year	Spatial scale
Topographical sheet	1958-59 (based on aerial photo taken in 1953 and field verification in 1954)	1:63360
Topographical sheet	1994 (based on aerial photo taken in 1990 and field verification in 1991)	1:25000
Satellite images (WorldView-2)	2009	Spatial resolution of 0.5 meter (MSS)
Cadastral Maps	2012	1:100

Source: Surveyor General of India and Department of Survey, Government of Nepal

Present land cover maps have been prepared using the segmentation and classification of WorldView-2 MSS images of the three study sites. Visual interpretation and Classification is done using sample data set from high resolution ortho rectified WorldView-2 MSS images and references taken from topographical data and LRMP maps. Number of trial and error has been done to get required image object. Image object created in the segmentation process is further classified to extract the required feature. Two different classifications process was done. One is supervised classification using *Nearest Neighbour* classification and another is the *Assign Class Algorithms* classification. For the optimum result both classification algorithms have been used. Classification results were exported in thematic raster files. The raster files were converted into vector datasets and analysed to get statistical results of classification. Verification of classified result is done by taking random samples from the Google earth images and compared it with the classified images. Then confusion matrix was created to find the overall accuracy. Over all Accuracy was 70.00% and Kappa coefficient was 0.65.

Furthermore, both the published and unpublished official records available in the central and district office of different line agencies (DADO, DDC, and VDCs) were collected as important sources of information. For which, published materials included district resource profiles and district development plans of the Nawalparasi district and village development profiles of Jahada, Palhi and Ramnagar VDCs and annual progress report of District Agricultural Development Office (DADO), Nawalparasi, meteorological information of study sites recorded in Semari, Nawalparasi from Department of Hydrology and Meteorology (DHM). Unpublished materials consisted of document of resource management and development plans and the records of irrigation projects and their command area, livestock population etc.

3.7 Data Analysis

Spatial, qualitative and quantitative methods were adopted to analyze derived information in this study. A summary of research objectives, types of data use, methods and tools of data generation and analysis with expected outcomes is given in Table 3.3.

3.7.1 Spatial Analysis

The spatial changes of agricultural land cover and use of agricultural land under different crops, area under intensification and diversification was calculated from maps, using spatial analysis in Geographic Information System (GIS) tool. The aerial extent and pathways,

magnitude and pace of agricultural land use change were obtained through the spatial overlay analysis of maps and derived from field survey information.

3.7.2 Qualitative Data Analysis

After data collection, the inconsistencies were checked thoroughly in the comparison of information derived from household questionnaire survey, FGD and KII as well as field observation. Then local units (pathi, muri, kattha, bigha) were converted into SI unit. The notes and field level discussions were categorized by issues and coding was done for summarizing the findings.

3.7.3 Quantitative Data Analysis

The agricultural land use change, trends, drivers and its implications to the change, cropping intensity, crop productivity and crop diversification were analyzed based on different statistical indices, such as i) Rate of Change Index, ii) Change Intensity Index, iii) Land Use Type of Dynamic Index, iv) Land Use Integrated Index, v) Crop Productivity Index, vi) Cropping Intensity Index vii) Crop Diversification Index and viii) Correlation Coefficient (r). These indexes were used while studying the change in agricultural land use and its development (Ndabula, Averik, Jidauna, Abaje, Oyatayo, & Iguisi, 2013). Correlation Coefficient was used to measure the association between cropping area and production by crops. The results are also presented using different maps, figures and diagrams wherever relevant.

The following equations have been used for computing quantitative indices to analyze quantity, rate, as well as the magnitude of change among various land use in the study area, which provides a basis for comparisons with other places to better explain the spatio-temporal dynamics of land use and land cover as an Index of land degradation.

Rate of Land Use Change (A_i): It indicates the rate of change in specific type of land use category like cultivated land in particular area within study period.

$$\text{Rate of Land Use Change } (A_i) = \frac{U_{bi} - U_{ai}}{\sum(U_{bi} - U_{ai})} \dots\dots\dots (1)$$

Where A_i = rate of change of i^{th} land use

U_{ai} = i^{th} Land use area at beginning of study period

U_{bi} = i^{th} Land use area at end of study period

Land Use Change Intensity Index (T_i): It indicates extend or magnitude of land use change pattern within specific type during study period.

$$\text{Land Use Change Intensity Index } (T_i) = \frac{U_{bi} - U_{ai}}{B} \dots\dots\dots (2)$$

Where (1, 2,.....,7) Total number of land use classes.

T_i = intensity index for i^{th} land use type

U_{ai} = i^{th} Land use area at beginning of study period

U_{bi} = i^{th} Land use area at end of study period

B = Total study Area

Land Use Type of Dynamic Index (D_i): It indicates changing rate among land categories during the study period. It is used to describe the changing speed of land use which plays an important role in comparing the regional differences of land use change analyzing the changing trend of land use.

$$\text{Land Use Type of Dynamic Index } (D_i) = (U_{bi}-U_{ai})/ U_{ai}*(1/T)*100\% \dots\dots\dots (3)$$

Where i = (1, 2,.....,7) Total number of land use classes.

D_i = Land use dynamic Index for i^{th} Land use type

U_{ai} = i^{th} Land use area at beginning of study period

U_{bi} = i^{th} Land use area at end of study period

T = Total study period in years.

Land Use Integrated Index (I_d): It reflects overall change of different land categories in the study area during study period.

$$\text{Land Use Integrated Index } (I_d) = 100 \times \sum_{i=1}^7 A_i * C_i \dots\dots\dots (4)$$

Where i limits (100.....700) Total number of land use classes.

I_d = Land use Integrated Index

A_i = percentage of i^{th} level landuse

C_i = Level of land use

(Assignment of C_i level is based on C_i values)

Crop Productivity Yield Index (P_i): It indicates condition of productivity for different crops in particular area during the study period.

Crop Productivity Yield Index (P_i)

$$P_i = \sum (y_1/t + y_2/t + y_3/t + \dots + y_n/t) / (Y_1/T + Y_2/T + Y_3/T + \dots + Y_n/T) \dots \dots \dots (5)$$

Where,

P_i = Productivity index

y = Yield of the 1 to nth crops at the unit level.

t = Area under 1 to nth crops at the unit level.

Y = Yield of the 1 to nth crops at the field level.

T = Total area of 1 to nth crops at the field level.

Cropping Intensity: It indicates the use of cropping land of several times during a cropping year. It is a measure of land efficiency, which is defined as the extent to which the net area is cropped or sown.

$$\text{Cropping Intensity} = (\text{Gross cropped area} / \text{Net sown area}) \times 100 \dots \dots \dots (6)$$

Crop Diversification Index (CDI): It indicates monoculture or polyculture in specified region during the study period. If the total cultivated area in a region is devoted wholly to one crop (i.e., specialization), the index value will be zero (0), and if it is evenly distributed among all crops (i.e., maximum diversification), the index value approaches one (1).

$$\text{Crop Diversification Index (CDI)} = 1 - \{ \sum X^2 / (\sum X)^2 \} \dots \dots \dots (7)$$

Coefficient of Correlation (r):

To measure the association between cropping area and production by crops, the Karl Pearson's Coefficient (r) of Correlation is used. The coefficient correlation is calculated with the following formula:

$$r = \frac{\sum XY - (\sum X) \cdot (\sum Y) / N}{\sqrt{[\sum X^2 - (\sum X)^2 / N][\sum Y^2 - (\sum Y)^2 / N]}} \dots \dots \dots (8)$$

Where, r = Coefficient of Correlation X, Y = the two given Variables N = Number of Observations

Population Growth Rate is calculated with the following formula:

$$\text{Geometric Growth Rate } (r) = \sqrt[t]{P_t/P_0} - 1 \dots\dots\dots (9)$$

Where, r = Rate of change

t = Time interval, P_t = Final population and P₀ = Initial population

Labour Intensity: It is the ratio between labour input and cropping area. It is calculated by total number of labour inputs in particular crop divided by total cropping area under the same crop.

Table 3.3: Data Collection and Analysis Methods

Objectives	Types of data	Data generation methods	Analytical methods/tools	Expected Output
Analyze the trends of agricultural land use change in terms of its pathways, magnitude and pace	Area by different types of land use and crops	Interpretation and field verification of available maps, satellite images, digitization and calculation of area	GIS overlay and Spatial analysis	Change in area
	Cropping intensity	Household survey, Focus Group Discussion, Key Informant Interview	Quantitative description	Cropping intensity
	Cropping pattern			Cropping pattern
	Production and productivity			Change in production and productivity
Examine the main drivers of agricultural land use changes.	In-migration and population pressure	Household survey and Census reports	Quantitative and qualitative description, GIS application	Pressure on land and production
	Population density	Household survey and Census reports		Accessibility
	Distance from home to farm	Household survey, Focus Group Discussion, Key Informant Interview		
	Institutional and infrastructural development	Field observation, Focus Group Discussion, Key Informant Interview		Access to service centers

Assess the state of input use in agricultural land management	Input use (labour, manure, fertilizers, pesticides and irrigation) by different crops	Field observation, Household survey, Focus Group Discussion, Key Informant Interview	Quantitative and qualitative description	Status of input use and their impact on output
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Source: Prepared by researcher

The biophysical and socio-economic condition of the study area is discussed in the proceeding chapter four.

CHAPTER 4

INTRODUCTION TO THE STUDY AREA

4.1 Nawalparasi District

This chapter examines general situation of Nawalparasi district, physical setting of three VDCs and the biophysical, socio-economic and infrastructural development of study sites in particular.

Nawalparasi District is located in Lumbini zone in Western Development Region of Nepal and lies between 27°21' to 27°47' north latitude and 83°36' to 84°25' east longitude. Its elevation ranges from 91 meters in the south to 1936 meters in the north. Ecologically, it lies in the Tarai region bordering Palpa and Tanahun districts in the north, Chitwan in the east, Bihar (India) in the south, and Rupandehi in the west. Before the field work, the district was divided into 56 VDCs, 7 Municipalities, 15 Ilakas and 6 constituencies (MoFALD, 2015). While it has been divided into two districts, the eastern part lies in federal state 4 and western part in federal state 5 after the restructuring of the federal system. The eastern part (Bardaghat-Susta East) has incorporated four municipalities and four rural municipalities, whereas the western part (Bardaghat-Susta West) has incorporated into three municipalities and four rural municipalities (MoFALD, 2017). According to new structure, the study area, ward number 3 of Jahada VDC lies in ward number 13 of Bardaghat Municipality, ward number 9 of Palhi VDC lies in ward number 4 of Palhi Nandan Rural Municipality and ward number 5 of Ramnagar VDC lies in ward number 11 of Sunwal Municipality.

The total land area of Nawalparasi district (before restructuring) is 2,162 sq km. Total population of Nawalparasi district is 643,508 and out of it, 303,675 are male and 339,833 are female as per census 2011. The sex ratio is 89.36 in the study area. The total number of households in the district is 128,670. The average household size is remained 5 in this district, whereas, it is only 4.88 at the national level (CBS, 2014c). The population growth rate of the district between 2001 and 2011 is (1.34) as similar as the national average of 1.35 percent (CBS, 2014a). The population density of the district is 298 person/sq km, which is higher than national figure of 180 person/sq km.

Out of the 56 VDCs and 7 municipalities, three VDCs (Jahada, Palhi and Ramnagar) are selected for detail field survey based on biophysical and socio-economic characteristics. Ward number 3 of Jahada VDC (here after refer Jahada), ward number 9 of Palhi VDC (here after refer

Palhi) and ward number 5 of Ramnagar VDC (hereafter refer Ramnagar) were selected for detail study.

4.2 Physical Setting of Study Sites

4.2.1 Location

Jahada VDC is located in the middle part of the district and extends from 83°44'17" to 83°46'51" East longitude and 27°28'18" to 27°31'23" North latitude within the surface area of 14.34 sq km. Palhi VDC is located in southern part of the district and extends from 83° 39' 14" to 83° 40' 39" East longitude and 27° 27' 38" to 27° 30' 04" North latitude within the surface area of 6.42 sq km. Ramnagar is situated between Chure hill in northern side and plain land in southern part. It extends from 83° 40' 04" to 83° 43' 57" east longitude and 27° 32' 46" to 27° 37' 12" north latitude within the surface area of 29.47sq km. (Figure 4.1).

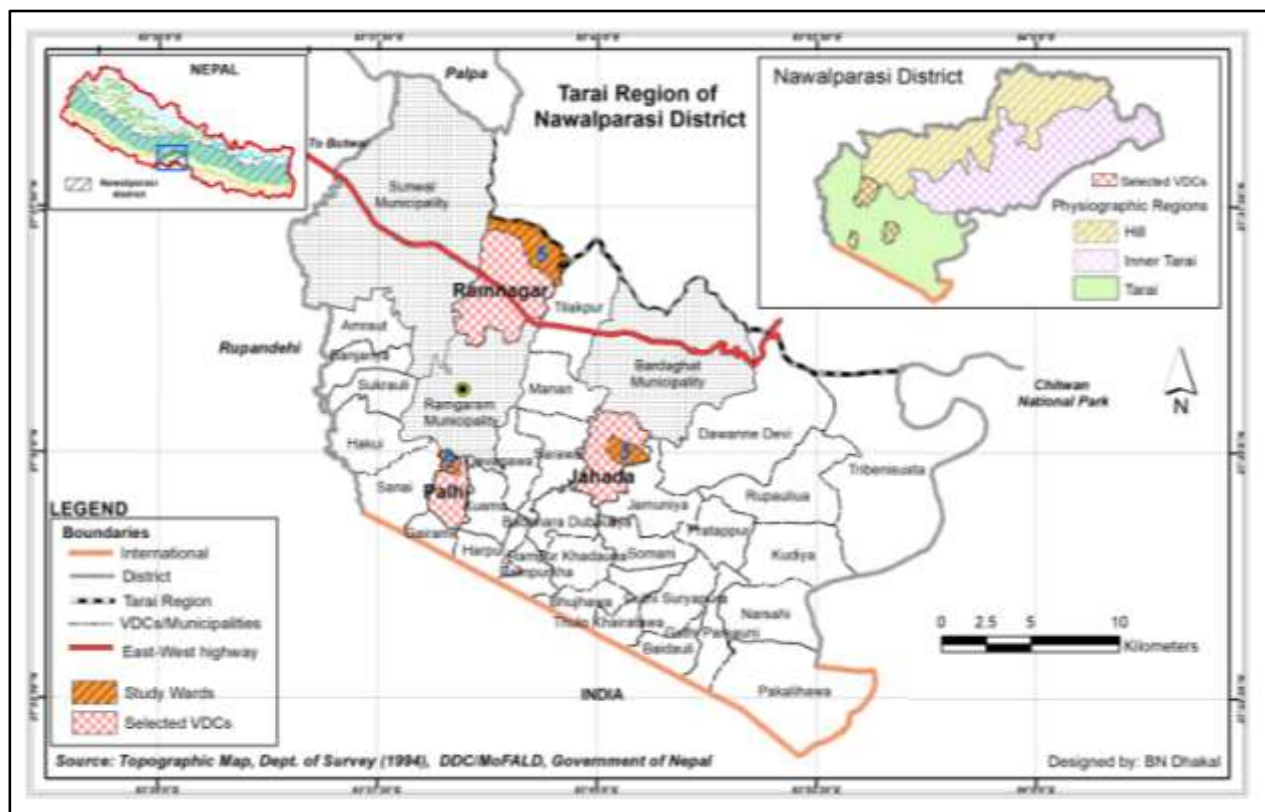


Figure 4.1: Location Map of the Study Area

4.2.2 Geology

Tarai is depositional zone, consisting of recent to Post-Pleistocene quaternary deposits. The terrain is flat with minor relief caused by ongoing river actions and tectonics. Geologically, the study area consists of active alluvial deposits, recently deposited alluvial plain, alluvial fan and colluviums. The area belongs to the Indo-Gangetic Plain. The sediments are distributed southern part of the Main Frontal Thrust (MFT). They are still in formative process and could potentially be inundated during the high floods (Pandey, 2009).

The relative height of this area is up to 5 m above from present riverbed and decreases downstream. Lithologically it consists of sub angular to sub rounded, poorly sorted boulder, cobble, and pebble intercalated with sand and silty clay layers derived from Siwalik range and Lesser Himalayan rock.

4.2.3 Elevation

The elevation of Jahada VDC ranges from 104-109 m., Palhi VDC ranges from 102-111 m. and Ramnagar VDC ranges from 112-153 m. above the mean sea level. However, the most part of Jahada VDC falls under 105-106 m. Palhi VDC however, falls under 103-106 m. and Ramnagar VDC falls under 116-124 m. elevation.

4.2.4 Land Systems

It has undulating type of land unit surface and most area of the study site of Jahada VDC is composed of this type of land unit. All agricultural land use pattern of Jahada is categorized as Tarai cultivation based on the physiographic characteristics and wet land cultivation based on the land form and land system (LRMP, 1986). Whereas Palhi VDC has dominant of depressional type of land unit, whose more than sixty percent of land area is composed of this type of land unit. Agricultural land of Palhi VDC is also classified as Tarai cultivation based on the physiographic characteristics. All the agricultural land falls under wetland cultivation category. The wetland cultivation is further divided into lowland khet and upland khet. About 98.28 percent of wetland cultivation is of upland khet category, and 1.72 percent wetland cultivation is of lowland category. Active alluvial plain, upper and lower piedmont, gentle slopes with intermediate position and low terrace, river channel, sand and gravel bars are the major land unit types found in Ramnagar VDC occupying more than 80 percent of land area. The wetland cultivation covers about 64 percent of the total agricultural area, and the rest by mixed land cultivation (LRMP, 1986).

4.2.5 Climate

The climate of the study sites is sub-tropical monsoon type like other areas of Tarai. Summer is very hot during the day time. Sometime, in summer heat wave occurs in the study sites. This climate has three distinct seasons. Dry summer season begins in the month of March and lasts till the middle of June, when mean minimum temperature reaches up to 25.2⁰ Celsius and mean maximum temperature is nearly 37.7⁰C. Rainy season starts from the month of July and ends in September. The amount of rainfall that occurred in this season is more than 2000 mm in 2010 (Annex VI). Winter season begins in the month of October and lasts till February. In this season mean maximum temperature is as high as 31.9⁰C in the month of October and mean monthly temperature is as low as 7.9⁰C in the month of January (DHM, 2016) (Figure 4.2).

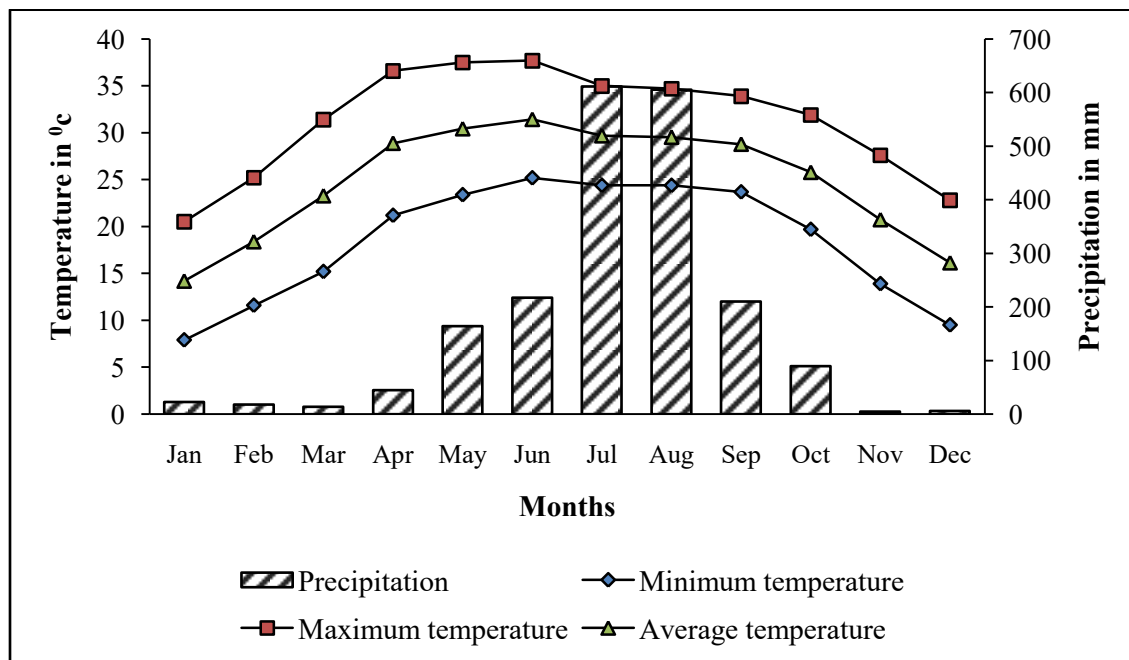


Figure 4.2: Mean Monthly Maximum, Minimum, Average Temperature (in °C) and Mean Monthly Precipitation (in mm) recorded at Semari, Nawalparasi District (2002-2011)

4.2.6 Drainage

Most of the rivers and streams in the study area are originated from Churiya Range and they flow only in rainy season with high velocity and remain dry in winter. These stream and rivers are considered more important with the perspective of irrigation. The Dhanewa is the major river in Jahada VDC. With this, there are some local streams originated within the study area in the rainy season only. There is the Gandak canal passing through center of Palhi VDC,

which is the main source of irrigation in this area. With the main canal, network of some branches are also distributed in this area. Bhumahi Khola and Bhulahi Khola are the major rivers in Ramnagar VDC. The land has been irrigated by Bhulahi Khola. In the summer season, these small rivers and streams are filled with a huge volume of water creating the situation of inundation. Similarly, a lot of ponds are available in the study area (Figure 4.3, figure 4.4 and figure 4.5).

4.2.7 Soil

The main classes of soil according to their texture are sands, clay and loams with intermediate classes are dominant in the study sites. Jahada lies in an alluvial terrace and more than 80 percent area is covered by unconsolidated sediments of the alluvial deposits (river deposits) with silt clay. Palhi area consists of active alluvial deposits, recently deposited alluvial plain with fine clay and Ramnagar area covered by moist and coarse sandy soil.

4.2.8 Vegetation

The sub tropical forest is found in the study area, is characterized by hardwood, bushes, and mixed types of vegetation. Sal (*Shorea robusta*), Khair (*Acacia catechu*), Sissoo (*Delbergiasissoo*), Karma (*Adina cardfolia*), Sattissal (*Dalbergialatifolia*), Bans (*Dendrocalmuspp*), Pipal (*Populusreligiosa*), Kusum (*schloecheraoleosa*), Jamun (*Syziuumcumini*), Teak (*Tectonagrandis*), Asna (*Terminaliaalata*), Mango (*Mangiferaindica*), Bakaino (*Meliaazaderach*), Simal (*Bombaxceiba*) Neem (*Azadirachtaindica*), Badahar (*Artocarpuslakoocha*), Bijayasal (*Pterocarpusmarsupium*) etc. are the major species of tree (plant) in the study sites. Many of these trees have the characteristics of deciduous forest.

4.2.9 Land Cover Condition

The total land of Jahada VDC has an extent of 1433.5 hectares. Figure 4.6 shows that the agricultural land has dominant land cover class in this area which covers 1322.7 hectares with 92.3 percent of the total area. The total land of Palhi VDC has an expanse of 641.8 hectares. The agricultural land has dominant land cover class in this area which covers 567.4 hectares with 88.4 percent of the total area. Similarly, cultivation is also a predominant land use type in Ramnagar VDC. Out of total surface area of 2947 hectares, agricultural land covers 58.4 percent.

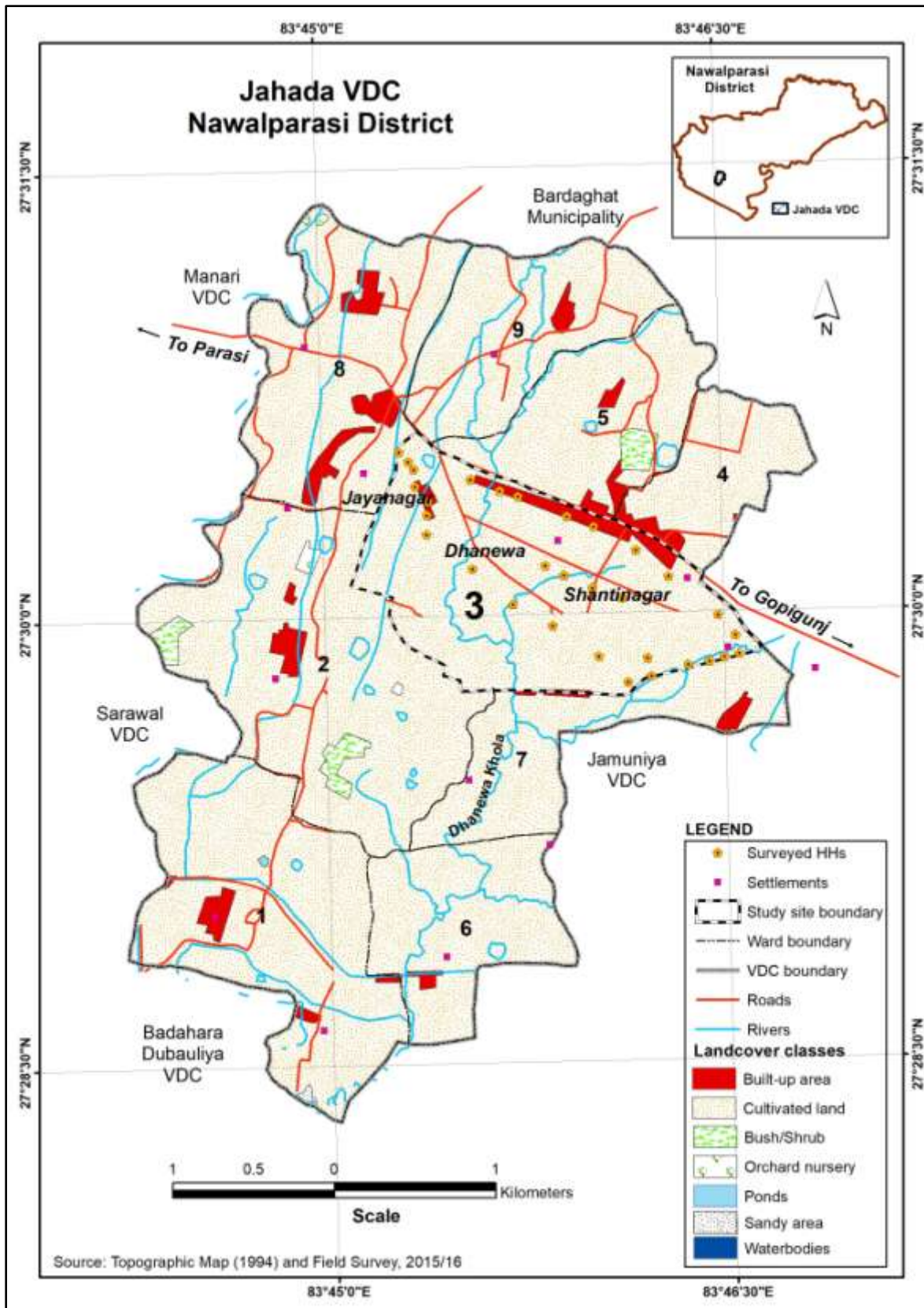


Figure 4.3: Topographic Map of Jahada VDC

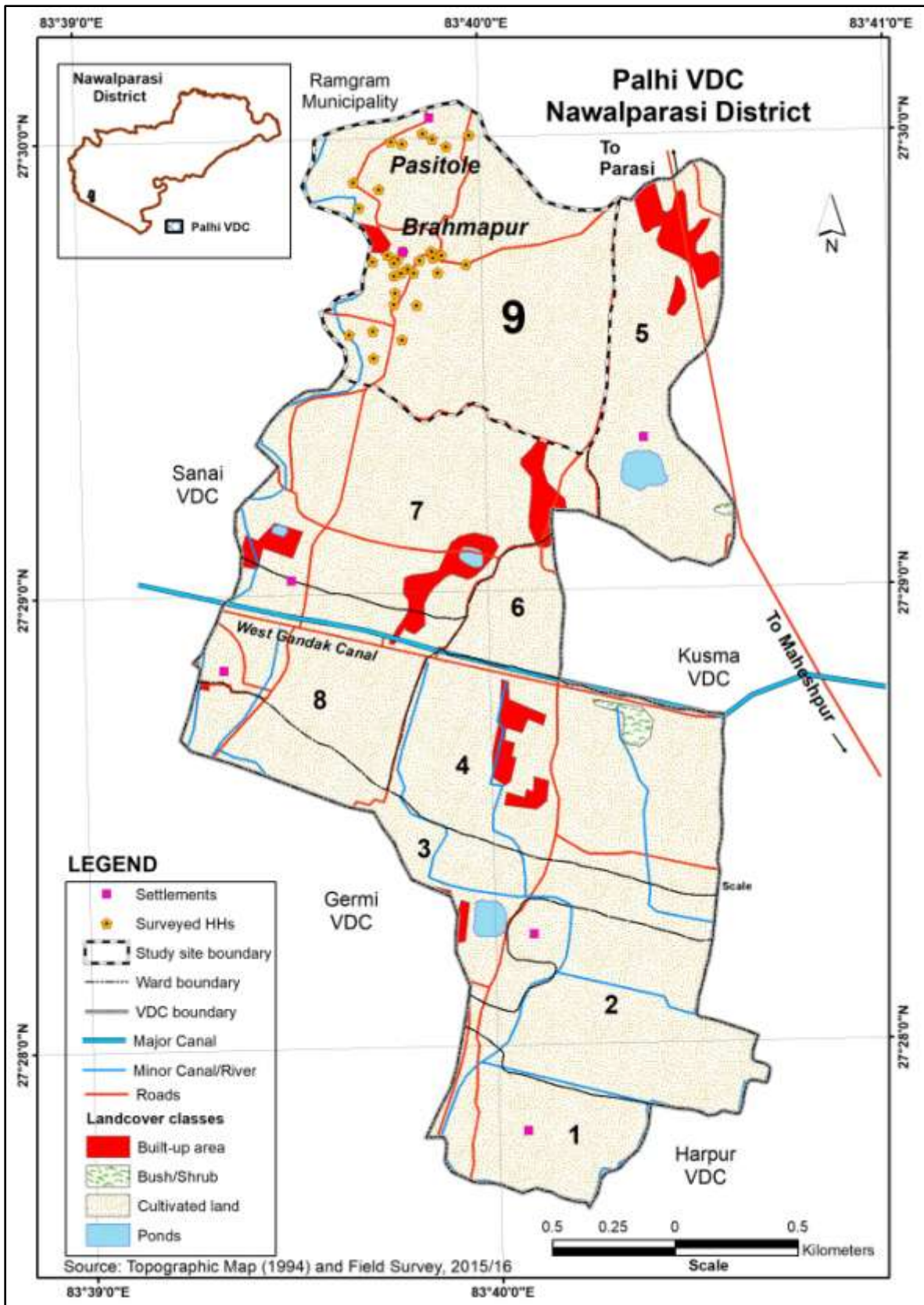


Figure 4.4: Topographic Map of Palhi VDC

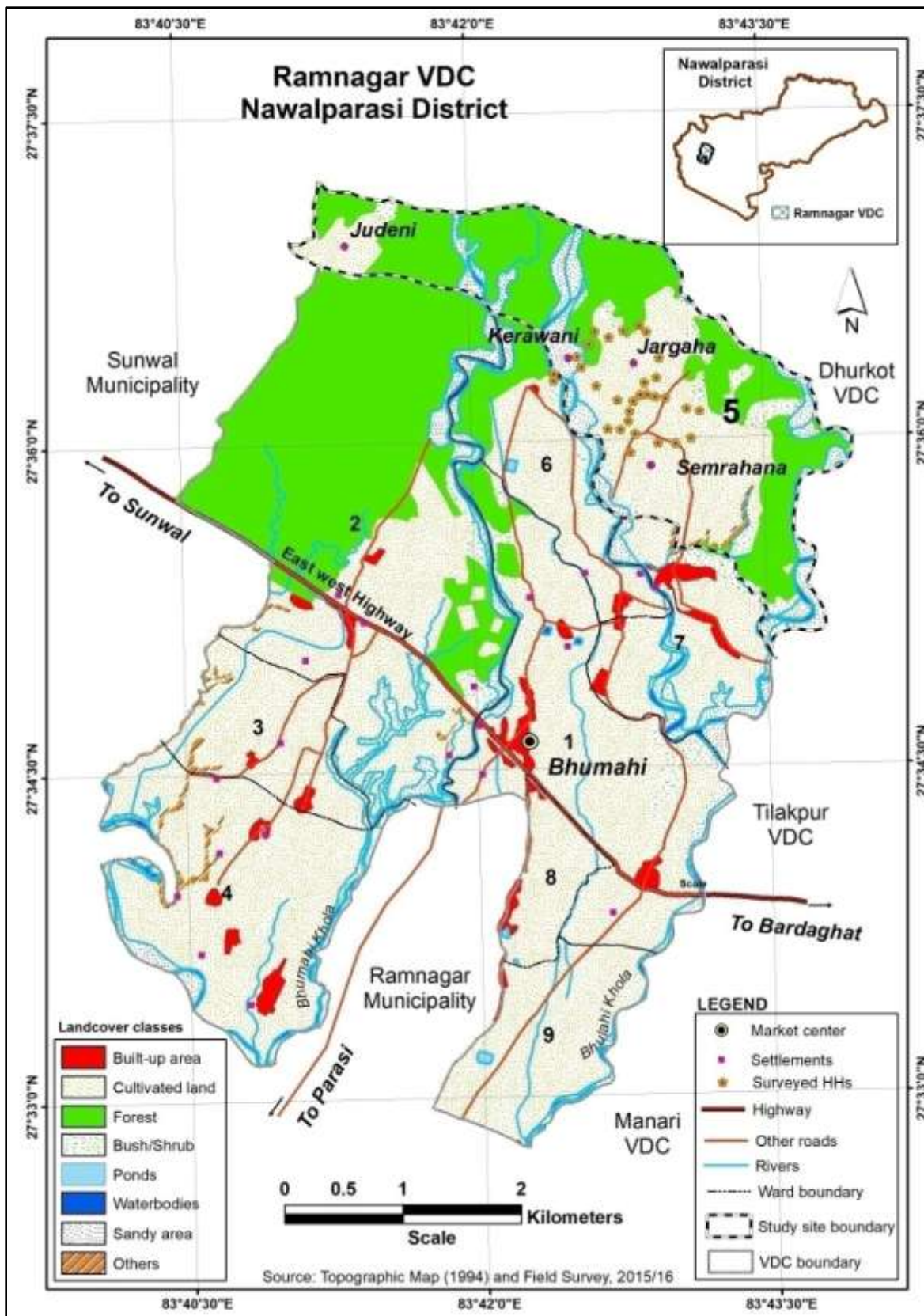


Figure 4.5: Topographic Map of Ramnagar VDC

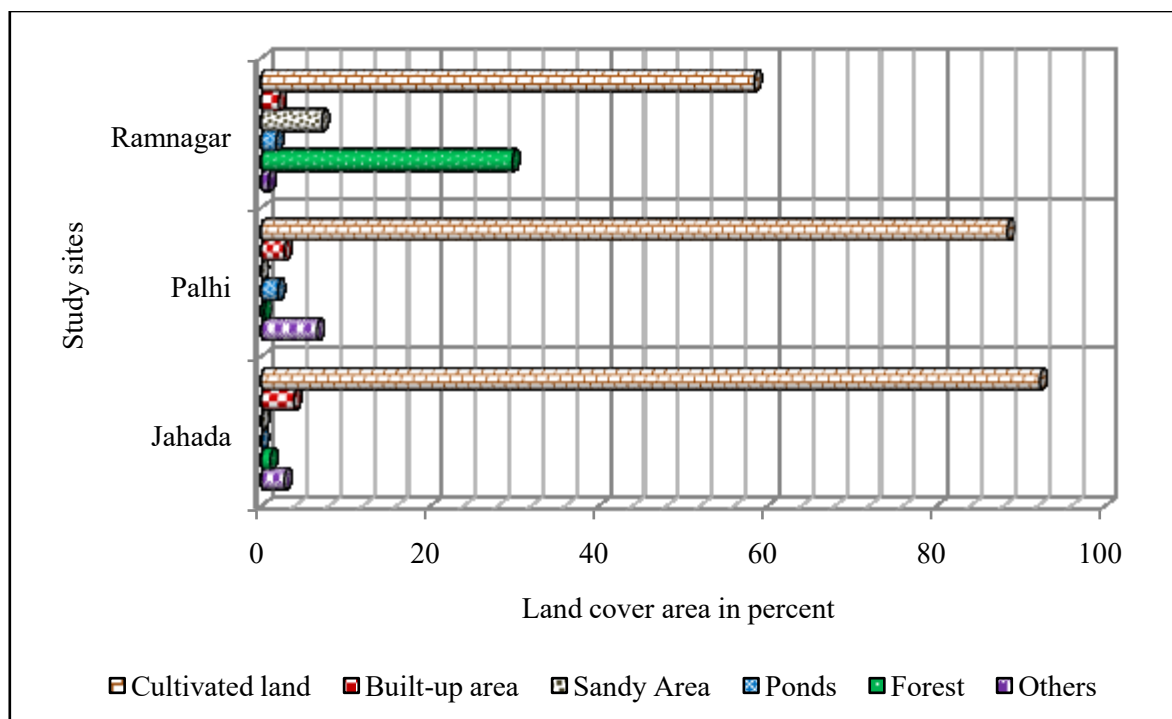


Figure 4.6: Land Cover Condition in the Study VDCs

4.3 Social Setting

4.3.1 Population

The total population in Jahada has 1116 residing within households of 246. The sex ratio has 71.9 in this area. And the average household size has remained 4.5 in this area, which is similar with the district level. Population growth rate of this area has 0.92 between 2001 and 2011 which is less than the district and national level. Population density of this area has 467 person/sq km which is higher than district and national figure. The total population in Palhi has 484 residing within households of 74. Sex ratio has 93.6 in this area. The average household size has remained 6.5 in this area, which is more than the district level. Population growth rate of this area is 0.32 between 2001 and 2011 which is less than the district and national level. Population density of this area has 397 person/sq km which is higher than district and national figure. The total population in Ramnagar has 1851 who are residing within households of 406. And sex ratio has 72.7 in this area. An average household size has remained 4.6 in this area, which is less than the district level. Population growth rate of this area has 1.43 between 2001 and 2011 which is more than the district and national level. Population density of this area has 302 persons/sq km which is higher than district and national average figure (Table 4.1).

Table 4.1: Demographic Characteristics in the Study Sites

Characteristics	Jahada (Ward no. 3)	Palhi (Ward no. 9)	Ramnagar (Ward no. 5)
Area (ha)*	239	122	612
Households	246	74	406
Total population	1116	484	1851
Male female ratio	71.9	93.6	72.7
Average household size	4.5	6.5	4.6
Population density (person/sqkm)	467	397	302
Population growth rate	0.92	0.32	1.43

Source: *Topographic Map (1994) and CBS, 2011

4.3.2 Population Composition

The composition of population by age group in different three study sites is presented in Table 4.2 below. Working age population (15-59 years) is 60.2 percent in Jahada, 67.0 percent in Palhi and 68.4 percent in Ramnagar. And working age population is higher than national average (57 percent) in the all study sites.

Table 4.2: Population Composition by Age Group

Age group	Jahada	Percent	Palhi	Percent	Ramnagar	Percent
Below 4	8	4.2	9	4.1	11	5.1
4-14	37	19.4	40	18.3	28	13.0
15-59	115	60.2	146	67.0	147	68.4
Above 59	31	16.2	23	10.6	29	13.5
Total	191	100.0	218	100.0	215	100.0

Source: Field Survey, 2015/16

Table 4.3 shows the ethnic composition of population in the study sites. Dominant of Brahmin-hill is (67.5 percent of total population) over the ethnic group in Jahada, dominant of Tharu (46.3 percent of total population) ethnic group is in Palhi and the dominant of Brahmin-hill (57.7 percent of total population) ethnic group is in Ramnagar. People use Nepali, Bhojpuri, Maithili, Tharu, and Magar as a native language in the study sites. The demographic makeup is therefore mixed type.

Table 4.3: Composition of Population by Caste/ethnicity

Caste/ethnicity	Jahada	Percent	Palhi	Percent	Ramnagar	Percent
Brahmin	129	67.5	3	1.4	124	57.7
Chhetri	16	8.4	0	0.0	12	5.6
Dalit	0	0.0	65	29.8	0	0.0
Kushaha	0	0.0	21	9.6	0	0.0
Madhesi	6	3.1	20	9.2	0	0.0
Magar	38	19.9	4	1.8	65	30.2
Muslim	2	1.0	4	1.8	0	0.0
Thakuri	0	0.0	0	0.0	4	1.9
Tharu	0	0.0	101	46.3	10	4.7
Total	191	100.0	218	100.0	215	100.0

Source: Field Survey, 2015/16

4.3.3 Migration of Population

Table 4.4 shows a trend of migration of population in the study sites. Altogether 34.4 percent of populations are migrated before 1990 AD and 17.2 percent of populations are migrated during 1990 AD to 2005 AD, whereas only 11.8 percent of populations are migrated after 2005 AD. Altogether 36.6 percent Tarai origin people are living in the study sites mainly in Palhi area.

Among the migrants, altogether 76.3 percent people are found to have migrated from Syangja, Parbat, Kaski and Baglung districts of Gandaki zone 22.0 percent of people have migrated from Palpa, Gulmi, Arghakhanchi and Rupandehi districts of Lumbini zone and 1.7 percent from other areas in the study sites (Annex VIII).

Table 4.4: Trend of migration of population (in percent)

Periods	Jahada	Palhi*	Ramnagar	Total
Before 1990	61.3	0.0	41.9	34.4
1990 to 2005	16.1	0.0	35.5	17.2
After 2005	19.4	0.0	16.1	11.8
Native	3.2	100.0	6.5	36.6

Source: Field Survey, 2015/16

Note: *All people are native.

4.3.4 Educational Attainment

Table 4.5 shows literacy status of population aged 5 years and above by educational attainment in the study sites. Altogether 36.6 percent of the total population has only primary

level education in Jahada. Similarly, 40.9 percent of the total population has the primary level education in Palhi, whereas 31.5 percent of total population has the SLC and above qualification in Ramnagar. In addition, more female have only primary level education in all study sites whereas male are more educated in Palhi and Ramnagar but female are more educated in Jahada.

Table 4.5: Literate Population 5 Years of Age and above by sex (in percent)

Educational level	Jahada		Palhi		Ramnagar	
	Male	Female	Male	Female	Male	Female
Illiterate	3.1	12.6	7.7	32.7	7.3	16.2
Primary(1-7)	33.3	40.0	39.3	42.6	26.4	33.3
Secondary(8-10)	28.1	18.9	31.6	10.9	21.8	24.8
SLC and above	27.1	27.4	16.2	11.9	39.1	23.8
Others	8.3	1.1	5.1	2.0	5.5	1.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field Survey, 2015/16

4.4 Economic Setting

4.4.1 Agriculture Land Use Pattern

Different types of crops are grown in the study sites. Major foods crops are paddy, wheat, maize, oilseeds, pulses, green vegetables and potato. Among these, paddy is dominant crop in all study sites. It is an important staple crop of the country. After paddy, oilseed is another important cash crop grown in Jahada, respectively wheat is another important cereal crop grown in Palhi whereas, maize and oilseeds are other important crops grown in Ramnagar. Table 4.6 represents the area and production of major crops in the study sites.

Table 4.6: Area (ha), Production (kg) and Yield (kg/ha) of Crops

Crops	Jahada			Palhi			Ramanagar		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Paddy	18.66	121120	6492	40.70	305678	7511	12.93	79420	6143
Maize	0.65	685	1053	0.08	200	2367	6.10	4125	676
Wheat	6.46	15950	2471	21.50	63045	2933	2.91	8050	2769
Potato	1.85	3173	1715	1.99	7420	3737	0.72	3731	5195
Vegetables	0.23	200	877	0.94	3495	3726	3.52	2600	740
Oilseeds	7.55	5550	735	6.54	4448	680	4.63	4514	975
Pulses	4.78	2054	429	6.49	5969	920	1.42	822	579

Source: Field Survey, 2015/16

4.4.2 Cropping Pattern

Table 4.7 presents the cropping pattern in the study sites. It has been found that dominant of two crops in Jahada and Palhi, but there is dominance of three crops in Ramnagar. All together 64.5 percent of crop land is under two crops (Paddy+ Wheat / Oilseeds /Pulses) in Jahada. Similarly, 80.3 percent of crop land is under two crops (Paddy+ Wheat / Oilseeds / Pulses) in Palhi. Whereas 48.4 percent area of total crop land is under three crops (Paddy + Wheat/Vegetables/Pulse/Oilseeds + Maize) in Ramnagar (Figure 4.7).

Table 4.7: Cropping Patterns in the Study Sites (in percent)

Number of crops	Crops	Jahada	Palhi	Ramnagar
Single crop	Paddy	19.4	3.2	6.4
Two crops	Paddy+ Wheat / Oilseeds/ Pulses	64.5	80.3	45.2
Three crops	Paddy + Wheat/Vegetables/Pulse/ Oilseeds + Maize	16.1	16.5	48.4

Source: Field Survey, 2015/16

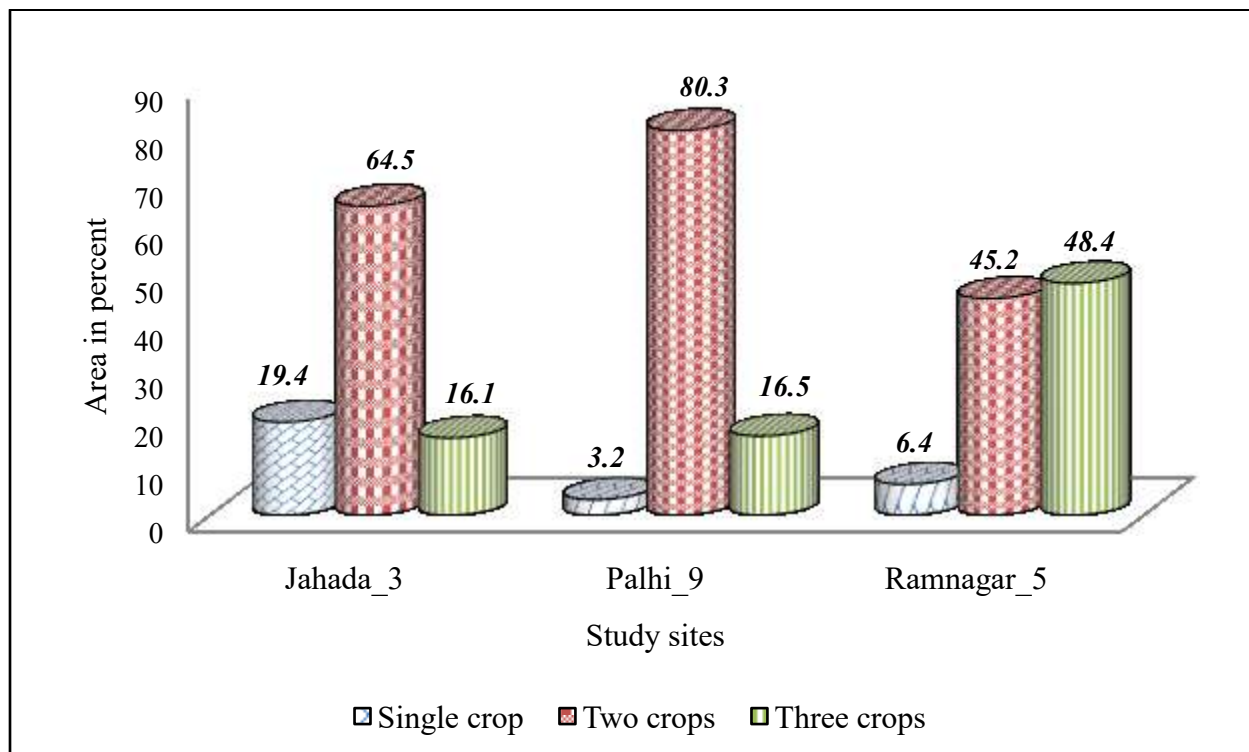


Figure 4.7: Cropping Patterns in the Study Sites

4.4.3 Occupational Structure

Table 4.8 shows that agriculture is the dominant occupation in all study sites. Altogether 44.5 percent of the total population in Jahada, 50.5 percent of the total population in Palhi and 51.6 percent of the total population in Ramnagar have involved in agriculture. Apart from the agricultural activities, peoples have also involved in business, services and other activities (daily wages, labours and students).

Table 4.8: Occupational Status of Population in the Study Sites (in percent)

Occupations	Jahada	Palhi	Ramnagar
Agriculture	44.5	50.5	51.6
Business	4.2	1.8	1.4
Services	6.3	2.3	3.3
Foreign Services	8.4	7.8	15.3
Others	36.6	37.6	28.4
Total	100.0	100.0	100.0

Source: Field Survey, 2015/16

4.4.4 Livestock

Table 4.9 shows number of livestock by study sites. There are altogether 9176 livestock being raised in the study area. The highest number of livestock is in Ramnagar and lowest number is in Palhi.

Table 4.9: Livestock Status in the Study Sites (in number)

Types	Jahada	Palhi	Ramnagar	Total
Cattle	65	29	52	146
Buffalo	27	48	57	132
Goat	165	190	263	618
Poultry	1747	1253	5280	8280
Total	2004	1520	5652	9176

Source: Field Survey, 2015/16

4.5 Service Infrastructure

4.5.1 Transportation

Transportation of the study sites is comparatively developed than other Tarai districts (DDC, 2015). There are good accessibility networks among market centers and settlements in the study sites by different types of road network. Among them, East West Highway passes through Ramnagar VDC. The Parasi-Mahespur road passes through Palhi VDC which provides service from India (Mahespur) to Nepal (southern part of the Tarai). There is another important road

(*Hulaki sadak*) starting from Parasi and linking to Jahada-Gopigunj-Tribeni (Figure 4.3, Figure 4.4 and Figure 4.5).

4.5.2 Market Centers and Major Settlements

There are Bhumahi, Bardaghat, Sunwal, Gopigunj, Tribeni, Maheshpur and Parasi as major market centers along and nearby areas of study sites. Similarly, Dhanewa, Jayanagar and Shantinagar in Jahada, Bramhapur and Pasitole in Palhi and Jargaha, Semrahana and Jodeni in Ramnagar are the major settlements in the study sites (Figure 4.3, Figure 4.4 and Figure 4.5).

4.5.3 Water Supply

Tube well/hand pump and tap/piped water are the main sources of drinking water in the study sites. The larger proportions (63.5 percent) of the total households in Jahada use tube well/hand pumps. 96.7 percent of total households in Palhi use tube well/hand pumps water whereas 82.5 percent of the total households in Ramnagar use supply tap water. Remaining households are using drinking water from other sources like well/ *kuwa*, spout water and stream/ river water which are other sources of drinking water in the study sites.

4.5.4 Irrigation

Irrigation is considered as an important input to the increase agriculture production and productivity. There are different types of irrigation system in the study sites. Shallow and deep tube well irrigation system has been used in Jahada providing irrigation facilities in 62.9 percent of total cropping land and canal irrigation system (Gandak Western Canal) which has been providing irrigation facility in 79.5 percent area of total cropping land in Palhi. Whereas, surface irrigation through construction of traditional as well as modern ditches provide irrigation facilities in Ramnagar in 85.4 percent area of total cropping land.

4.5.5 Housing

Table 4.10 shows that most of the households (46.2 percent) in Jahada used tile/slate roofed buildings. Similarly, larger numbers of households (57.5 percent) live in house roofed with RCC in Palhi, and 49.7 percent household in Ramnagar live in house roofed with RCC. It is followed by tile/ slate, galvanized iron, and so on.

4.6 Energy Use

Most of the households in the study area use firewood as usual as source of fuel for cooking. People used to collect firewood from the nearby government forest particularly in Ramnagar and purchase from sawmills and furniture factories in Jahada and Palhi area. In Jahada, 62.7 percent of households use firewood as a main source of fuel, followed by LP gas by

13.6 percent of users, bio-gas by 12.9 percent of users and cow dung, kerosene, electricity are also used by other households respectively. Similarly, 70.1 percent of households use firewood as a main source of fuel, followed by cow dung users (24.2 percent of households), bio-gas by 2.8 percent of households and liquefied petroleum gas use by 2.7 percent of total households in Palhi. Similarly, 70.9 percent of total households use firewood as a main source of fuel, 19.3 percent use LP gas and 7.1 percent of households use bio-gas in Ramnagar (Table 4.11).

Table 4.10: Households by Roof of House (in percent)

Roof types	Jahada	Palhi	Ramnagar
RCC	33.9	57.5	49.7
Tile / slate	46.2	31.7	22.4
Corrugated sheets	12.6	2.5	20.5
Thatch/straw	5.3	6.7	4.4
Others	2.0	1.6	3.0
Total	100.0	100.0	100.0

Source: Field Survey, 2015/16

Table 4.11: Household by Type of Fuel Used for Cooking in the Study Area (in percent)

Type of fuel	Jahada	Palhi	Ramnagar
Wood / firewood	62.7	70.1	70.9
LP gas	13.6	2.7	19.3
Bio gas	12.9	2.8	7.1
Cow dung	5.5	24.2	0.4
Kerosene	0.3	0.1	0.3
Electricity	0.2	0.0	0.0
Others	4.8	0.1	2.0
Total	100.0	100.0	100.0

Source: Field Survey, 2015/16

It is found the diversity on agricultural land cover and land use condition in all study sites under different biophysical and socio-economic conditions vary. Within these biophysical, socio-economic and infrastructural development context, trends, magnitude and pathways of agricultural land use change has been discussed in the proceeding chapter.

CHAPTER 5

CHANGES IN AGRICULTURAL LAND

5.1 Introduction

The use of agricultural land depends on the socio-economic condition of farmers and technological development on the one hand and conservation of land resources on the other. The change in agricultural land use is the shift in the intent, use pattern and the management of agronomic attributes of land (Makowski, Nesme, Papy & Dore, 2013).

This chapter explores trends of agricultural land use in spatial and temporal context. The change of agricultural land in terms of magnitude and pathways, landholding size, and change in cropping area is discussed in this chapter.

5.2 Land Cover Change

Agricultural land and built-up area has increased and forest area has decreased significantly in Jahada and Ramnagar within the 51 years of time interval. While, an area under built-up and water bodies has increased and agricultural land has decreased significantly in Palhi within the same time interval. Further, it is found crop land has decreased significantly in all study sites and remarkably has converted to built-up areas. Besides, built-up area has changed significantly during this period. Area covered by built-up was 0.9 percent in 1958 and reached to 20.1 percent in 2009 in Jahada. Similarly, built-up area was 4.9 percent during 1958 and reached to 14.3 percent in 2009 in Palhi. Likewise, the coverage of built-up area was 1.0 percent in 1958 and which changed to 7.3 percent in 2009 in Ramnagar (Annex VIII).

5.3 Agricultural Land Cover Change

Agricultural land has increased during 1958 to 1994, but it has decreased from 1994 to 2009 in the all study sites. Agricultural land was covered 92.3 percent of total land area in 1994 and decreased to 67.5 percent in 2009 in Jahada VDC. Similarly, it was covered 88.4 percent of total land area by agricultural land in 1994 and changed to 78.9 percent in 2009 in Palhi VDC. Whereas agricultural land was covered 58.4 percent of total land area in 1994 has decreased to 54.7 percent in 2009 in Ramnagar VDC (Table 5.1 and Figure 5.1, Figure 5.2, Figure 5.3 and Figure 5.4).

Change has been observed and verified through map (Figure 5.1) in the field. Moreover, respondents during household survey, FGD and KII also argued on the area converted to built-up

area (roads and buildings) due to the pressure of in-migrated population in the study area. This type of change has also been reported in Tarai area of Nepal (CBS, 2014a).

Table 5.1: Change in Agricultural Land Cover (Area in ha)

Study sites	1958		1994		2009	
	Area	Percent	Area	Percent	Area	Percent
Jahada	793.07	55.3	1322.71	92.3	967.43	67.5
Palhi	542.78	84.6	567.43	88.4	506.04	78.9
Ramnagar	1276.05	43.3	1721.49	58.4	1612.50	54.7

Source: Topographic Maps (1958 and 1994) and Images (2009)

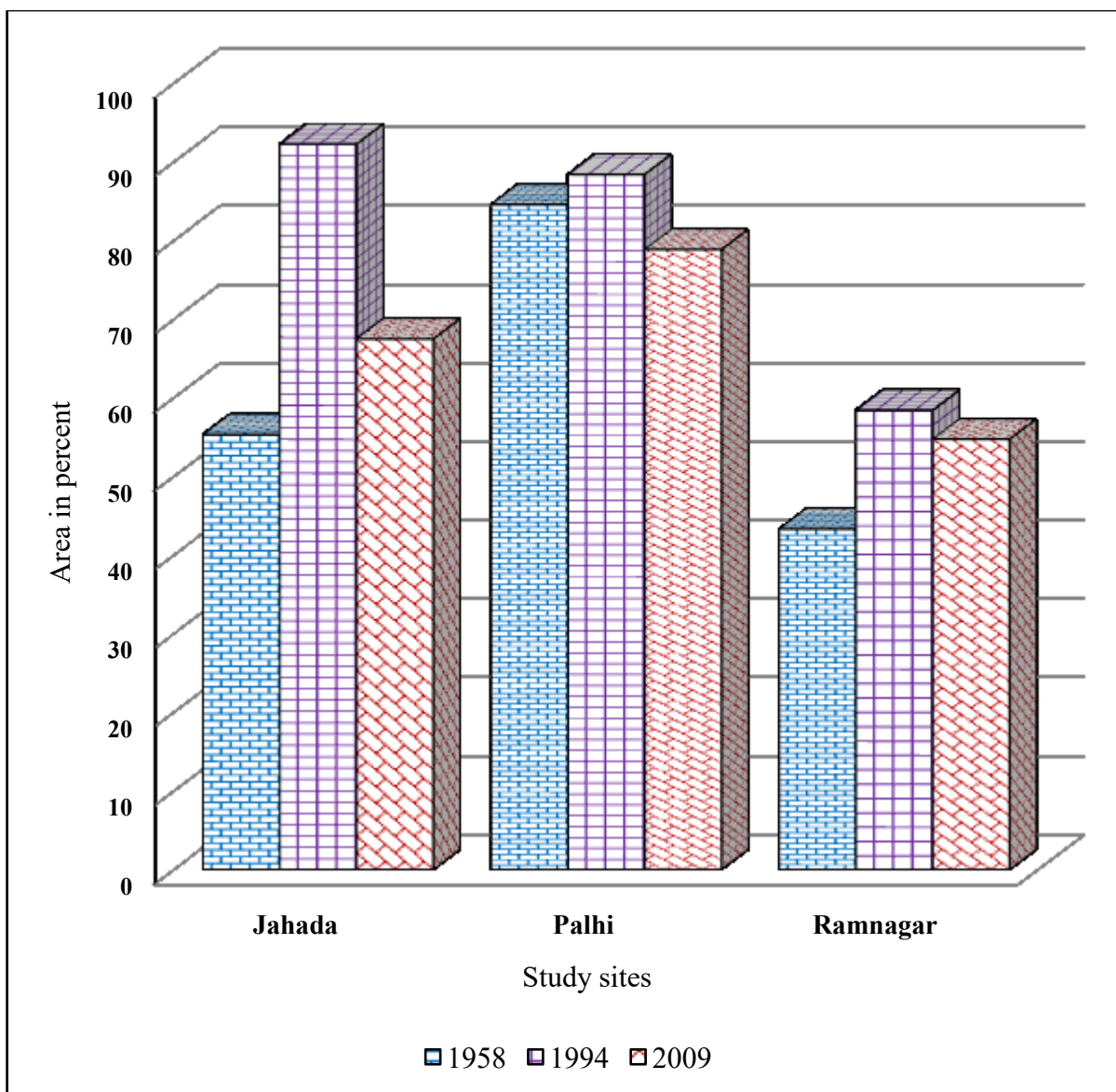


Figure 5.1: Trends of Agricultural Land Cover Change

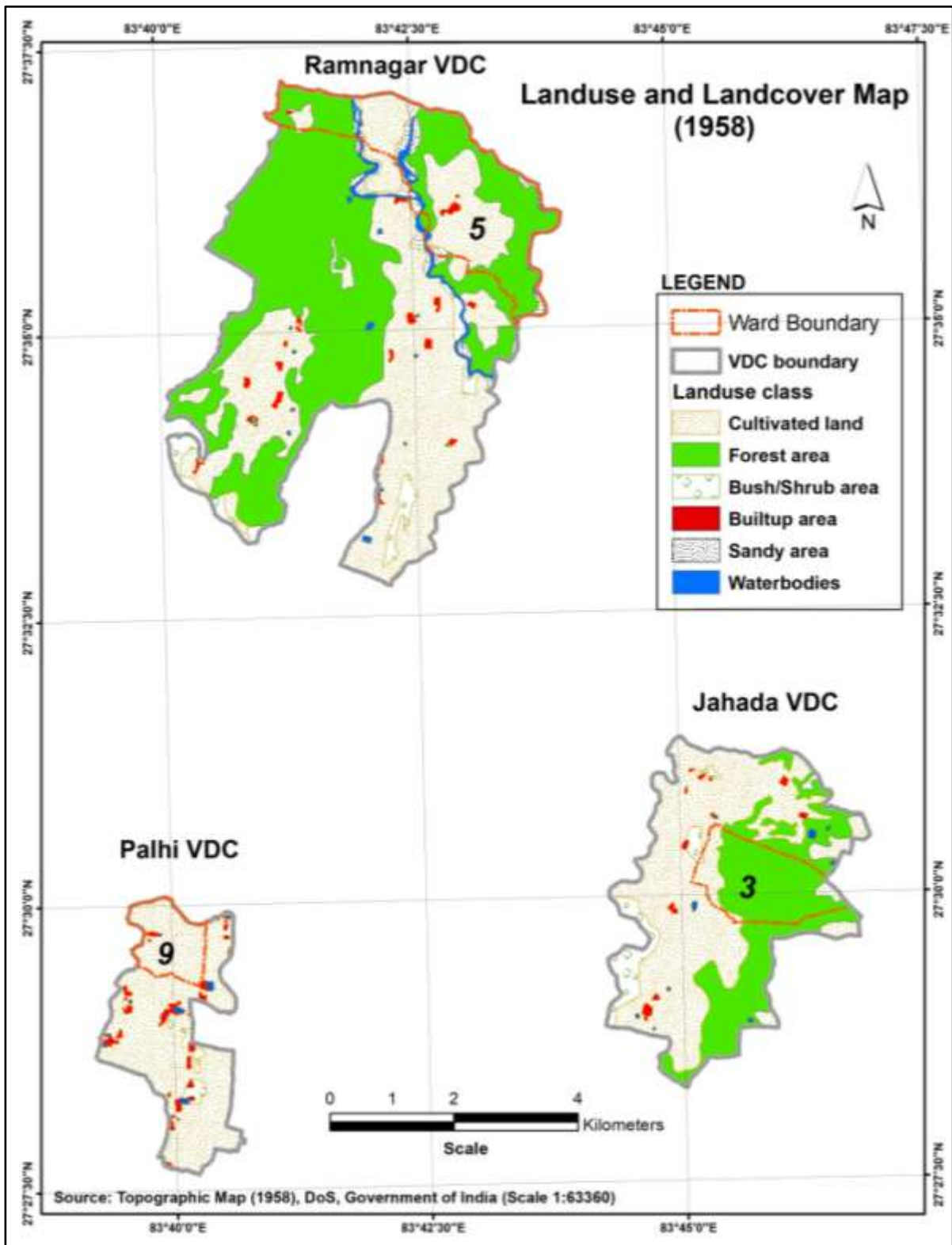


Figure 5.2: Land Use and Land Cover Condition in the Study Sites (1958)

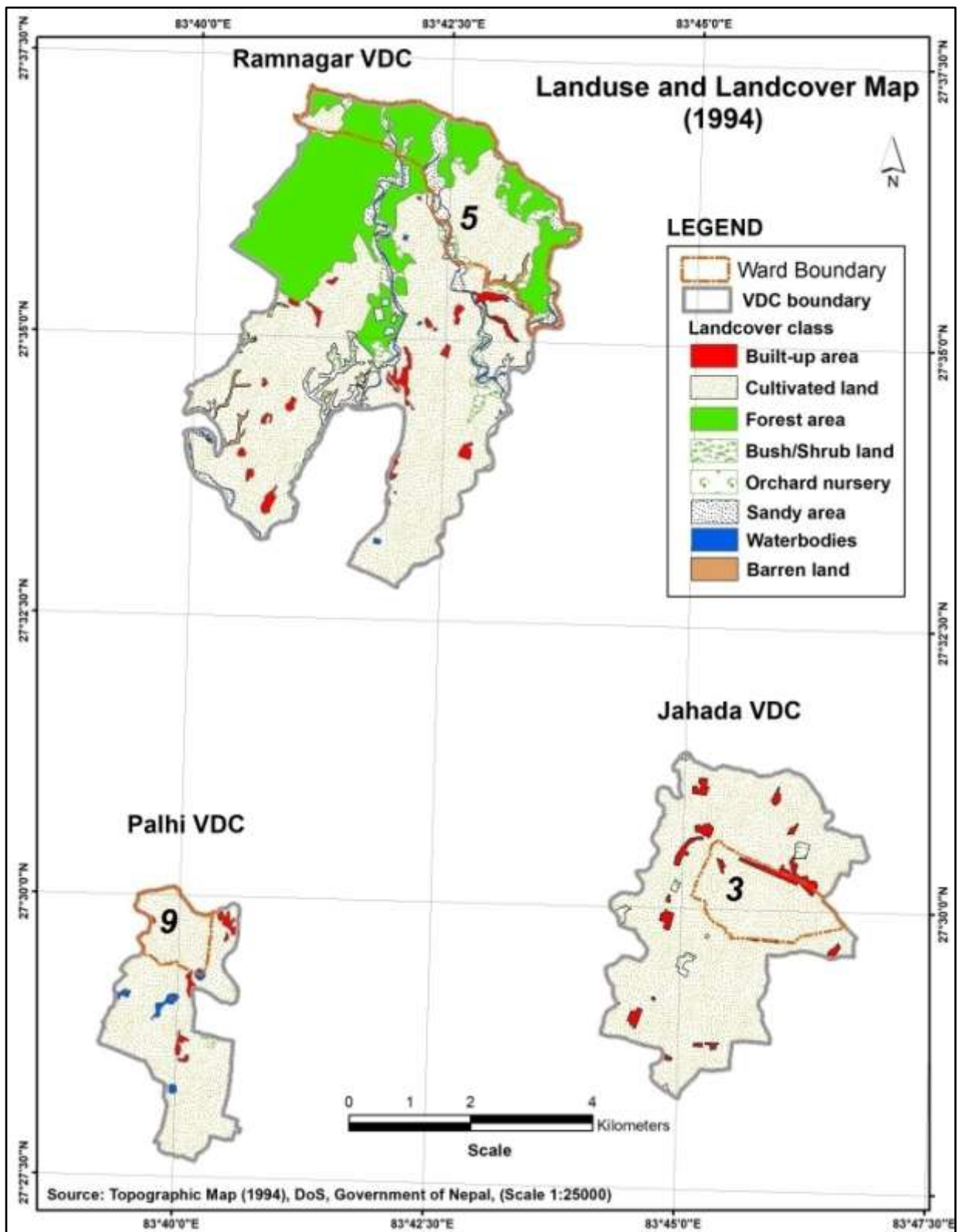


Figure 5.3: Land Use and Land Cover Condition in the Study Sites (1994)

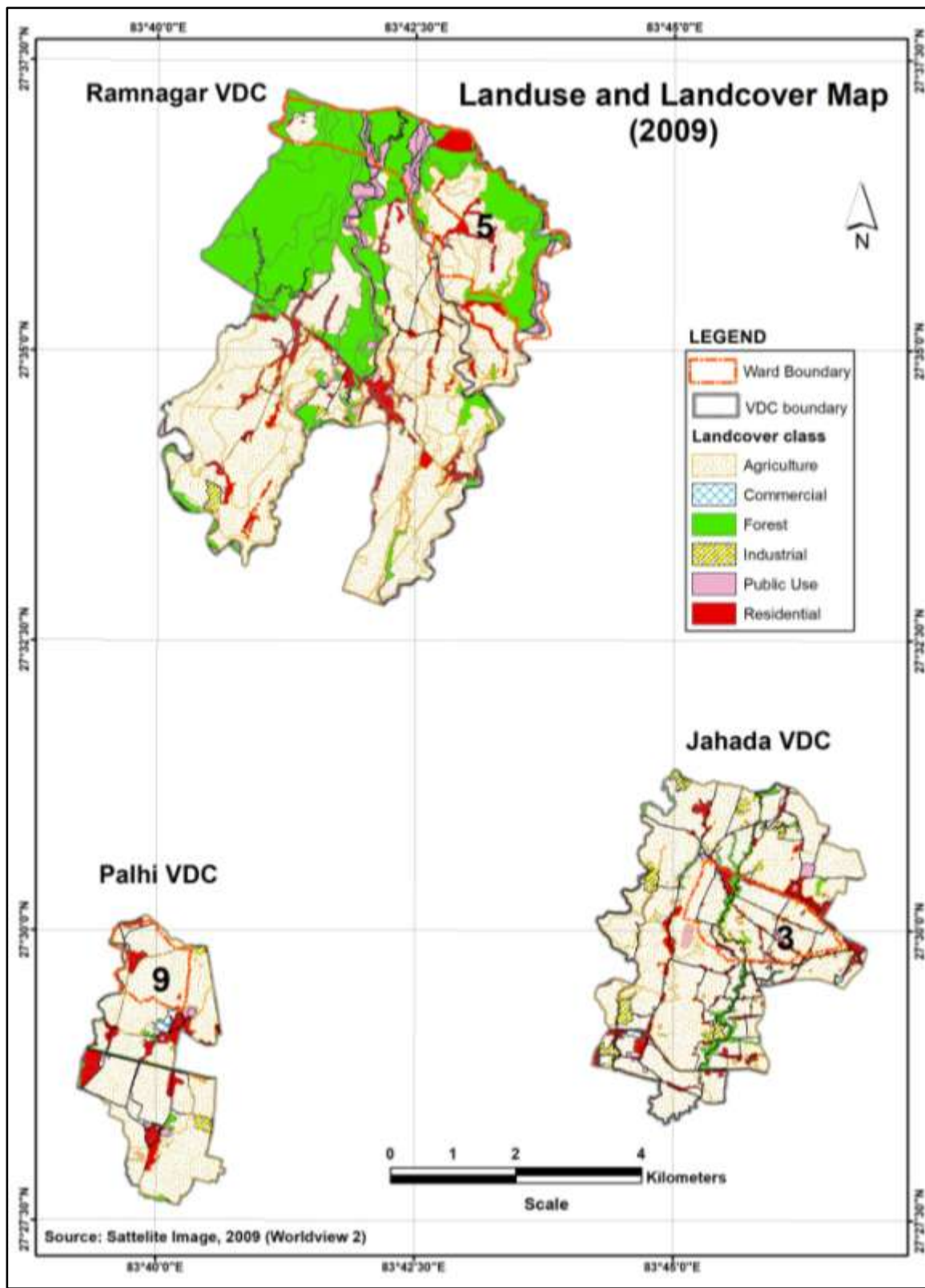


Figure 5.4: Land Use and Land Cover Condition in the Study Sites (2009)

This study found land use land cover to be dynamic by space and time. Different four quantitative indexes have been used to analyze the spatio-temporal dynamics of land cover change. These are: Change Intensity Index (T_i), Dynamic Index (K_i), Integrated Index (I_d), and Rate of Change (A_i) as developed and used by Ndabula et al. (2013). These indices critically analyze the extent, rate, as well as the magnitude of change among various land use types, which provides a basis for comparisons with other places and better explain the nature of spatio-temporal dynamics of land use changes as an index of land degradation (see equations in Chapter III).

Change Intensity Index (T_i) indicates extends or magnitude of land use change pattern within specific type during study period. Dynamic Index (D_i) however indicates changing rate among all land categories during the study period. It is used to describe changing trend of land use as well. Similarly, Integrated Index (I_d) reflects overall change of different land categories in the study area during study period. Rate of Change (A_i) indicates the rate of change in specific type of land use category, like cultivated land in particular area within study period.

Table 5.2 shows built-up area has found the highest Change Intensity Index (T_i), Rate of Change (A_i), Dynamic Index (K_i), and Integrated Index (I_d). This indicates, the agricultural land has followed second in terms of Rate of Change (A_i) and Integrated Index (I_d) in Jahada. That is, it indicates that magnitude of changing pattern, trend of change, rate of change and overall change is higher in built-up area and followed by agricultural land (increased by 106.7 percent) within the span of 51 years time period in Jahada.

Table 5.2: Score of Land Cover Change Indexes in Jahada VDC (1958-2009)

Land cover class	Change Intensity Index (T_i)	Dynamic Index (K_i)	Rate of Change (A_i)	Integrated Index (I_d)
Agricultural land	1.53	0.43	17.78	106.67
Forest area	-6.44	-1.81	-47.55	-47.55
Bush/shrub area	-0.32	-0.09	-0.36	-1.09
Built-up area	151.42	42.56	27.98	195.83
Water bodies	40.16	11.29	3.66	18.28
Sandy area	4.61	1.30	0.59	2.36
Others	-4.90	-1.38	-2.09	-4.18

Source: Calculated from Topographic Maps (1958 and 1994) and Images (2009)

Table 5.3 shows water bodies have the highest Change Intensity Index (T_i), and Dynamic Index (K_i) whereas, built-up area has highest Rate of Change (A_i), and Integrated Index (I_d) in Palhi. But agricultural land has the lowest Integrated Index (I_d) which has decreased by 45.9

percent agricultural area in Palhi. It indicates that magnitude of changing pattern and trend of change is higher in area under water bodies, whereas rate of change and overall change is higher in built-up area within the span of 51 years time period in Palhi.

Table 5.3: Score of Land Cover Change Indexes in Palhi VDC (1958-2009)

Land cover class	Change Intensity Index (T_i)	Dynamic Index (K_i)	Rate of Change (A_i)	Integrated Index (I_d_i)
Agricultural land	-1.05	-0.13	-22.95	-45.90
Forest area	31.54	3.97	3.68	14.72
Bush/shrub area	-4.32	-0.54	-3.17	-9.50
Built-up area	30.18	3.80	37.77	226.60
Water bodies	32.00	4.03	8.56	42.79
Others	-14.92	-1.88	-23.88	-23.88

Source: Calculated from Topographic Maps (1958 and 1994) and Images (2009)

Table 5.4 shows built-up area which has the highest Change Intensity Index (T_i) and Dynamic Index (K_i) but, bush/shrub land has the highest Rate of Change (A_i) and Integrated Index (I_d_i) in Ramnagar. While, the agricultural land has followed the second highest in terms of Rate of Change (A_i) and Integrated Index (I_d_i) within the span of 51 years time period in Ramnagar. It indicates magnitude of changing pattern and trend of change which is higher in built-up area, whereas rate of change and overall change is higher in area under bush/shrub land and followed by agricultural land (increased by 108.6 percent) in Ramnagar.

Table 5.4: Score of Land Cover Change Indexes in Ramnagar VDC (1958-2009)

Land cover class	Change Intensity Index (T_i)	Dynamic Index (K_i)	Rate of Change (A_i)	Integrated Index (I_d_i)
Agricultural land	0.89	0.52	18.09	108.55
Forest area	-2.26	-1.30	-50.00	-50.00
Bush/shrub area	12.14	7.01	18.35	128.47
Built-up area	21.13	12.21	9.92	49.62
Water bodies	0.75	0.43	1.07	2.14
Sandy area	1.97	1.14	1.25	3.76
Others	4.92	2.84	1.30	5.21

Source: Calculated from Topographic Maps (1958 and 1994) and Images (2009)

5.4 Changes in Average Land Holdings Size

This study found landholding size owned by agricultural holding which has decreased in all study sites (Figure 5.5). Landholding size was 0.297 ha per capita in 2005/06 and subsequently has decreased to 0.150 ha in 2015/16 in Jahada. Similarly, it has decreased from

0.325 ha to 0.189 ha during the same study period in Palhi and it has also decreased from 0.098 ha to 0.066 ha in the same period in Ramnagar (Table 5.5). It is noticed that average landholding size in all three sites is less than district average (0.55 ha) and national average (0.68 ha) (CBS, 2014a) which indicates population growth and pressure of population which is higher in agricultural land in study area than other areas of the country.

Table 5.5: Changes in Average Agricultural Land Holdings (ha/person)

Study sites	2005/06	2015/16	Change
Jahada	0.297	0.150	-0.147
Palhi	0.325	0.189	-0.136
Ramnagar	0.098	0.066	-0.032

Source: Field Survey, 2015/16

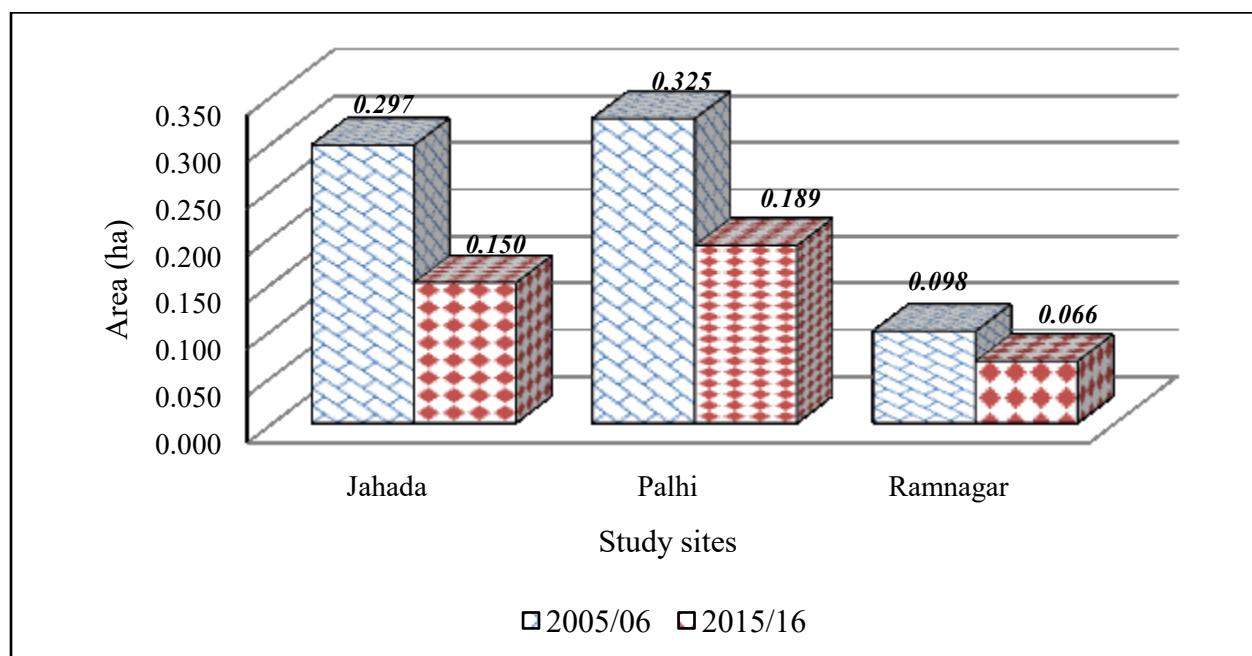


Figure 5.5: Changes in Agricultural Land Holdings (ha/capita)

The changing trend is found varying with size of land holdings and study sites (land holding size classification has been used according to Agricultural Development Strategy, 2015). Area with different land holdings size has decreased in Jahada. However, area with the small size of land holding has increased by 7.7 percent but large size of land holdings has decreased in Palhi due to the fragmentation of land parcels. In addition, area under small size of land holdings has decreased, but area with large size of land holdings has increased by 5.7 percent in Ramnagar (Table 5.6).

Table 5.6: Changes in Area by Land Holding Size and Households

Study sites	Size of holding (ha)	HHs	2005/06 (Area in ha)	2015/16 (Area in ha)	Change in percent
Jahada	Less than 0.5	16	6.24	5.24	-16.0
	0.5 to 1.0	6	9.46	4.23	-55.4
	1.1 to 1.5	3	4.60	4.06	-11.8
	More than 1.5	6	16.19	15.07	-6.9
Palhi	Less than 0.5	6	1.32	1.42	7.7
	0.5 to 1.0	7	5.07	4.39	-13.3
	1.1 to 1.5	9	26.03	10.55	-59.5
	More than 1.5	9	27.04	24.34	-10.0
Ramnagar	Less than 0.5	22	9.35	8.16	-12.7
	0.5 to 1.0	8	5.95	4.93	-17.0
	1.1 to 1.5	1	1.18	1.25	5.7
	More than 1.5	0	0	0	0

Source: Field Survey, 2015/16

5.5 Pathways and Magnitude of Area Change

This study found variation in pathways and magnitude of agricultural land use change in the study area. It is found that area under crop land has changed to other area, particularly in built up area by 18.59 percent in Jahada from 2005/06 to 2015/16. Similarly, area under crop land has changed to pond area using for fisheries by 2.30 percent and changed to plantation area by 0.74 percent during the study period. This has resulted decreasing in crop land and increasing in built up area, pond area and plantation area in Jahada (Table 5.7 and Figure 5.6).

Table 5.7: Pathways and Magnitude of Agricultural Area (ha) Change between 2005/06 and 2015/16 in Jahada.

Types of land	Crop land	Plantation area	Pond area	Built-up area
Crop land	36.487	0.270	0.840	6.782
Plantation area	0.963	0.000	0.000	0.000
Pond area	0.000	0.000	0.000	0.000
Built-up area	2.090	0.000	0.000	0.000

Source: Field Survey, 2015/16

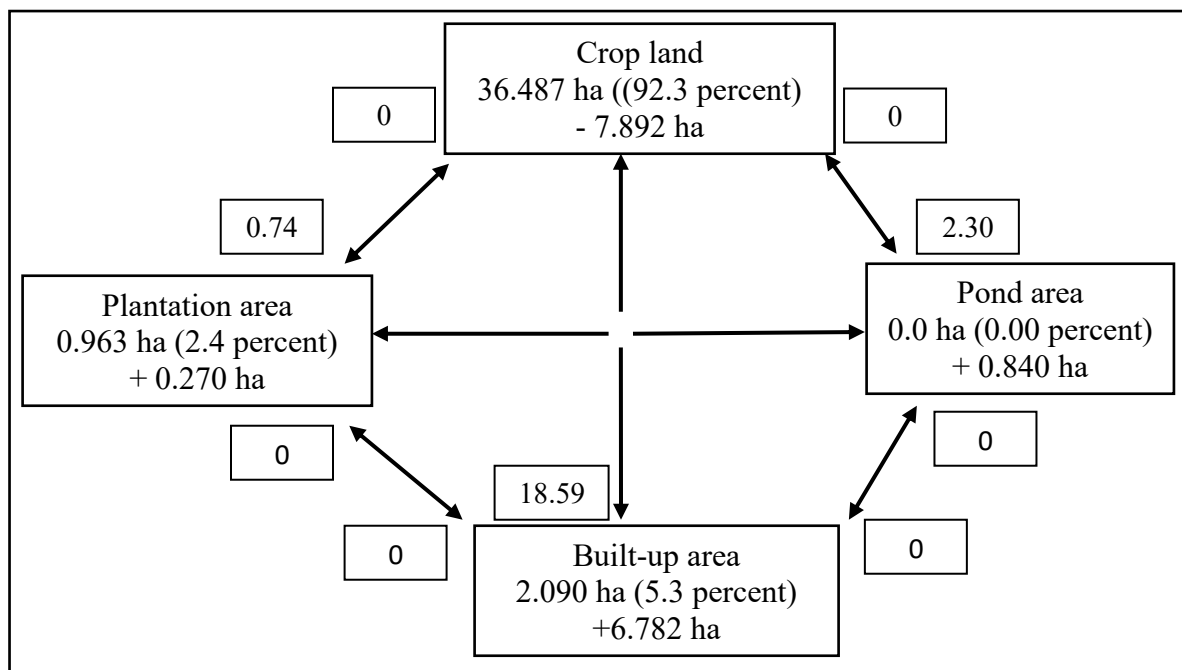


Figure 5.6: Pathways and Magnitude of Area Change between 2005/06 and 2015/16 (in percent) in Jahada

Similarly, area under crop land has changed to other area, particularly in built up area by 31.5 percent in Palhi from 2005/06 to 2015/16. Similarly, area under crop land has changed to pond area using for fisheries by 0.1 percent and plantation area has changed to built up area by 0.9 percent during the study period. This has resulted decreasing in crop land and plantation area but increasing in built up area and pond area in Palhi (Table 5.8 and Figure 5.7).

Table 5.8: Pathways and Magnitude of Agricultural Area (ha) Change between 2005/06 and 2015/16 in Palhi.

Types of land	Crop land	Plantation area	Pond area	Built-up area
Crop land	59.454	0.000	0.059	18.700
Plantation area	1.058	0.000	0.000	0.010
Pond area	0.008	0.000	0.000	0.000
Built-up area	1.518	0.000	0.000	0.000

Source: Field Survey, 2015/16

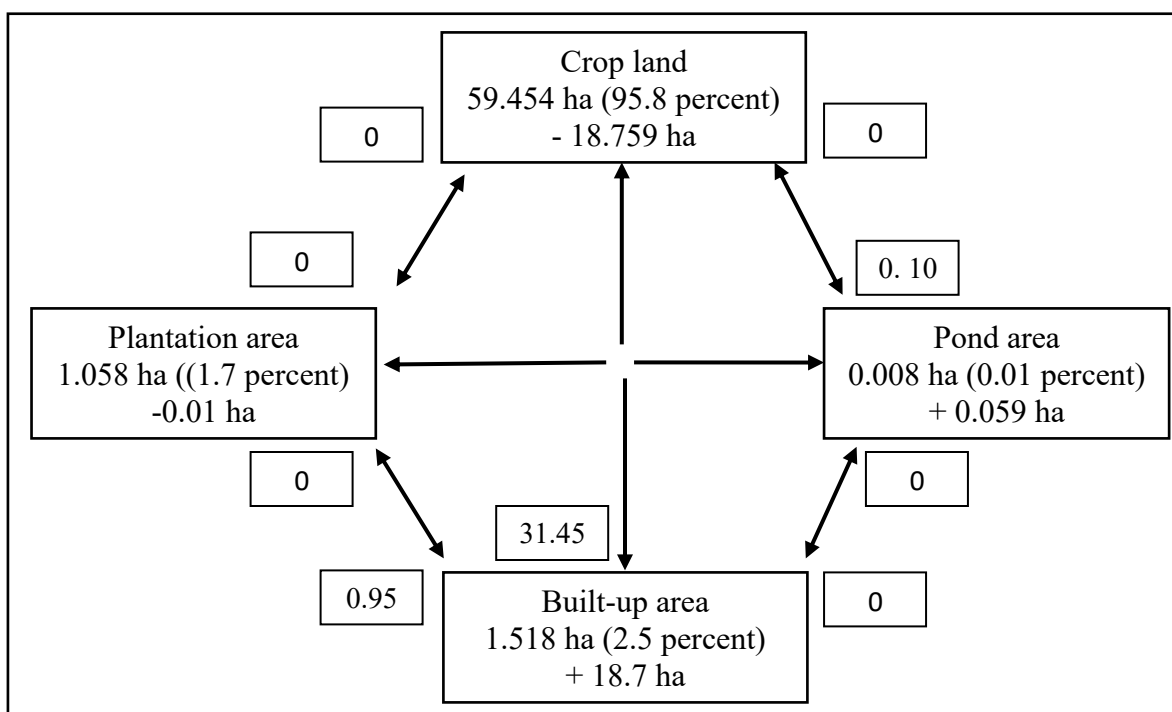


Figure 5.7: Pathways and Magnitude of Area Change (in percent) in Palhi between 2005/06 and 2015/16.

Furthermore, area under crop land has changed to other area, particularly in built up area by 10.9 percent in Ramnagar from 2005/06 to 2015/16. Similarly, area under crop land has changed to pond area by 1.6 percent and changed to plantation area by 0.4 percent during the study period. This has resulted decreasing in crop land area and increasing in built up area, pond area and plantation area in Ramnagar (Table 5.9 and Figure 5.8).

Table 5.9: Pathways and Magnitude of Agricultural Area (ha) Change between 2005/06 and 2015/16 in Ramnagar.

Types of land	Crop land	Plantation area	Pond area	Built-up area
Crop land	16.478	0.068	0.270	1.792
Plantation area	0.000	0.000	0.000	0.000
Pond area	0.000	0.000	0.000	0.000
Built-up area	1.606	0.000	0.000	0.000

Source: Field Survey, 2015/16

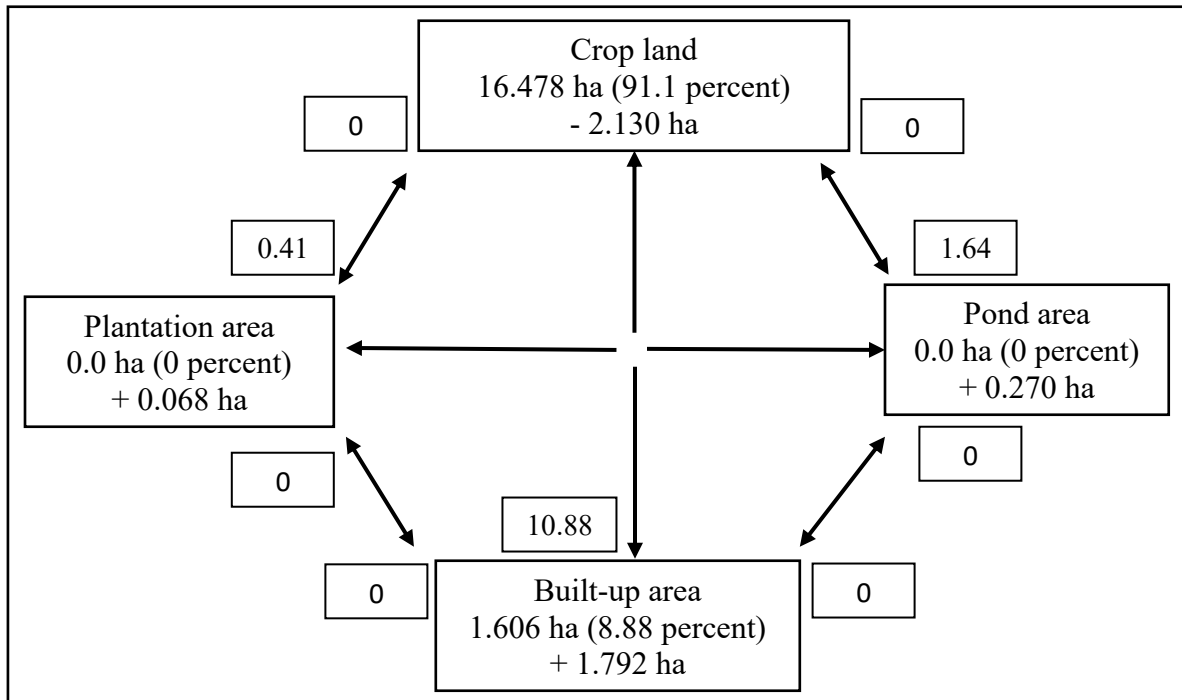


Figure 5.8: Pathways and Magnitude of Area Change (in percent) in Ramnagar between 2005/06 and 2015/16.

5.6 Changes in Cropping Area

Major crops grown in the study area are paddy, maize, wheat, potato, pulses, oilseeds and vegetables. Table 5.10 shows the changes in area occupied by different crops in the study area. Paddy accounts highest (65.3) percent of total cropping area in Jahada in 2015/16, which was 89.4 percent of total cropping area in 2005/06. It represents that area occupied by paddy, oilseeds and pulse which has been decreasing, whereas area occupied by wheat, potato, maize and vegetables grown area has been increasing in Jahada (Figure 5.9). Paddy was cultivated in all cropping area in Palhi in 2015/16 which was 99.7 percent of total area in 2005/06. It represents that area occupied by paddy, wheat, oilseeds and vegetable has been increasing, whereas area occupied by pulses, potato and maize area has been decreasing in Palhi (Table 5.10 and Figure 5.9). Paddy accounts in 90.1 percent of the total cropping area in Ramnagar in 2015/16 which was 84.6 percent of total area in 2005/06. Further, it represents that percentage of area occupied by maize, wheat, potato, vegetables and oilseeds has been increasing and cropping area occupied by paddy and pulses has decreasing during the 10 years of study period in Ramnagar (Table 5.10 and Figure 5.9).

Table 5.10: Changes in Area (ha) by Crops

Crops	Jahada			Palhi			Ramnagar		
	2005/06	2015/16	Change in Percent	2005/06	2015/16	Change in Percent	2005/06	2015/16	Change in Percent
Paddy	32.60	18.66	-24.1	59.29	40.70	0.3	13.94	12.93	-18.7
Maize	0.24	0.65	1.6	0.14	0.08	-0.02	3.31	6.10	13.9
Wheat	4.19	6.46	11.1	23.15	21.50	13.9	2.21	2.91	2.2
Potato	1.42	1.85	2.6	3.11	1.99	-0.4	0.57	0.72	0.4
Vegetables	0.24	0.23	0.2	0.96	0.94	0.7	2.48	3.52	4.1
Oilseeds	13.03	7.55	-9.3	8.86	6.54	1.2	2.70	4.63	9.3
Pulses	6.57	4.78	-1.3	10.00	6.49	-0.9	1.45	1.42	-1.5

Source: Field Survey, 2015/16

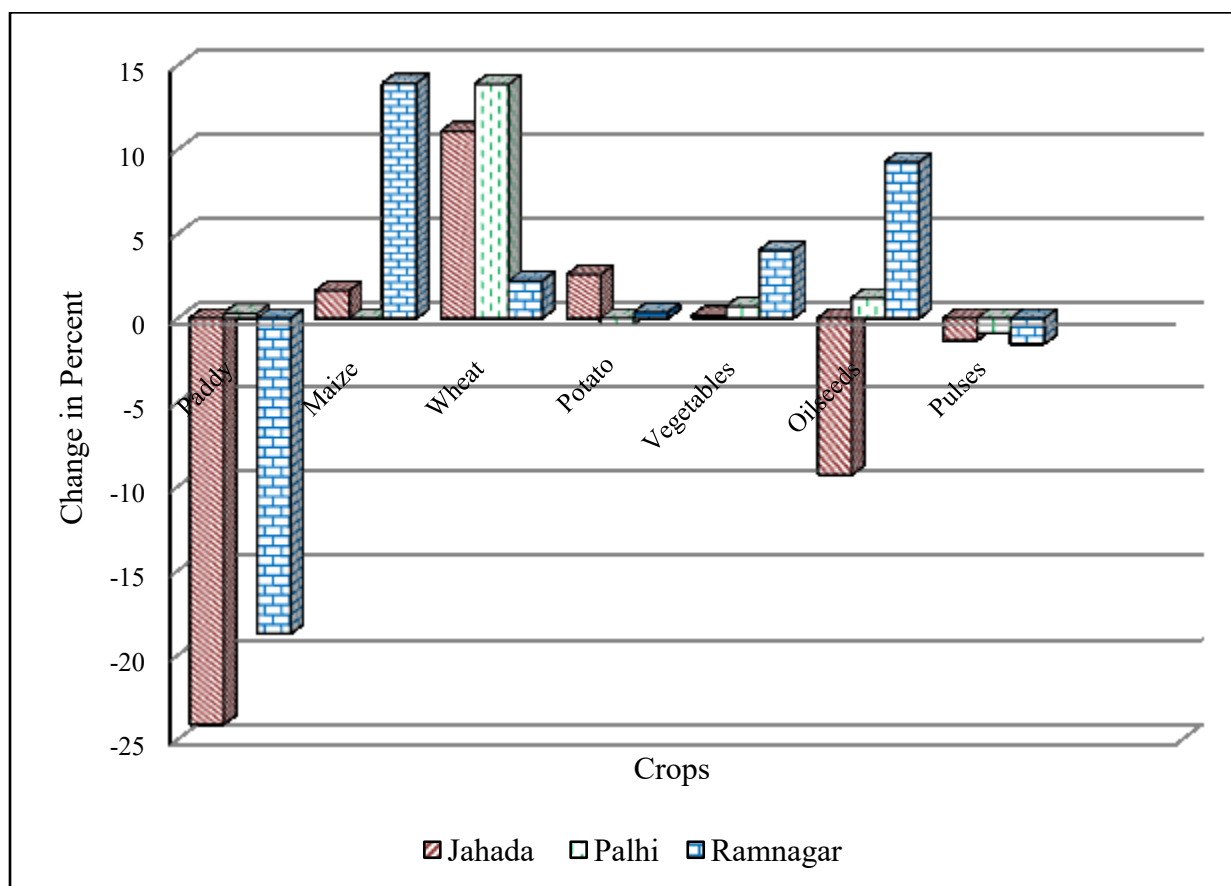


Figure 5.9: Changes in Cropping Area in the Study Sites

Table 5.11 shows the variation in relationship between area and production in all study sites by crops during the study period. There is very strong positive relationship (at 0.01 confidence level) between area and production of paddy in Jahada and Ramnagar area whereas only strong positive relationship between area and production of paddy in Palhi area. Similarly there is no relationship on area and production of potato and vegetables in Jahada area due to irregularity of weather, insufficient water supply in the farm and effect of diseases last year.

Table 5.11: Correlation between Area and Production (2005/06 to 2015/16)

Crops	Jahada (n = 31)		Palhi (n = 31)		Ramnagar (n = 31)		
	2005/06	2015/16	2005/06	2015/16	2005/06	2015/16	
Paddy	0.926**	0.966**	0.557**	0.663**	0.911**	0.755**	
Maize	0.970**	0.920**	0.945**	0.891**	0.936**	0.678**	
Wheat	0.860**	0.989**	0.886**	0.881**	0.980**	0.948**	
Potato	0.657**	0.228	0.908**	0.858**	0.767**	0.637**	
Vegetables	0.200	0.181	0.687**	0.656**	NA	NA	
Oilseeds	0.808**	0.679**	0.836**	0.682**	0.813**	0.725**	
Pulses	0.807**	0.580**	0.535**	0.773**	0.939**	0.790**	
	**. Correlation is significant at the 0.01 level (2-tailed).						

Source: Calculated from Field Data

NA = Not Applicable

5.7 Changes in Cropping Pattern

The measurement of cropping pattern is fundamental to an understanding of spatial management of agriculture. This study found that crop land is under different cropping pattern such as Paddy, Paddy + Wheat/Oilseed/Pulse and Paddy + Wheat / Vegetables / Pulse / Oilseeds + Maize. Paddy is the dominant crop in all the study sites like in other Tarai areas of Nepal. Table 5.12 shows the trend of change in the study area and its percentage under different crop combination. Area under single crop has decreased in all three study sites, whereas area under two or three has increased in Jahada and Palhi. But area under two crops has decreased in Ramnagar from 65.1 percent to 45.2 percent during the study period. Contrarily enough, area under three crops has significantly increased from 13.6 to 48.4 percent during the same period in Ramnagar. It shows that cropping intensity is highly increasing in Ramanagar than Jahada and Palhi. Most of the agricultural land in the study sites has been found as intense based on the cropping pattern.

Table 5.12: Changes in Cropping Pattern (Area in ha)

Number of crops	Crops	Jahada		Palhi		Ramnagar	
		2005/06	2015/16	2005/06	2015/16	2005/06	2015/16
Single crop	Paddy	13.354	5.533	10.404	1.314	3.510	0.920
Two crops	Paddy+ Wheat / Oilseeds /Pulses	18.827	18.449	46.850	32.686	10.727	6.480
Three crops	Paddy + Wheat/Vegetables/Pulse /Oilseeds + Maize	4.305	4.612	2.200	6.694	2.241	6.949
Total area		36.487	28.595	59.454	40.695	16.478	14.348

Source: Field Survey, 2015/16

Table 5.13 shows changes in number and area of parcels by different crops in study sites. This study found that maximum numbers and area of parcels have changed from Paddy + Wheat to Paddy + Wheat /Oilseeds/Pulses crops in all study sites (Figure 5.10, 5.11 and 5.12). However, highest area under the Paddy + Wheat to Paddy + Wheat/Vegetables/Pulse/Oilseeds + Maize (three crops) has found in Ramnagar than other two sites. This indicates monoculture of paddy is still in practice in some areas of all study sites. However, the area occupied by monoculture is small than other cropping area during the study period. Farmers have practiced to grow more than one crop and also covered most of the area of parcel.

Table 5.13: Changes in Number and Area (ha) of Crops by Parcels

Study sites	Identified Parcels		Paddy to Paddy (No change)		Paddy+Wheat to Paddy+Wheat / Oilseeds/Pulses		Paddy+Wheat to Paddy + Wheat/Vegetables/ Pulse/Oilseeds + Maize	
	No	Area	No	Area	No	Area	No	Area
Jahada	37	21.39	15	4.1	16	13.8	6	3.4
Palhi	42	17.47	11	0.6	26	14.1	5	2.9
Ramnagar	51	10.29	9	0.7	24	4.6	18	5.0

Source: Cadastral Maps and Field Survey, 2015/16

5.8 Changes in Cropping Intensity

The intensity of crop refers to the use of a field several times during a cropping year. It is one of the types to measure of land efficiency, which is defined as the extent to which the net area is cropped or sown. The change in cropping intensity has also considerably modified the land use pattern in the study area. However, the direction of the agricultural land use changes

arising from the change in cropping intensity which varies by location (see in Chapter III equation number 6).

The higher cropping intensity means that a higher portion of the net area is being cropped more than once during one agricultural year. This also implies higher productivity per unit of arable land during one agricultural year. There has been a change in the cropping intensity. The result shows cropping intensity has increased in the study area with the increasing of irrigation facilities. The value of cropping intensity is ranging from 141 to 226 in the study area. It is found that cropping intensity has increased from 178 to 193 in Palhi and from 162 to 226 in Ramnagar due to the availability of increasing irrigation facilities but it has decreased in Jahada from 160 to 141 during the study period due to not availability of sufficient irrigation facilities (Figure 5.13). The cropping intensity is found less than national average (185) and district average (197) in Jahada but it is more than national and district average in Ramnagar. Similarly, it is more than national average and nearly equal to district average value in Palhi (CBS, 2013b).

5.9 Changes in Cropping Calendar

Figure 5.14 shows crop calendar of the study area which has found change by crops. This indicates all the stages (such as, land preparation, sowing, transplantation, weeding and harvesting period) of paddy shifted earlier than before. Similarly, preparation, sowing and harvesting period of wheat and oilseeds also have shifted earlier as informed by respondents. Whereas, regarding the land preparation, sowing and harvesting period of maize and potato cultivation has been shifted some later than before. However, the land preparation and sowing period of pulses has found some earlier trends but for harvesting period, it is required some later time than previously expected. Respondents informed that there is uncertainty of weather during crop planting and harvesting time which caused changes in annual crop calendar. This way, it results to manage alternate activities for farmers during the shifting period than in regular or normal crop calendar.

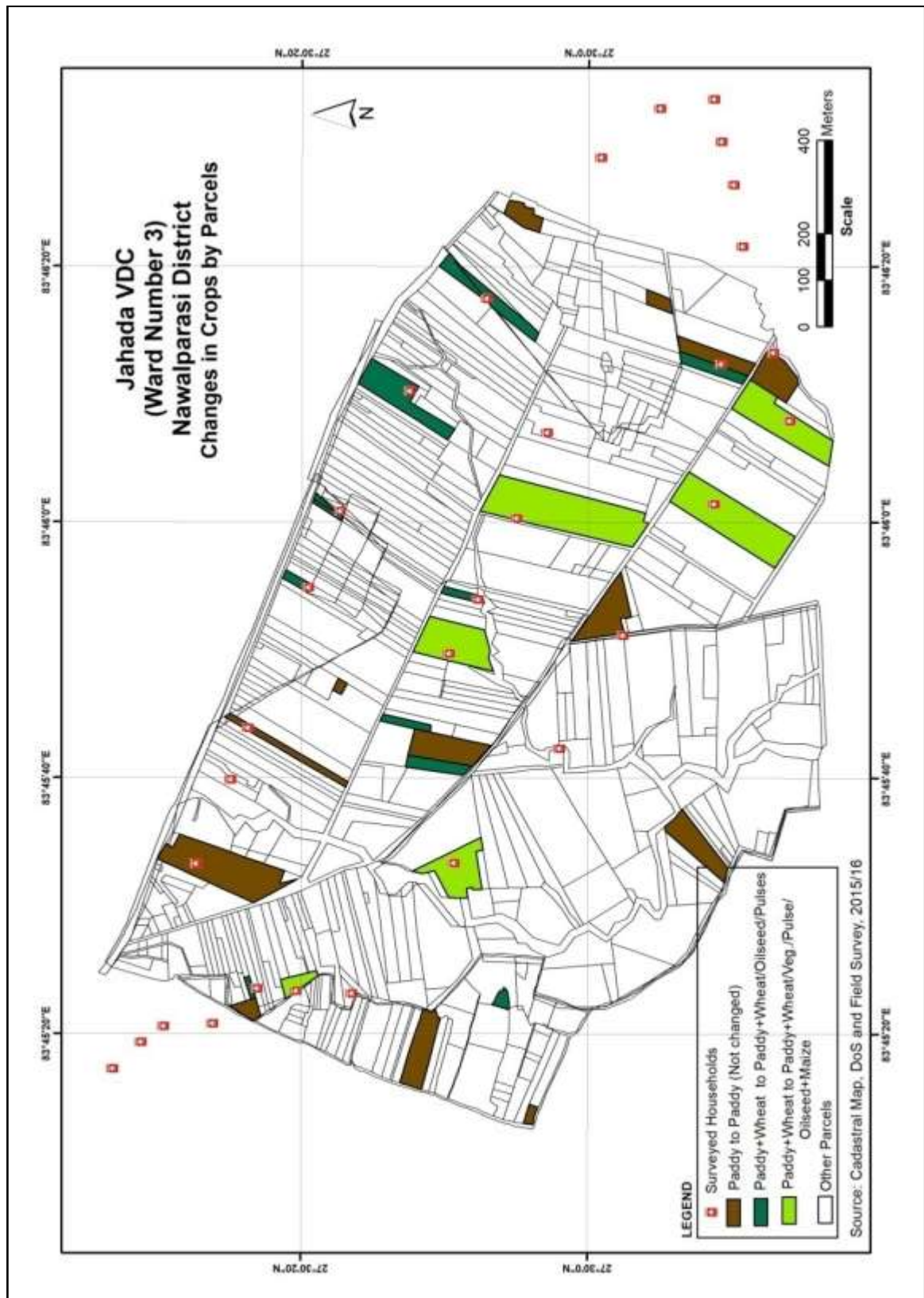


Figure 5.10: Changes in Number and Area (ha) of Crops by Parcels in Jahada

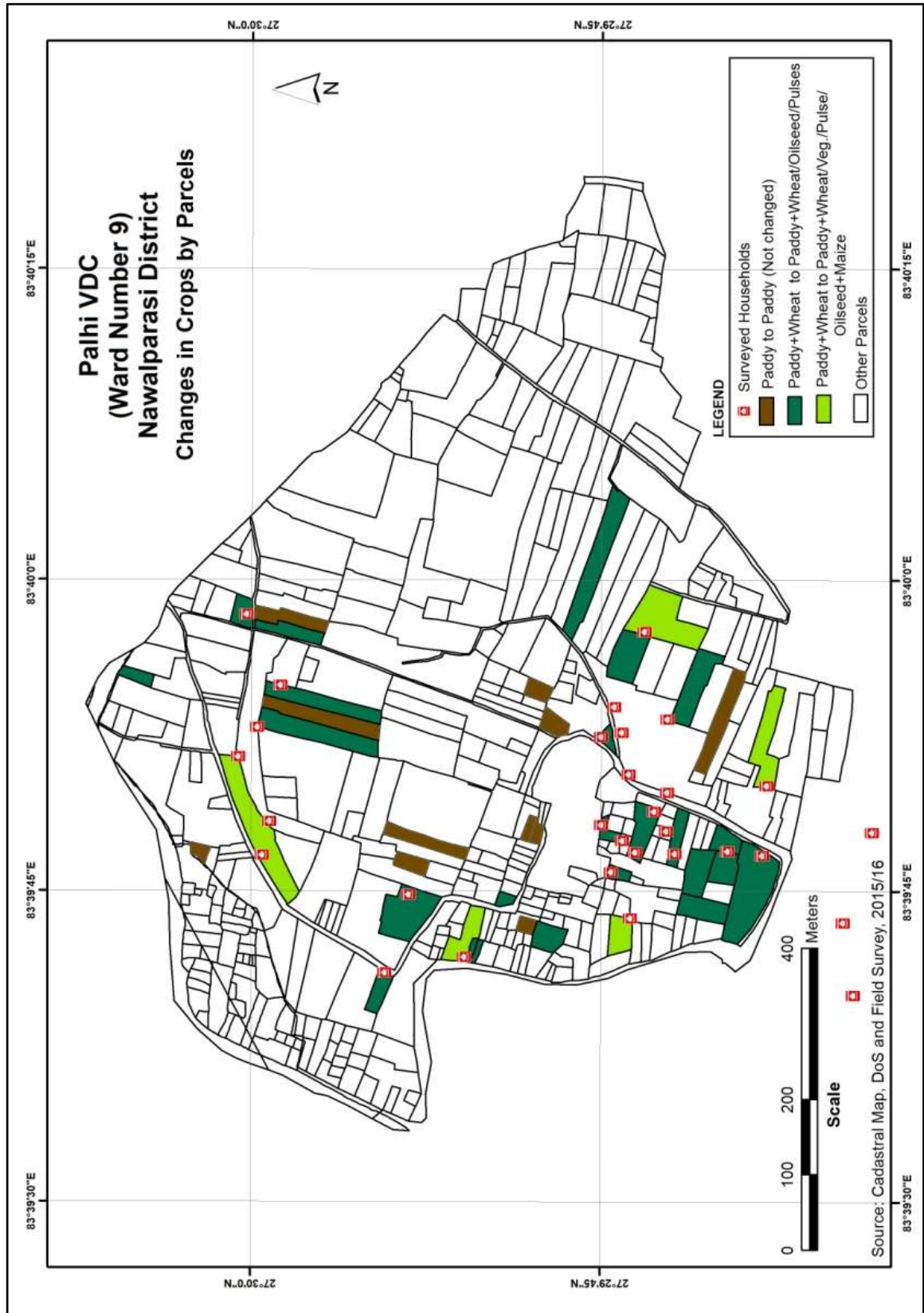


Figure 5.11: Changes in Number and Area (ha) of Crops by Parcels in Palhi

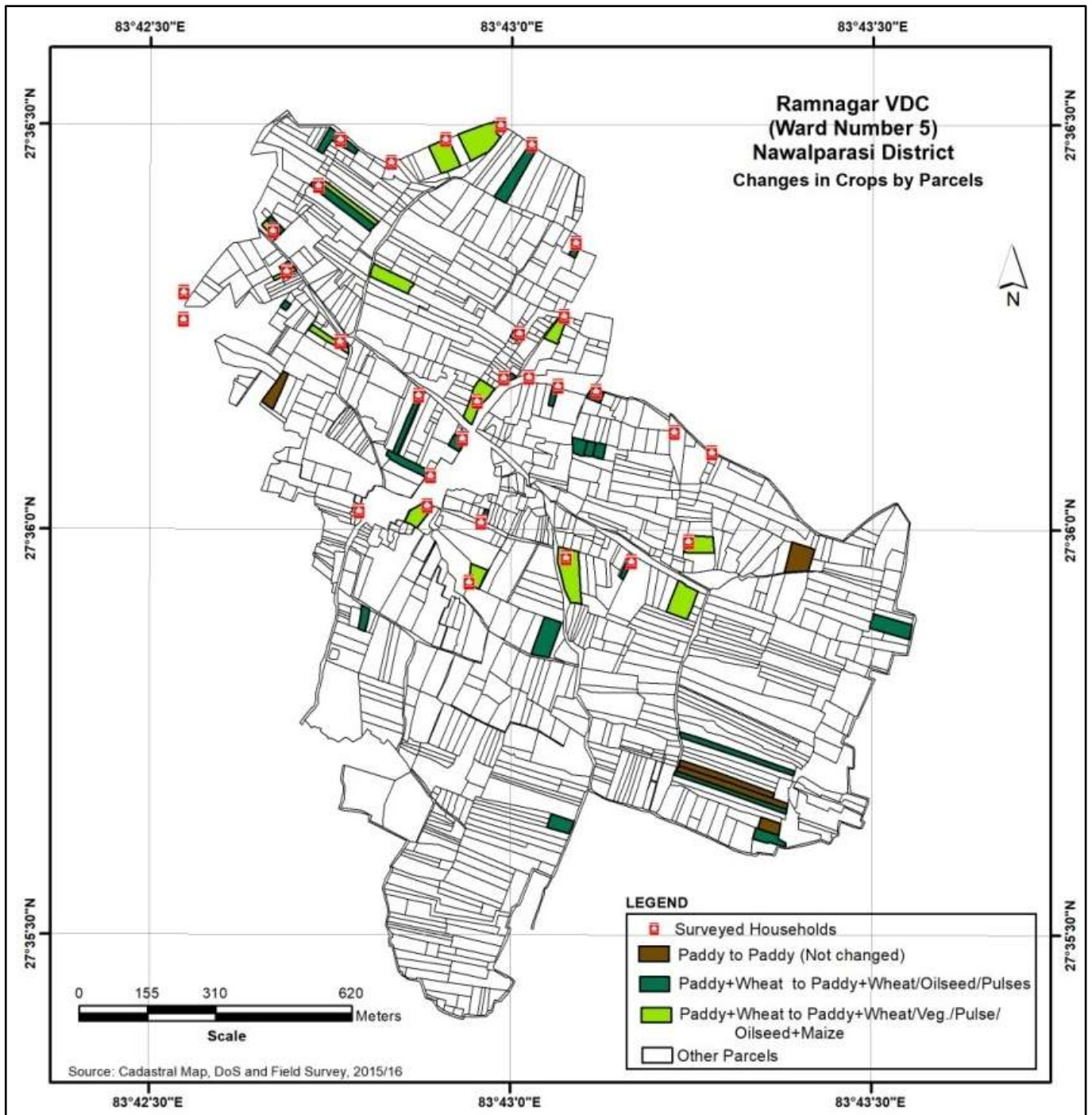


Figure 5.12: Changes in Number and Area (ha) of Crops by Parcels in Ramnagar

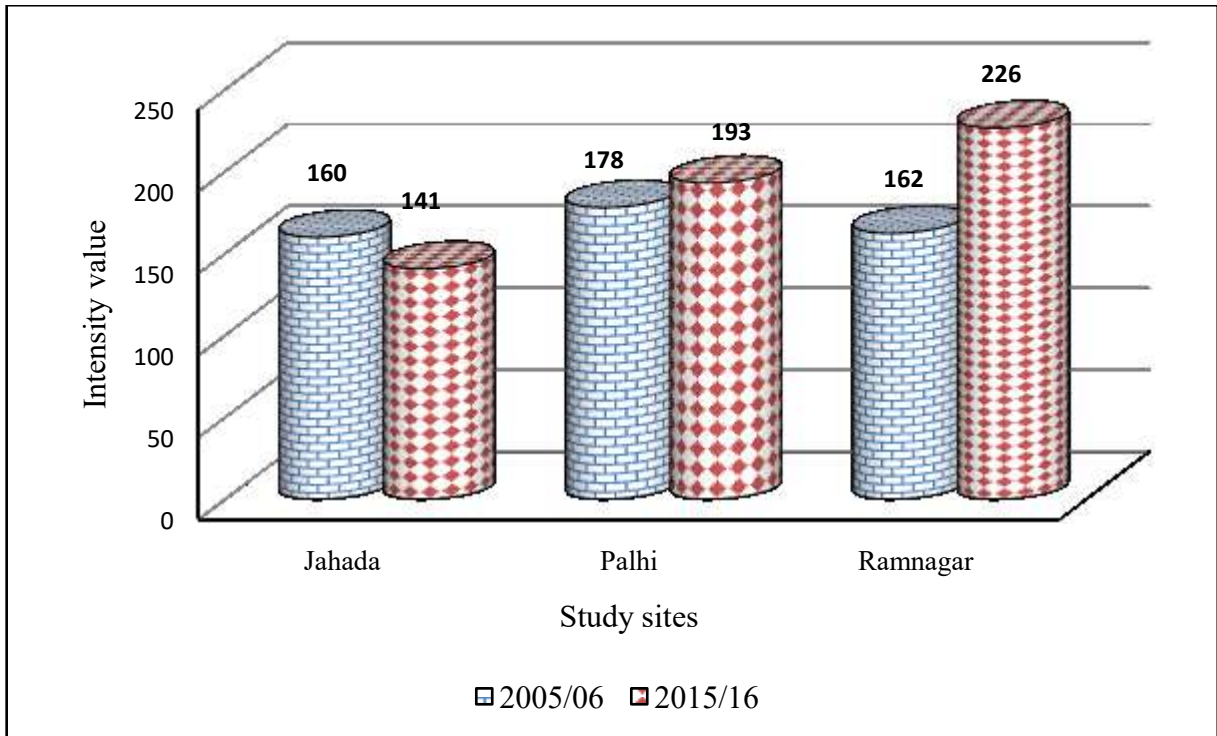


Figure 5.13: Changing Trends of Cropping Intensity

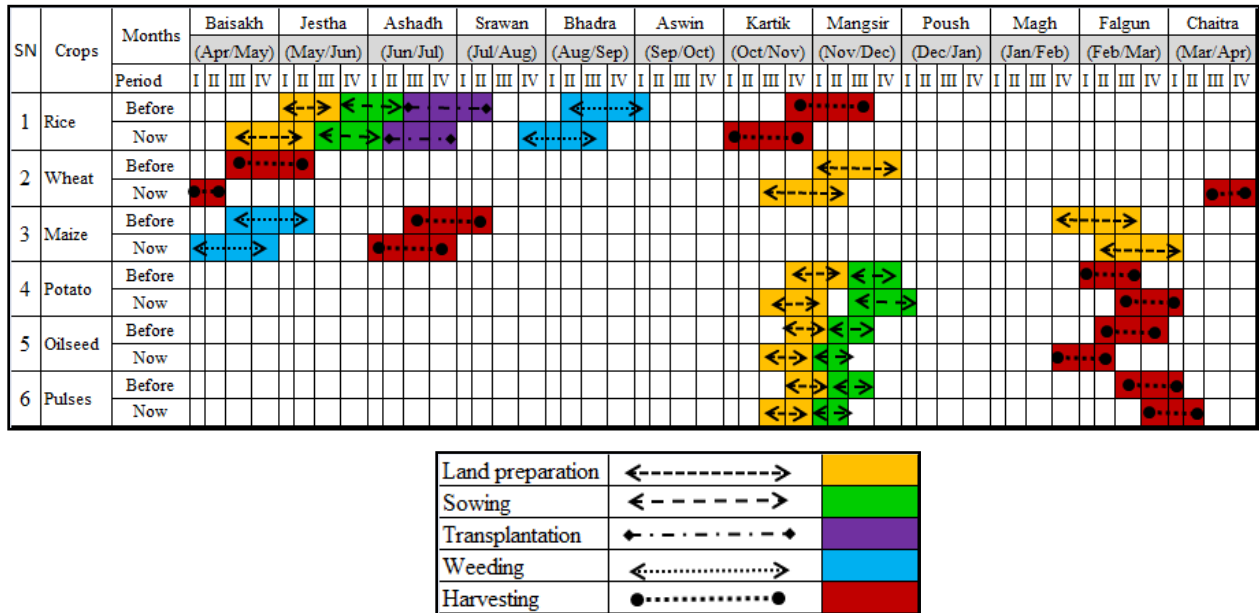


Figure 5.14: Crop Calendar in the Study Area

This study has found the change in cropping area, cropping pattern, cropping intensity in the study area. Similar type of change is also found by Rahman and Saha (2009) in Bangladesh; Kodiwo and Okere (2012) in Kenya; Li, Yu, and Gong (2013) in China; Salvati (2013) in Italy and Fu, Zhang, and He (2014) in China. Furthermore, changes in agricultural land have noticed various researchers in different parts of Nepal. Khanal (2002) has found increased in the area under paddy, wheat, potato, pulses and decrease in the area under maize and millet in Mid-Hills of Nepal. Balla, Awasthi, Shrestha, and Sherchan (2003) have found significant increase in area under agriculture in Chitwan district and Tanahu district. Khanal and Watanabe (2006) have found the changes in agricultural land abandonment in the Mid-Hills of Nepal. Bhujju, Yonzon, and Baidya (2007) have found that agricultural land increased in Eastern Churiya hills of Nepal. Chapagain (2008) has noticed change in agricultural land and found more than 70 percent cultivated land abandonment in the Upper Manang Valley of Nepal. Besides, Baidya, Bhujju, and Kandel (2009) have found increased trend in agricultural land in the buffer zone of Chitwan National Park. Dhakal (2010) has found increased agricultural land in Khageri watershed, Chitwan. Paudel, Tamang, and Shrestha (2014) have found continuous land abandonment across the Mid-Hills of Nepal. Similarly, Pandey (2015) has found the crop diversity in Jutpani Village Development Committee in Central Nepal. However, this study has found the decreasing in agricultural land in the study area due to unavailability of other areas for extensification of cultivated land like in other parts of lowlands.

Similarly, population has increased in the study area during the study period which is found similar with the argument of Boserup that agricultural land use change is caused by the pressure of population. During the study period, cropping areas have changed to built-up area and mono cropping areas changed into multi cropping pattern. Similar nature of changes has been noticed by Paudel et al. (2016) in the Koshi River Basin of Nepal.

The rapidly increasing population has increased pressure in farmland, and has declined farm sizes, and increased land fragmentation over time in the study area which is almost consistent with Boserup's arguments. Similarly, the agricultural land has decreased significantly in all study sites and noticeably converted to built-up areas during the study period. This study has found the variation in change of cropping area by crops and study sites. Area under paddy cultivation has decreased in Jahada and Ramnagar but has slightly increased in Palhi. Furthermore, area under maize and potato has increased in Jahada and Ramnagar but it has decreased in Palhi. This study

also found the change in cropping pattern in all study sites. Similar types of changes are also noticed by Paudel et al. (2014) in Chitwan, Nepal. They have found intensified cropping systems and changed from rice-wheat-maize system to rice-vegetable-maize system. The area under single crop has decreased in all three study sites, whereas area under two or three crops has increased in Jahada and Palhi but area under two crops has decreased and area under three crops has significantly increased in Ramnagar because land intensification with road and market accessibility. Cropping intensity has increased in Ramnagar and Palhi due to the access of irrigation facilities and market, whereas it has decreased in Jahada due to the insufficient access of irrigation facilities and market. This study has also found increasing pressure of population in agricultural land is higher in Ramnagar and Palhi than in Jahada.

5.10 Summary

Land use is dynamic by space and time. It is associated with different factors related to land use, its application, and peoples' willingness to utilize it. Agricultural land has increased during 1958 to 1994, whereas it has decreased from 1994 to 2009 and converted to built-up areas in all study sites. Magnitude and trend of agricultural land use change to built-up area is higher in all study sites. Furthermore, it has found that landholding size has decreased in study sites. Area with different land holdings size has decreased in Jahada. Whereas, area has increased with small size of land holding, but it has decreased with large size of land holdings in Palhi. Furthermore, area with small size of land holdings has decreased and area with large size of land holdings has increased in Ramnagar. It has found variation in pathways and magnitude of agricultural land use change in the study area. Area under agricultural land has changed to other area particularly to built-up area in all study sites. Paddy, maize, wheat, potato, pulses, oilseeds and vegetables are the major crops grown in the study area. This study has found that the changes in area occupied by different crops and changes in the cropping pattern. Area under paddy has decreased by 24.1 percent in Jahada, 18.7 percent in Ramnagar, but it has increased by 0.3 percent in Palhi. Further, area under wheat cultivation has increased by 11.1 percent in Jahada, 13.9 percent in Palhi and 2.2 percent in Ramnagar. Similarly, cropping intensity has increased in Ramnagar and Palhi with the increasing irrigation facilities but decreasing in Jahada. There is a changing in cropping calendar in study sites. Cultivation period for paddy, wheat and oilseeds has shifted earlier than before whereas maize, potato and pulses cultivation has been shifted later than before.

In the next chapter, it has been discussed about the responsible drivers of such change.

CHAPTER 6

DRIVERS OF AGRICULTURAL LAND USE CHANGE

6.1 Introduction

Farmers modify landscapes' physical characteristics to meet their production requirements. The appearance of agriculture has extremely been influenced by landscape patterns at different times in different parts of the world. In addition to biophysical conditions, agricultural activities are closely related to socio-economic, cultural factors, and available technology. Whenever changes within these parameters occur, they involve potential modification in agricultural activities and consequently change in composition of agricultural landscapes (Burel & Baudry, 2003).

Since agricultural land use change is a complex process incorporating multi-scale and multi-dimensional causes and consequences, it should be however examined from different socio-economic and spatial perspectives. Though land use change also takes place naturally without human activities, but agricultural land use change is predominantly due to the results of human activities (Dorward, 2014).

There are three factors playing significant roles in agricultural land use change in the study area. They are demographic condition, infrastructural and technological development. These factors are the major drivers of agricultural land use change. They are discussed under the following sub-headings:

6.2 Population Change

Change in population leads to the change in agricultural land use in particular and land cover as a whole through four distinct processes. These processes are extensification, intensification, deintensification and abandonment. To begin with, extensification is the process of expansion of agricultural land use by clearing new land, whereas intensification is the application of more input in order to raise output per unit of land. Similarly, deintensification is the reduction in inputs per unit of land, whereas complete withdrawal of inputs from land is the abandonment. Land use change processes operate differently due to the change in population. Natural growth rate and migration are two major components of the change in the size of population of any area. According to Khanal (2002), the growing population leads to extensification if more land is available for use where there is subsistence agricultural economy and the use of technology is limited. If the change in population is due to migration, very

different process of land use change occurs in the place of origin and destination. The process of change also differs with the type of migration whether it is temporary or permanent and individual or family. Deintensification and abandonment are the major processes at the place of origin, whereas extensification and intensification are major process of change in place of destination.

The result shows several reasons being responsible for agricultural land use change including in-migration and population change. All together 98.9 percent of respondents reported in-migration and population change are the main reasons for agricultural land use change in study area. The growth rate of population in the study area has been calculated 1.92 percent (highest in Palhi by 2.16 percent and lowest in Ramnagar by 1.62 percent) (Table 6.1). It is higher than district average (1.34 percent) and national average (1.35 percent) according to census 2011. It is found that number of households has increased by 32.2 percent, total population however has increased from 516 to 624 and population density has also increased by 14.8 percent in study area during the study period.

It is also found that the pressure of population on agricultural land has increased due to the population change. The man-land ratio on agricultural land has changed from 4.6 persons/ha in 2005/06 to 7.5 persons/ha in 2015/16 in the study area. This is increased from 5.6 persons/ha to 10.5 persons/ha between 1961 to 2011 in Nepal and it has increased from 6.3 persons/ha to 10 persons/ha between 1991 to 2011 in Tarai region. Similarly, this ratio has continued to be increasing in trend in Nawalparasi district from 4.1 persons/ha to 11.5 persons/ha (CBS, 2013b).

Table 6.1: Population Change in the Study Area

Study sites	Sample population		Annual growth rate (in percent)
	2005/06	2015/16	
Jahada	157	191	1.98
Palhi	176	218	2.16
Ramnagar	183	215	1.62
Total	516	624	1.92

Source: Field Survey, 2015/16

Table 6.2 shows the increasing trends in households and population due to in-migration in addition to natural growth of population in the study area. Total of 36.6 percent of population is native whereas 63.4 percent of households are migrated from different places and time periods in the study area (Table 6.2). Among them, 42.4 percent of households were migrated for seeking

of easy life in destination than the origin, 20.3 percent households were migrated due to the motivation of relatives and 15.3 percent households were migrated due to the resettlement program and land distribution by the government in Jahada. Similarly, 22 percent of households were migrated for higher education and employment purposes. Moreover, it has been found that 11.8 percent of total population are in-migrated and settled in the study area after 2005 AD. Among them, most of the households are migrated from nearby districts to the study area for better opportunity of livelihood (see Annex VII). People from rural areas of neighboring districts are migrating to these places and buying land because of better public services and the pace at which urbanization has developed.

Table 6.2: In-Migration in the Study Area

Study sites	Total households	In migrated households	Percent	After 2005 AD	Percent	Native households	Percent
Jahada	31	30	96.8	6	19.4	1	3.2
Palhi	31	0	0.0	0	0.0	31	100.0
Ramnagar	31	29	93.5	5	16.1	2	6.5
Total	93	59	63.4	11	11.8	34	36.6

Source: Field Survey, 2015/16

People involved in FGD and KII have claimed that the migrants purchased land near the road side and utilized for residential building construction and even some spaces are occupied public institutions such as, play ground, temples and schools.

6.3 Off-farm Employment

About 47.3 percent of respondents argued that off-farm opportunities such as business, services, foreign employment are the important drivers of agricultural land change. Increasing trend of foreign employment results shortage of agricultural labour (working age group population) during the planting and harvesting time of crops. It caused difficulties to carryout agricultural activities. Thus farmers have given less priority in agriculture and started to change their occupation from agriculture to off farm activities.

The district has around 79,149 hectares of arable land. Of this, only 70,149 hectares of land is being used for agricultural purpose only because of shortage of agricultural labour. This means 11 percent of the arable land in the district is out of agricultural crops. Most of the youths are working in the Gulf countries and other labour destination counties (DADO, 2015). Table 6.3 presents that 16.7 percent of working age group (15-59 years) from the study area has left for the

foreign employment. This trend is found the highest in Ramnagar (21.8%) and the lowest in Palhi (11.6%). Farmers have faced problems of labour shortage during the planting and harvesting time of cultivation. It results in change the crop from high labour consuming crops like paddy/vegetables/potato to low labour consuming crops like maize/wheat/pulses in study sites. In addition, farmers have used hired labour and exchange labour in their farms (Table 7.2).

Table 6.3: Status of Out-Migration (Temporary/Foreign Job)

Study sites	Total population (working age group)	Out migrated population (working age group)	Percent
Jahada	115	19	16.5
Palhi	146	17	11.6
Ramnagar	147	32	21.8
Total	408	68	16.7

Source: Field Survey, 2015/16

Table 6.4 shows the involvement of farmers to off farm activities in the study area during the study period. Respondents have informed that insufficient return from agriculture sector has forced people to move from agriculture to other occupations. This result changes in cultivated land which even sometimes remains fallow for long period. This research study found 18.5 percent of total population have involved in off farm activities together with agriculture. Among them, the highest number of people from Jahada (24.6 %) has involved in off-farm activities. Similarly, 18.1 percent from Palhi and 13.6 percent from Ramnagar have involved in off-farm activities, such as business, services and other activities like, wages/labouring. The participants during FGD and KII have also informed that the trend of out migration of youths for alternate job opportunities has increased in the study area.

Table 6.4: Status of Off-Farm Activities (person)

Occupations	Jahada	Percent of total population	Palhi	Percent of total population	Ramnagar	Percent of total population
Agriculture + Business	8	6.3	4	2.6	3	2.0
Agriculture + Services	12	9.5	5	3.2	7	4.8
Agriculture + Others	11	8.7	17	11.0	10	6.8
Total	31	24.6	28	18.1	20	13.6

Source: Field Survey, 2015/16

6.4 Infrastructural Development

Two types of change have been observed with the development of infrastructure in the study area. Road access in existing agricultural land has increased in all study sites, and thereby people get easy access to market that has further intensification on agricultural land. Agricultural land has decreased due to the construction of road, new residential buildings and public institutions such as, school/colleges, temples, and play ground.

More than two-third of the respondents informed that infrastructure development (road and market centers) was the major factor of agricultural land use change in the study area. Many roads were constructed in each study sites (9.615 km in Jahada, 8.7 km in Palhi and 16.35 km in Ramnagar), new market centers (hat bazaars) also appeared and built-up area was also expanded (increased by 11.9 percent). In addition, health, agricultural service centers, educational institutions such as, schools and collages/ (+2) are also constructed in agricultural land during the study period (Table 6.5). It is also reported that the trend of road network has increased by 39.4 percent in the district during 2001 to 2011(DDC, 2015).

Table 6.5: Status of Infrastructure Development (2005/06 to 2015/16)

Study sites	Increased road network (km)			Number of market centers developed	Number of service centers developed (Health & Agriculture)	Schools/ college	Others*
	2005/06	2015/16	Change				
Jahada	7.250	16.865	9.615	1	1	1	2
Palhi	3.010	11.710	8.700	0	1	1	1
Ramnagar	11.765	28.115	16.350	2	2	2	3

Source: Field Survey, 2015/16

*(temples and community buildings)

Farmers have perceived that infrastructures to have played an influential role in the promotion of agricultural intensification in the study sites. Altogether 27.98 percent of respondents reported that infrastructure development and improvement in accessibility of road and market facilities have encouraged farmers for intensive farming. The total of 22.6 percent of respondents from Jahada, 35.5 percent of respondents from Palhi and 16.1 percent of respondents from Ramnagar reported that development of irrigation facilities are also one of the major drivers to contribute to the agricultural land use change. Development of swallow and deep tube wells in Jahada, maintenance of old canal and water for irrigation in Palhi and construction of irrigation ditch (kulo) have contributed irrigation facilities in Ramnagar. This has greatly encouraged

farmer for multi cropping during an agricultural year. It has also resulted high yield in crops. Whereas 21.4 percent of respondents noticed that lack of irrigation facilities, insufficient water supply on existing canals and untimely weather condition caused decreasing production of crop. Table 6.6 shows that cultivated area with irrigation facilities has increased in all study sites during the study period. Altogether 12 percent of the total crop land has increased irrigation facilities during the study period. It has increased by 13.6 percent in Jahada, 11.4 percent in Palhi and 11 percent in Ramnagar (Figure 6.1).

Table 6.6: Change in Irrigation Facilities (area in hectare)

Study sites	2005/06		2015/16		Change in percent
	Area	Percent	Area	Percent	
Jahada	17.988	49.3	17.986	62.9	13.6
Palhi	40.488	68.1	32.353	79.5	11.4
Ramnagar	12.260	74.4	12.253	85.4	11.0
Total	70.736	63.9	62.592	75.9	12.0

Source: Field Survey, 2015/16

Similarly, participants during FGD reported that the development of road network and market centers were the major factors decreasing cultivated land. Most of the infrastructure developments have taken place in agricultural land. Further, they added that development of irrigation networks along the study area have encouraged farmers to cultivate more than one crop. Similarly, respondents also reported that the other opportunities such as, business, services, wages were created by the development of infrastructure in nearby areas. They further informed that construction of road and opening of market centers have encouraged farmers to produce and supply local product to the market. It further helps in purchasing daily consuming goods as well as agricultural inputs.

6.5 Use of Modern Inputs and Technology

The increasing productivity and cropping intensity are primarily caused by modern inputs. It has been found that more than 67.9 percent farmers have used modern inputs such as, chemical fertilizers, varieties of seeds, pesticides, irrigation facilities, and machineries like tractors and thresher for more production and substitution for labour shortage during planting, weeding and harvesting period of crops.

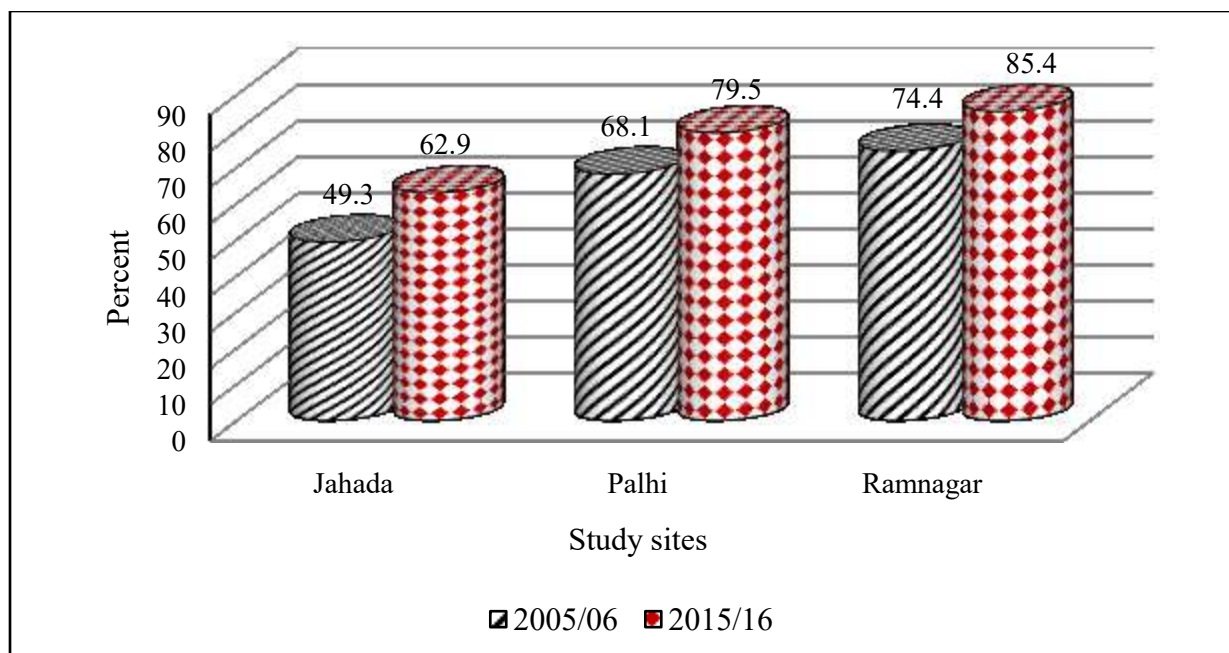


Figure 6.1: Change in Irrigation Facilities

Table 6.7 shows that users of modern input have increased in all study sites. The result shows that highest modern input users have increased in Palhi by 34.3 percent; it has increased by 22.6 percent in Jahada and 15.2 percent in Ramnagar during the study period. It is found that highest users of chemical fertilizers have increased by 40.3 percent in Jahada during the study period. Similarly, the users of improved seeds have increased by 35.3 percent in Palhi. The users of pesticides have also increased in Palhi by 58.3 percent. The irrigated area has increased by 13.6 percent in Jahada, 11.4 percent in Palhi and 11 percent in Ramnagar.

Table 6.7: Status of Input User Households (in percent)

Types of inputs	Jahada			Palhi			Ramnagar		
	2005/06	2015/16	Change in percent	2005/06	2015/16	Change in percent	2005/06	2015/16	Change in percent
Chemical fertilizer	46.8	87.1	40.3	64.4	96.8	32.4	41.4	58.1	16.7
Improved seeds	51.5	71.0	19.5	48.6	83.9	35.3	35.2	57.8	22.6
Pesticides	11.8	29.0	17.2	28.8	87.1	58.3	5.7	16.1	10.4
Irrigation	49.3	62.9	13.6	68.1	79.5	11.4	74.4	85.4	11.0
Average	39.9	62.5	22.6	52.5	86.8	34.3	39.2	54.4	15.2

Source: Field Survey, 2015/16

Farmers have been using different varieties of improved seeds in their field. There has been changing in the varieties of paddy (*Mansuli, Janaki, Sabitri, Gorakhnath to Radha-7, Radha-14, Hardinath-2, Gorkhnath-509*) wheat (*Gautam, Aditya, Bhirkuti, UP 262, Tilottama*) and maize (*Rampur-2, Rampur Composite, Manakamana-4, Khumal Hybrid-2*) in study sites. There has been increasing in productivity of paddy, wheat and vegetables in Jahada but decreasing in productivity of maize, potato and oilseeds in the same area with the use of high yielding variety of seeds. Similarly, the productivity of wheat and vegetables has been increasing and the productivity of paddy, potato and oilseeds has been decreasing in Palhi. Whereas the productivity of potato, vegetables and oilseeds has been increasing and the productivity of paddy, maize and wheat has been decreasing in Ramnagar. FGD and KII, participants have reported that productivity of crops have decreased due to the effect of diseases like *patera (rice bug) and daduwa (sheath blight)* last year, especially in potato in Jahada area and in paddy in Palhi and Ramnagar. They also agreed that insufficient water supply in ditches and canals and untimely rainfall have caused the loss of productivity last year in maize and oilseeds in winter season.

In addition, they have been using modern machineries like, tractors and threshers in major crops such as, paddy, wheat and pulse cultivation to manage land in the absence or lacking of labour during the plantation and harvesting period in the study sites. The using trend of machineries has also increased in all study sites during the study period. Table 6.8 shows that the highest user of tractors has increased by 29 percent in Jahada whereas highest user of threshers has increased by 51.6 percent in Ramnagar.

Table 6.8: Use of Machineries (in percent)

Study sites	Tractors			Threshers		
	2005/06	2015/16	Change	2005/06	2015/16	Change
Jahada	61.3	90.3	29.0	38.7	64.5	25.8
Palhi	71.0	87.1	16.1	48.4	83.9	35.5
Ramnagar	74.2	96.8	22.6	41.9	93.5	51.6
Average	68.8	91.4	22.6	43.0	80.6	37.6

Source: Field Survey, 2015/16

6.6 Land Ownership Status and Availability of Agricultural Land

Land ownership status and availability of agricultural land have played a determinant role on the use of inputs. Land owner farmers have significantly used more items of inputs in

cropland than sharecroppers. Socioeconomic characteristics such as age and literacy status of land owner farmers are also found important drivers in the decision to use inputs such as pump sets, farm implements and fertilizers. This study shows that 45.2 percent of land owners have been using modern technologies like machinery and other inputs, whereas only 16.1 percent of sharecroppers have been using such facilities on their farm land. Similarly, land availability has also found influencing factor in cropping land use change. It is reported that use of inputs is higher (62.3 %) with land owner than sharecroppers (22.8 %). Similarly, it is also found that farmers with more area and more than one parcel (41.7 %) have used more modern technologies like machinery and other inputs (manure, high yielding varieties of seeds, chemical fertilizers and pesticides) than farmers having small area and less number of parcels (Table 6.10). Among them, highest percent of landowners were found in Jahada and lowest in Ramnagar.

Table 6.9: Status of Land Tenure

Study sites	Land owner		Sharecropper		Both	
	HHs	Percent of total sampled HHs	HHs	Percent of total sampled HHs	HHs	Percent of total sampled HHs
Jahada	17	54.8	5	16.1	9	29.0
Palhi	14	45.2	6	19.4	11	35.5
Ramnagar	11	35.5	4	12.9	16	51.6
Total	42	45.2	15	16.1	36	38.7

Source: Field Survey, 2015/16

During the FGD and KII, the participants agreed that land owner have used more amount of modern inputs and take risk where as sharecropper do not always use modern inputs and they always priorities for benefit from their inputs. Further, they shared that farmers with large area with more numbers of parcels has taken initiation to use modern inputs than farmers with small area and less number of parcel. Table 6.10 shows that the numbers of parcels by study sites. The study further found that around 75 percent of farmers have more than three parcels. In addition, participants during KII reported that the majority of land owner with educated family have been using modern inputs in their field than the others.

Population change, off-farm employment, and infrastructural development, use of modern inputs and technology were found major drivers on agricultural land use change in the study

area. These factors are the major drivers of agricultural land use change in different parts of Nepal and elsewhere.

Table 6.10: Number of Land Parcels by Households and Area (ha)

Number of parcels	HHs	Percent	Area (ha)	Jahada		Palhi		Ramnagar	
				HHs	Area	HHs	Area	HHs	Area
2	24	25.8	18.63	10	2.14	6	7.95	8	8.54
3 to 4	50	53.7	40.89	16	17.05	20	20.62	14	3.23
Above 4	19	20.5	24.12	5	9.41	5	12.13	9	2.58
Total	93	100.0	83.64	31	28.60	31	40.70	31	14.35

Source: Field Survey, 2015/16

Bilsborrow and Ogendo (1992) have also found that population change as major factor for the agricultural land use changes in Latin America and Sub-Saharan Africa. Similarly, Liu et al. (2009) and Wu et al. (2009) have concluded population to be responsible factors for change in crop land in China. Further, development of agricultural technology is also one of the drivers of the agricultural land use changes in Iowa, USA (Brown & Schulte, 2011). Zhao et al. (2012) have noticed that the off-farm employment of rural labor force and commercialization of agricultural product were the main driving forces behind the agricultural land use changes in China. In the same way, Kumar and Singh (2012) have pointed that the urbanization, occupational status, educational level of household head, household size, farm size and status of land ownership are considered to be driving factors of agricultural land use change in the eastern and northeastern regions of India. In addition to this, Diack et al. (2017) have found that the population change and urbanization have reduced the farmlands through uncontrolled construction of buildings and companies in Niayes region of West Senegal. Miheretu and Yimer (2017) have found education, family size, tenure security, access to farm credit and extension services as the main determinants of agricultural activities in Ethiopia.

Virgo and Subba (1994) have mentioned that development of trade and off-farm employment opportunities to be the driving factors of change in agricultural land use in Dhankuta. Besides, Khanal (2002) has found the development of new irrigation facilities, distance to farm from the village/farmer, access to market centers, land ownership and use right, land tax, use of labor, trade, transport and use of technology in combination have significant implications for agricultural land use change in Mid-Hills of Nepal. Chapagain (2008) in the same vein, has found the rapid out migration and involvement to non-agricultural activities to have caused

massive land abandonment and negative impact on local farming system in Manang Valley, Nepal. Resettlement programme by government, migration from Mid-Hills of the country to Tarai area, natural growth of population, construction of east-west highway and development of Khageri irrigation canal were main drivers of agricultural land use change in Khageri watershed of Chitwan district (Dhakal, 2010). Paudel et al. (2016) have found population growth and foreign labor migration, construction of roads and settlements as main driving factors to change cropland area in to the Koshi River Basin.

The increasing population pressure on agricultural land has forced the farmer for either intensification in cropping land or diversification of crops for more output from the existing land. Farmers have adopted land intensification and diversification practices in the study sites. So the finding of this study is relevant to the intensification theory of Boserup, where she has stated population growth as the determinant factor for agricultural land use change.

The result shows that the growth of population has resulted fragmentation of land parcels and pressure in farmland. In addition, lowlands are densely populated and have provided the space for larger portion of population which is to have migrated from Mid-Hills and Mountains of the country. Farmers are involving in different activities such as, business, services, and wages apart from agriculture in the study area. Similarly, farmers have expanded their production according to market oriented demand, such as vegetables and dairy products with the development of road and market infrastructures in the study area, which is similar to the resource exploitation model of Hubbert. According to his model, farmers expand production rapidly under the motivation of new markets; they play the different strategies by situation.

6.7 Summary

It has found three major drivers of agricultural land use change. These are demographic condition, infrastructural and technological development. In-migration and population change have found the main reasons for agricultural land use change in study area during the study period. The man-land ratio on agricultural land has increased from 4.6 persons/ha to 7.5 persons/ha during the study period. Development of roads, market centers and service centers have also caused change in agricultural land in the study areas. Two types of changes have been observed with the development of infrastructure in the study area. Due to the access of road network, new market centers have been encouraged and also developed good access to existing market centers. It has encouraged farmers for intensification of agricultural land. Meantime, the

agricultural land has decreased due to the construction of new buildings for residence, school/colleges, play ground and temples. In addition, increasing trend of modern technology use such as, chemical fertilizers, varieties of seeds, pesticides, irrigation facilities and machineries like tractors and thresher also have affected crops productivity in all the study sites.

The possible measures and strategies to manage agricultural land are discussed in proceeding chapter.

CHAPTER 7

MANAGEMENT OF AGRICULTURAL LAND USE

7.1 Introduction

This chapter discusses the land management practices for agricultural land use in the study area. It includes labour, manure, high yielding varieties of seeds, chemical fertilizers, pesticides and irrigation for proper management of agricultural land.

Land resource management helps to promote economic and social development in both urban and rural areas. Land management must be based on knowledge, which depends on information, that is compatible to the methods of data collection and the manner in which their results are communicated. Land-related information is an important and must be managed efficiently in order to maximize its potential benefits (UN, 1996). Agricultural land resource management is the actual practice of using the land by the local human population (FAO/Netherlands, 1991).

The agronomic practices have been observed in the study area. These practices include intensity of labour force, use of manure, improved seeds, chemical fertilizers, pesticides and irrigation, land intensification and crop diversification for agricultural land management practice. These issues are discussed in the following section:

7.2 Use of Agricultural Labour

Data on agricultural labour force is important in order to assess the extension of agricultural activities with the involvement of rural labour force and the extent of non-farm jobs in rural areas. Due to labour moving out and seasonal farming, hiring labor and exchange of labor (*Parma*) become more important in rural areas. Farmers increasingly hired labour for land preparation and harvesting, or rent a tractor to plough and thresher to harvest the crops (Singh, 2003).

Table 7.1 shows the use of labour by land holding size in the study area. There are more numbers of farmers with small size of land holdings in Jahada and Ramnagar than Palhi. The variation has found in labour use by land holding size. Labour input has increased in crops such as, potato, wheat, pulses and oilseeds by different sizes of land holdings in all study sites. Whereas labour input has decreased in all sizes of land holdings in Jahada for potato cultivation. It has caused decreasing trend in production of potato in Jahada. Similarly, it has decreased only in small size of land holdings in Palhi for vegetables cultivation. The labour input is higher in

small size of land holding in major crops such as, paddy and wheat cultivation in all study sites whereas it has been found that higher number of labour input in large size of land holdings in all study site for oilseeds cultivation. Moreover, labour input has found higher in small size of land holdings in Palhi for potato cultivation. Table below presents change of labour inputs (per hectare of farm land) in different crops by land holding size in study sites.

Table 7.1: Involvement of Agricultural Labour by Land Holdings Size

Crops	Land holdings size (ha)	Jahada			Palhi			Ramnagar		
		HHs	person/ha		HHs	person/ha		HHs	person/ha	
			2005/06	2015/16		2005/06	2015/16		2005/06	2015/16
Paddy	Less than 0.5	16	78	87	6	112	133	22	83	92
	0.5 to 1.0	6	52	78	7	49	57	7	99	105
	1.1 to 1.5	3	43	55	9	60	62	1	56	70
	More than 1.5	5	79	83	9	51	63	0	0	0
Maize	Less than 0.5	2	32	30	0	0	0	18	37	49
	0.5 to 1.0	2	27	39	0	0	0	7	51	60
	1.1 to 1.5	1	16	22	0	0	0	1	30	44
	More than 1.5	2	37	42	2	67	79	0	0	0
Wheat	Less than 0.5	3	68	73	6	46	48	13	38	43
	0.5 to 1.0	3	46	49	7	23	35	5	23	49
	1.1 to 1.5	2	27	30	9	25	12	1	31	30
	More than 1.5	4	62	52	9	19	26	0	0	0
Potato	Less than 0.5	12	96	85	4	129	131	17	73	85
	0.5 to 1.0	6	81	74	4	69	82	7	66	71
	1.1 to 1.5	3	79	66	8	51	65	1	101	118
	More than 1.5	4	101	89	9	48	65	0	0	0
Vegetables	Less than 0.5	3	109	118	2	37	20	0	0	0
	0.5 to 1.0	3	48	59	4	45	52	1	57	71
	1.1 to 1.5	0	0	0	5	57	70	0	0	0
	More than 1.5	1	31	30	6	68	75	0	0	0
Oilseeds	Less than 0.5	13	31	33	5	38	51	21	38	43
	0.5 to 1.0	6	46	35	7	47	58	6	41	45
	1.1 to 1.5	3	38	37	9	39	45	1	35	47
	More than 1.5	5	33	42	9	57	58	0	0	0
Pulses	Less than 0.5	12	29	37	6	57	73	5	37	43
	0.5 to 1.0	4	25	26	7	40	35	2	45	38
	1.1 to 1.5	1	18	33	9	39	47	1	19	24
	More than 1.5	3	25	34	9	26	37	0	0	0

Source: Field Survey, 2015/16

During the FGD, participants reported that labor input has been increasing as compared before. KIs also added that farmers usually discussed on how to cultivate more intensively so that they can have optimum returns from their agricultural land. They have utilized hired and exchanged labours in addition to own family labours during the planting, weeding and harvesting time. It is found that farmers have been using modern machineries like, tractors and threshers in major crops such as, paddy, wheat and pulse cultivation to manage land in the absence or lacking of labour during the plantation and harvesting period in the study sites. During the discussion, KIs also informed about labour scarcity during peak farming season. Most farmers have also responded that they faced acute supply of labourers in the neighbourhood.

Moreover, it has been found that labour input is higher in small size of land holdings (less than 0.5 ha) for major crop cultivation in all study sites because of inappropriate size for machineries' use. Labour input in paddy cultivation is found higher in Palhi and less in Jahada and Ramnagar than district average (105 persons/ha) and national average (121 persons/ha) (MoAD, 2016). At district level, labour input was nearly as similar as it was 10 years before in most of the crops (MoAD, 2016). The participants during FGD and KII reported increasing trend of machinery use in large size of land holdings to be the major factors behind the less number of labour input in the study area. Farmers hired the tractors and threshers from the neighbours.

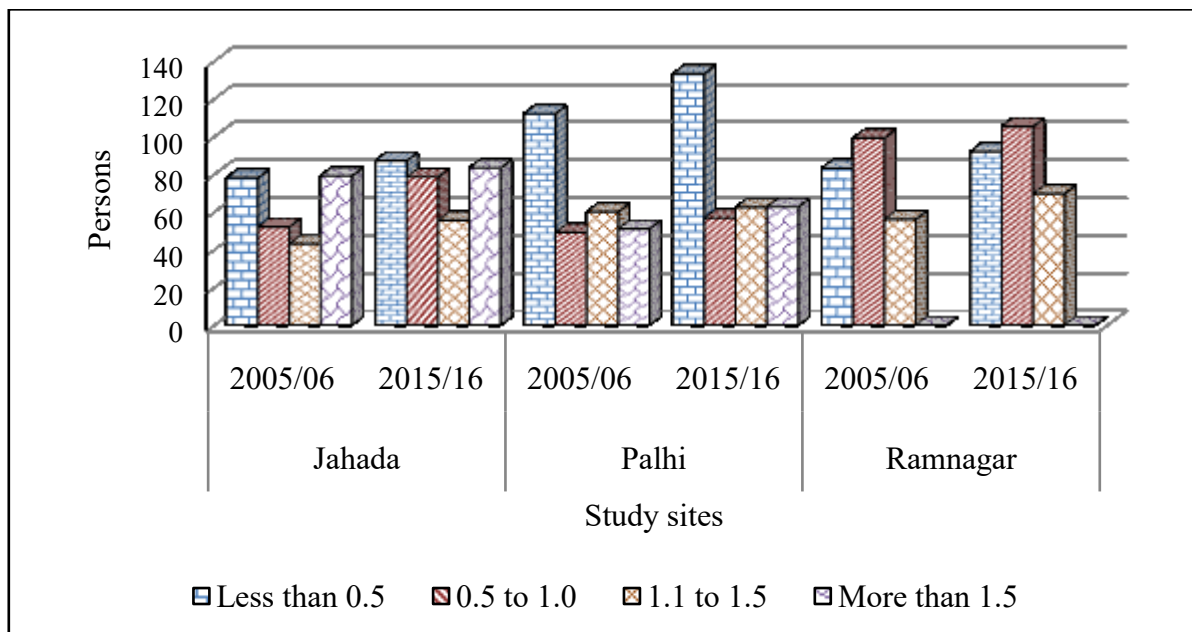


Figure 7.1: Involvement of Agricultural Labour (person/ha) in Paddy by Land Holdings Size

There are different types of labour input practices observed in study sites. Among them, family labour are higher in Palhi than Jahada and Ramnagar because of large family size and availability of working age group of family members. Whereas, hired labour are higher in Jahada and Ramnagar due to scarcity of agricultural labor force. In addition, the practice of exchange labour system also is found in Jahada and Ramnagar from neighbours particularly in paddy, wheat and potato cultivation (Table 7.2).

Table 7.2: Types of Agricultural Labour (person/ha)

Study sites	Crops	HHs	Labour Intensity	Family members	%	Hired labour	%	Exchange labour	%
Jahada	Paddy	30	80	16	20	37	46	27	34
	Maize	7	35	6	17	29	83	0	0
	Wheat	12	51	13	25	23	45	15	30
	Potato	25	81	19	24	54	67	8	10
	Vegetable	7	61	31	51	30	49	0	0
	Oilseeds	27	36	5	14	31	86	0	0
	Pulses	20	32	12	38	20	62	0	0
Palhi	Paddy	31	64	38	59	26	41	0	0
	Maize	2	19	13	68	6	32	0	0
	Wheat	31	24	21	88	3	13	0	0
	Potato	25	70	28	40	42	60	0	0
	Vegetable	17	62	33	53	29	47	0	0
	Oilseeds	30	54	39	72	13	24	2	4
	Pulses	31	40	27	66	13	32	0	0
Ramnagar	Paddy	30	95	25	26	48	50	22	23
	Maize	26	52	12	23	32	61	8	16
	Wheat	19	44	14	32	24	54	6	14
	Potato	25	81	18	22	57	71	6	7
	Vegetable	1	24	15	63	9	38	0	0
	Oilseeds	28	44	15	34	29	66	0	0
	Pulses	8	38	10	26	28	74	0	0

Source: Field Survey, 2015/16

7.3 Labour Input and Production Output Intensity by Crops

The finding of the study also revealed variation on labour input and production output intensity by crops and study sites. Table 7.3 shows that labour input intensity is the highest in potato cultivation in Jahada (81 persons/ha) and Palhi (70 persons/ha) followed by paddy cultivation. Furthermore, labour input intensity is the highest in paddy cultivation in Ramnagar

(95 persons/ha) followed by potato cultivation. However, the highest productivity is found in paddy (7511 kg/ha in Palhi, 6494 kg/ha in Jahada and 6153 kg/ha in Ramnagar) followed by potato in all study sites. In addition, the highest production output intensity is found from paddy cultivation in all study sites followed by potato in Jahada and Ramnagar and by vegetables in Palhi.

Table 7.3: Labour Input and Production Output Intensity by Crops

Study sites	Crops	Area (ha)	Labour Intensity (person/ha)	Productivity (kg/ha)	Output Intensity (Rs/ha)
Jahada	Paddy	18.66	80	6494	181842
	Maize	0.65	35	789	55263
	Wheat	6.46	51	2806	98207
	Potato	1.85	81	4203	168108
	Vegetables	0.23	61	870	43478
	Oilseeds	7.55	36	735	62465
	Pulses	4.78	32	729	65608
Palhi	Paddy	40.70	64	7511	210294
	Maize	0.08	19	980	68627
	Wheat	21.50	24	2937	102782
	Potato	1.99	70	4715	188615
	Vegetables	0.94	62	3932	196605
	Oilseeds	6.54	54	681	57870
	Pulses	6.49	40	889	79993
Ramnagar	Paddy	12.93	95	6153	192297
	Maize	6.10	52	703	49187
	Wheat	2.91	44	3420	119691
	Potato	0.72	81	4803	172127
	Vegetables	3.52	24	882	44118
	Oilseeds	4.63	44	876	74475
	Pulses	1.42	38	592	53321

Source: Field Survey, 2015/16

Note: Per unit (kg) local market price of paddy is Rs. 28/-, maize 70/-, wheat 35/-, potato 40/-, vegetables 50/-, oilseeds 85/- and pulses 90/- in 2015/16.

7.4 Use of Manure

Manure is an organic matter mostly derived from animal feces, which is used as an organic fertilizer in agriculture. Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen (Das, Jeong, & Kim, 2017). Integrating manure as a fertilizer for crop production is an important mechanism. The value of manure as a fertilizer

source has been recognized for thousands of years. However, in modern agricultural systems, manure is under utilized as fertilizer for crop production has been massively used (Lory et al., 2004).

The timely use of manure in agricultural land management is essential for increasing productivity and economic benefit (FAO, 2009). Table 7.4 shows use of manure in paddy cultivation by agricultural land holding size in the study area. It is also found that use of manure input in paddy cultivation has increased in all study sites even in different sizes of land holdings. However, the use of manure in paddy cultivation has decreased in small size (less than 0.5 ha) of holdings than larger size in Palhi area. Participants during FGD reported that farmers have used maximum quantity of manure with chemical fertilizer in all study sites. After the discussion on issues of manure input and situation of production trend, KIs informed that they have faced the effect of diseases like *daduwa* (*sheath blight*), *patera* (*rice bug*) and *gobaro* (*borer*) to have damaged the potato and paddy crops in Palhi and Jahada last year.

Table 7.4: Utilization of Manure (kg/ha) by Land Holdings Size in Paddy

Size of land holding (ha)	Jahada		Palhi		Ramnagar	
	2005/06	2015/16	2005/06	2015/16	2005/06	2015/16
Less than 0.5 (n=44)	6728	8644	1897	1761	4239	4663
0.5 to 1.0 (n=20)	2935	3625	2071	2390	3574	3724
1.1 to 1.5 (n=12)	986	1409	1644	2560	0	0
More than 1.5 (n=14)	4994	6657	1942	2157	0	0

Source: Field Survey, 2015/16

This study found use of manure is higher in paddy cultivation in all the study sites than district average (1042 kg/ha) and national average (1190 kg/ha) (MoAD, 2016). It shows that farmers have given emphasis to use high input of manure in paddy cultivation.

7.5 Use of Chemical Fertilizers

Crop production also depends on inputs of chemical fertilizer. Use of chemical fertilizer in agriculture is the most important component for increasing agricultural production and productivity. Large quantities of plant nutrients are mainly possible through chemical fertilizers in the absence of domestic manure. Chemical fertilizer is used mainly in irrigated land. Consequently, new technology in the agriculture brings together the use of HYV seeds, use of fertilizers and assured irrigation. Three of them are inter-linked to increase productivity (Singh, 2003).

Table 7.5 shows the use of chemical fertilizer in major crops in the study sites by land holding size. Chemical fertilizers (Urea, Potash and DAP) has been used in paddy, wheat and oilseeds in all study sites. The trend of chemical fertilizer use has been increased in all crops by different size of land holdings in Jahada and Ramnagar. However, it has decreased in paddy cultivation under small land holdings sizes (less than 0.5 ha) in Palhi.

Table 7.5: Use of Fertilizers (kg/ha) by Land Holding Size and Crops

Crops	Size of land holding (ha)	Jahada		Palhi		Ramnagar	
		2005/06	2015/16	2005/06	2015/16	2005/06	2015/16
Paddy	Less than 0.5	136	169	338	313	102	112
	0.5 to 1.0	118	163	207	239	75	78
	1.1 to 1.5	54	77	194	230	0	0
	More than 1.5	160	266	237	263	0	0
Wheat	Less than 0.5	129	150	369	428	118	190
	0.5 to 1.0	0	0	247	290	0	0
	1.1 to 1.5	0	0	102	141	0	0
	More than 1.5	266	289	360	254	0	0
Oilseeds	Less than 0.5	21	29	44	69	11	7
	0.5 to 1.0	15	21	23	19	0	0

Source: Field Survey, 2015/16

Participants during the FGD and KII have also agreed that farmers have been using chemical fertilizers with organic manures in crops to increase production. However they are aware of the affect of using chemical fertilizers in crops and their impact on health.

The result shows that the average use quantity of chemical fertilizers in paddy and wheat which is higher than district and national level in all study sites. It is recorded 90 kg/ha in district level and 126 kg/ha in an average in national level in paddy and 150 kg/ha in district level and 104 kg/ha in average in national level in wheat cultivation during the same study year (MoAD, 2016).

7.6 Use of Pesticides

Pesticides and herbicides are applied in agricultural land to control pests. Agricultural pesticides are powerful chemical tools that are developed, produced and used to mitigate crop damage or loss by pest organisms (George, 2004). Being this the reason, crop productivity is increased by high-yielding varieties of seeds, fertilization and use of pesticides. An increased yield and potential of crops is associated with higher vulnerability to pest attack results absolute loss in productivity (Oerke, Dehne, Schonbeck, & Weber, 1994).

Table 7.6 shows the use of pesticides by land holding size in the study area. Farmers use pesticides only in paddy cultivation. It is found that use of pesticides has increased in paddy in different sizes of land holdings in all study sites. Furthermore, it has been noticed that the use quantity of pesticides is higher in small size of land holdings than large size in Jahada and Palhi, but it is increased by land holding size in Ramnagar.

Table 7.6: Use of Pesticides (ml/ha) in Paddy by Land Holdings Size

Size of land holding (ha)	Jahada		Palhi		Ramnagar	
	2005/06	2015/16	2005/06	2015/16	2005/06	2015/16
Less than 0.5	80	92	379	352	26	46
0.5 to 1.0	56	69	256	296	407	424
1.1 to 1.5	49	60	173	180	0	0
More than 1.5	0	0	129	144	0	0
Average	46	74	234	243	217	235

Source: Field Survey, 2015/16

The use quantity of pesticides is less (74 ml/ha in Jahada, 243 ml/ha in Palhi and 235 ml/ha in Ramnagar) than district average (370 ml/ha) and national average (391 ml/ha) in all study sites during the same study year (MoAD, 2016). Moreover, respondents during FGD and KII also informed that they have not given more priority to use chemical fertilizers. They are reported to have discussed for other alternates of chemical fertilizers before use.

7.7 Crop Productivity

Productivity depends mainly on the availability of irrigation facilities on the one hand and the varieties of seeds on the other.

7.7.1 Irrigation and Productivity

Irrigation is an important factor in agricultural development. Table 7.7 shows the productivity of crops by land holding size in irrigated land in Jahada. It is noticed that productivity of paddy, wheat and pulses in all size of land holdings has increased, whereas the productivity of maize, potato, vegetables and oilseeds has decreased in Jahada during the study period. However, it is found varying by land holding size. The productivity of all crops is higher in small and medium size of land holding than larger size of land holdings in Jahada. It is reported that due to insufficient use of other inputs such as, manure, chemical fertilizers, and seeds in large size of farms were the main causes behind the less productivity in Jahada.

Table 7.7: Change in Crop Productivity (kg/ha) by Crops in Jahada

Crops	Land holdings size (ha)	2005/06		2015/16		Change in percent
		Area	Productivity	Area	Productivity	
Paddy	Less than 0.5	6.20	4985	5.27	6607	32.5
	0.5 to 1.0	8.96	4769	3.68	7025	47.3
	1.1 to 1.5	3.65	5676	2.43	6410	12.9
	More than 1.5	13.79	5070	7.27	6165	21.6
Maize	Less than 0.5	0.03	2959	0.10	1726	-41.7
	0.5 to 1.0	0	0	0.10	1479	0.0
	1.1 to 1.5	0.14	1479	0.14	1183	-20.0
	More than 1.5	0	0	0.24	1057	0.0
Wheat	Less than 0.5	0.20	616	0.37	1022	65.9
	0.5 to 1.0	1.12	2035	0.57	2193	7.7
	1.1 to 1.5	0.41	1381	0.41	1775	28.6
	More than 1.5	2.03	2974	4.06	3087	3.8
Potato	Less than 0.5	0.41	6706	0.33	5128	-23.5
	0.5 to 1.0	0.30	5424	0.20	3452	-36.4
	1.1 to 1.5	0.14	4438	0.08	4076	-8.1
	More than 1.5	0.10	3945	0.14	2737	-30.6
Vegetables	Less than 0.5	0.03	4438	0.06	2536	-42.9
	0.5 to 1.0	0.05	0	0.07	740	0.0
	1.1 to 1.5	0	0	0	0	0
	More than 1.5	0.15	0	0.10	0	0
Oilseeds	Less than 0.5	2.74	996	3.24	709	-28.9
	0.5 to 1.0	3.72	748	2.23	614	-17.9
	1.1 to 1.5	2.52	1080	1.20	1000	-7.4
	More than 1.5	4.50	814	1.93	753	-7.6
Pulses	Less than 0.5	2.16	541	2.91	564	4.2
	0.5 to 1.0	1.89	545	1.42	679	24.5
	1.1 to 1.5	0.15	427	0.15	592	38.5
	More than 1.5	2.91	459	1.49	545	18.6

Source: Field Survey, 2015/16

Similarly, productivity of paddy, wheat, potato, vegetables, oilseeds and pulses has increased but productivity of maize only has decreased in all size of land holdings in Palhi (Table 7.8). Moreover, the trend of change in productivity by crops varies with size of land holdings. In general, changing trend of productivity has observed higher from small size of land holdings to large size in paddy and wheat, whereas it has reversed in other crops. However, the ratio of

change has found in medium size of land holdings in most of the crops in Palhi during the study period.

Table 7.8: Change in Crop Productivity (kg/ha) by Crops in Palhi

Crops	Land holdings size (ha)	2005/06		2015/16		Change in percent
		Area	Productivity	Area	Productivity	
Paddy	Less than 0.5	1.32	6309	1.42	6909	9.5
	0.5 to 1.0	5.07	2940	4.39	4310	46.6
	1.1 to 1.5	25.86	5210	10.55	5370	3.1
	More than 1.5	27.04	10030	24.34	10285	2.5
Maize	Less than 0.5	0	0	0	0	0
	0.5 to 1.0	0	0	0	0	0
	1.1 to 1.5	0	0	0	0	0
	More than 1.5	0.10	1479	0.05	1282	-13.3
Wheat	Less than 0.5	0.71	2372	0.81	2912	22.7
	0.5 to 1.0	1.93	1236	2.13	2087	68.8
	1.1 to 1.5	6.32	3005	6.05	2941	-2.1
	More than 1.5	14.20	2837	12.51	3084	8.7
Potato	Less than 0.5	0.10	6607	0.08	7561	14.4
	0.5 to 1.0	0.41	2712	0.30	5095	87.9
	1.1 to 1.5	0.78	5981	0.49	2755	-53.9
	More than 1.5	1.79	5540	1.08	3809	-31.2
Vegetables	Less than 0.5	0.02	5917	0.05	6410	8.3
	0.5 to 1.0	0.39	4245	0.36	6633	56.3
	1.1 to 1.5	0.25	2998	0.27	3070	2.4
	More than 1.5	0.30	1808	0.25	1913	5.8
Oilseeds	Less than 0.5	0.54	634	0.37	702	10.7
	0.5 to 1.0	0.81	477	0.85	469	-1.8
	1.1 to 1.5	2.50	977	1.54	1062	8.7
	More than 1.5	5.04	571	3.82	634	11.0
Pulses	Less than 0.5	0.57	761	0.29	1312	72.5
	0.5 to 1.0	0.81	687	0.83	819	19.2
	1.1 to 1.5	1.79	1348	1.42	1426	5.8
	More than 1.5	6.86	601	3.99	781	30.0

Source: Field Survey, 2015/16

It has been found that the increasing trend in productivity of paddy, wheat and potato whereas decreasing trends in productivity of maize, oilseeds and pulses in all sizes of land holdings in Ramnagar (Table 7.9). Furthermore, it has been noticed that increasing trend of

productivity is higher in large size of land holdings in paddy, maize, wheat and oilseeds but it is higher in small size of land holdings in potato and pulses during the study period.

Table 7.9: Change in Crop Productivity (kg/ha) by Crops in Ramnagar

Crops	Land holdings size (ha)	2005/06		2015/16		Change in percent
		Area	Productivity	Area	Productivity	
Paddy	Less than 0.5	8.91	6218	8.10	6545	5.3
	0.5 to 1.0	3.85	5128	4.26	5410	5.5
	1.1 to 1.5	1.18	7101	0.57	7710	8.6
	More than 1.5	0	0	0	0	0
Maize	Less than 0.5	2.20	910	4.21	528	-42.0
	0.5 to 1.0	1.12	1766	1.76	1027	-41.9
	1.1 to 1.5	0	0	0.14	740	0.0
	More than 1.5	0	0	0	0	0
Wheat	Less than 0.5	1.28	3099	1.89	3682	18.8
	0.5 to 1.0	0.93	2582	0.88	2777	7.5
	1.1 to 1.5	0	0	0.14	4734	0.0
	More than 1.5	0	0	0	0	0
Potato	Less than 0.5	0.37	6724	0.45	7692	14.4
	0.5 to 1.0	0.17	3787	0.25	4892	29.2
	1.1 to 1.5	0.03	6657	0.02	2959	-55.6
	More than 1.5	0	0	0	0	0
Vegetables	Less than 0.5	0	0	0	0	0
	0.5 to 1.0	0	0	0.34	962	0.0
	1.1 to 1.5	0	0	0	0	0
	More than 1.5	0	0	0	0	0
Oilseeds	Less than 0.5	3.19	1105	5.27	856	-22.5
	0.5 to 1.0	1.32	1062	2.03	838	-21.1
	1.1 to 1.5	0.68	2130	0.34	1420	-33.3
	More than 1.5	0	0	0	0	0
Pulses	Less than 0.5	0.57	1166	0.88	674	-42.2
	0.5 to 1.0	0.20	419	0.37	403	-3.7
	1.1 to 1.5	0.68	740	0.34	592	-20.0
	More than 1.5	0	0	0	0	0

Source: Field Survey, 2015/16

7.7.2 Variety of Seeds and Productivity

The variation on productivity of crop also depends on use of varieties of seeds. This plays an important role in the agricultural development. Variation is seen in productivity of paddy by land holdings size with the use of varieties of seeds in the study area. Table 7.10 shows

productivity of paddy by land holding size and varieties of seeds in Jahada. The productivity of paddy has increased by 17.3 percent in the area where improved seeds were used. Whereas, the productivity of paddy has decreased by 6.1 percent in the area with local seeds are used in Jahada. In addition, the productivity has increased by 57.8 percent in large size of land holding (more than 1.5 ha).

Table 7.10: Change in Crop Productivity (kg/ha) of Paddy with Varieties of Seeds in Jahada

Size of land holding (ha)	Local Seed			Improved Seed		
	2005/06	2015/16	Change in percent	2005/06	2015/16	Change in percent
Less than 0.5	5317	5313	-0.1	4449	5856	31.6
0.5 to 1.0	4734	4128	-12.8	8102	9190	13.4
1.1 to 1.5	0	0	0	7101	8043	13.3
More than 1.5	0	0	0	2367	3734	57.8
Average	5025	4721	-6.1	5505	6456	17.3

Source: Field Survey, 2015/16

The productivity of paddy has increased by 11.1 percent in the area where improved seeds were used but it has increased only by 4.1 percent in the area where local seeds were used in Palhi. Variation is seen in productivity by land holding size. The changing trend is higher in medium size of land holdings during the study period (Table 7.11). Furthermore, the result shows the productivity of paddy has increased from large size to small size of land holdings in Palhi.

Table 7.11: Change in Crop Productivity (kg/ha) of Paddy with Varieties of Seeds in Palhi

Size of land holding (ha)	Local Seed			Improved Seed		
	2005/06	2015/16	Change in percent	2005/06	2015/16	Change in percent
Less than 0.5	0	0	0	3902	4857	24.5
0.5 to 1.0	5763	5917	2.7	4665	6104	30.9
1.1 to 1.5	4054	4305	6.2	17673	18588	5.2
More than 1.5	0	0	0	4520	4637	2.6
Average	4908	5111	4.1	7690	8547	11.1

Source: Field Survey, 2015/16

The result shows the productivity of paddy has increased in both condition of area where the local and improved seeds were used in Ramnagar. Further, it is found that productivity of paddy has increased by 30.4 percent in areas where the improved seeds were used. But it has increased by 18.0 percent only in areas where the local seeds were used in Ramnagar (Table

7.12). In addition, the productivity of paddy is higher in medium size of land holdings as compared to other farming conditions.

Table 7.12: Change in Crop Productivity (kg/ha) of Paddy with Varieties of Seeds in Ramnagar

Size of land holding (ha)	Local Seed			Improved Seed		
	2005/06	2015/16	Change in percent	2005/06	2015/16	Change in percent
Less than 0.5	0	0	0	4540	5740	26.4
0.5 to 1.0	3787	4467	18.0	6305	8400	33.2
1.1 to 1.5	0	0	0	0	0	0
More than 1.5	0	0	0	0	0	0
Total	3787	4467	18.0	5422	7070	30.4

Source: Field Survey, 2015/16

The research finds through the enumerated data that productivity of paddy increased in both condition of areas where local and improved seeds were used in Palhi and Ramnagar, but it has decreased in the area where local seeds were used in Jahada due to insufficient water availability in time and comparatively poor irrigation facilities in Jahada.

7.7.3 Crop Productivity Yield Index (P_i)

Agricultural productivity determines the level of agricultural development in any region. It refers to per hectare of yield in a unit (kg/quintals etc.) of any crop in a region or field. That is, a farmer adopts more technique to increase the productivity of crop for economic as well as social development. Agricultural productivity of the selected crops is calculated for each study sites.

An agricultural productivity index developed by Shafi in 1984 is calculated by using seven crops in this study which include paddy, wheat, maize, oilseeds, pulses, potato and vegetables. Shafi's method represents the summation of the total yield of all the crops in the study unit area divided by the total area under the same crops in the study unit area. Then obtained value is compared in relation to the total yield of all the crops divided by the total area under those crops at the total area (see equation in Chapter III).

Table 7.13 shows the productivity index of the study area. The result indicates that the average productivity index is 1.072 in 2015/16 and which was 1.037 in 2005/06. The spatial distribution of Crop Productivity Index (CPI) reveals that the higher CPI obtained in Palhi (1.347) in 2015/16 and which was 1.205 in 2005/06. It is followed by the Ramnagar (1.034) in

the second and Jahada in the third (0.834) in 2015/16 (Figure 7.2). The average productivity index is seen increased by 0.035 between 2005/06 and 2015/16. Further, it indicates that the productivity of different crops in Palhi has improved comparatively than other sites due to the availability of better irrigation facilities.

Table 7.13: Crop Productivity Index (CPI)

Study sites	2005/06	2015/16	Change
Jahada	0.845	0.834	-0.011
Palhi	1.205	1.347	0.142
Ramnagar	1.062	1.034	-0.028
Average	1.037	1.072	0.035

Source: Calculated from the Field Data

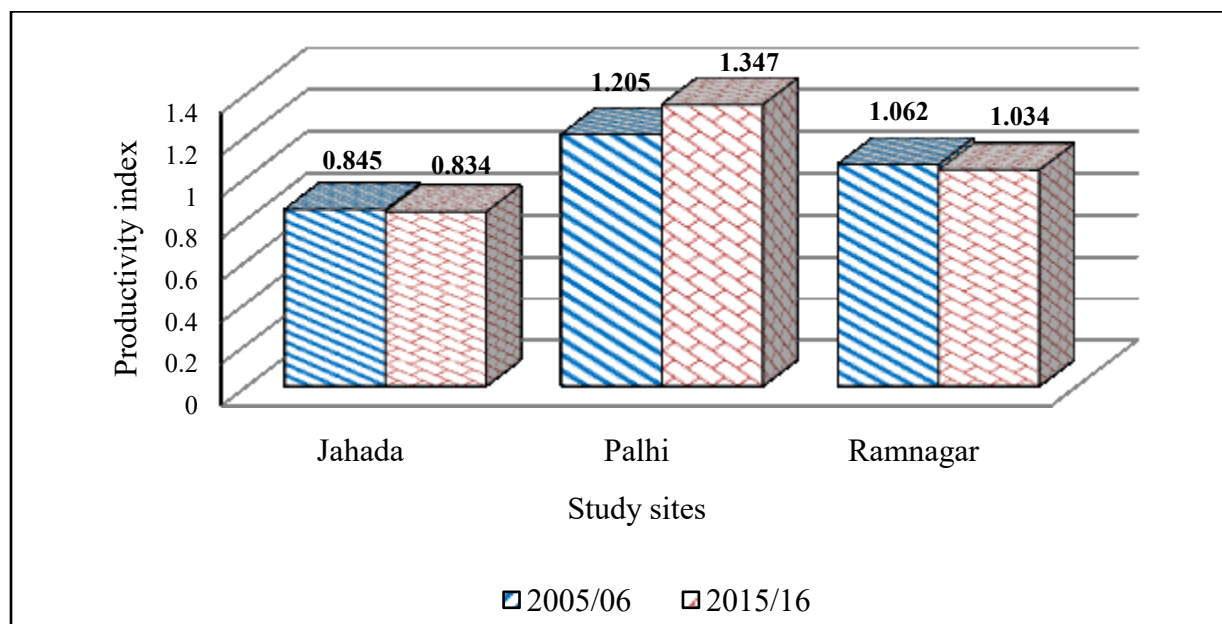


Figure 7.2: Change of Crop Productivity Index

7.8 Farmer's Decision

Decisions made on agricultural land management practices by farmers also play a significant effect on agricultural production and land conditions. That is, agricultural land use management is influenced by farmer's decision. Productivity in agriculture is a measurement of total output of per unit of land (Mather, 1989).

Respondents informed that the deciding role of farmer is crucial. Farmers take decision after the discussion in their family for the use and application of modern agricultural technology like machinery or labour force, and uses of high yielding varieties of seeds or local seeds, use of chemical fertilizers or manure and pesticides in the study areas. It is also mentioned by

participants during FGD and KII that the deciding role of farmer has been influenced by the level of education. Similarly, they are conscious in taking decision for changing new or varieties of crops for intensive cultivation on available crop land. Besides, it is found that 67.3 percent of respondents make discussion among family members within the household before taking decision to use modern agricultural technology in their farmland. Further, it has been found that the issue to use of modern technology such as, machineries, chemical fertilizers and pesticides raised by 54.5 percent of farmers with educated family members. In addition, KIs from Ramnagar area pointed that the use and management of farm land vary with land holding size.

Table 7.14 shows that 45.2 percent land owner households have adopted modern technology out of total respondents, whereas only 16.1 percent sharecropper households of crop farming have adopted the modern technology in their farms. Similarly, it has been found that 61.9 percent of total households with educational level SLC and above have adopted modern inputs in their farms whereas only 38.1 percent of total households with educational level below SLC have adopted modern inputs in their farms.

Table 7.14: Land Ownership and Education Level

Study sites	Land owner		Use of modern inputs by education level (in %)		Share cropper		Use of modern inputs by education level (in %)		Both		Use of modern inputs by education level (in %)	
	HH	%	SLC & Above	Below SLC	HH	%	SLC & Above	Below SLC	HH	%	SLC & Above	Below SLC
Jahada	17	54.8	70.5	29.5	5	16.1	60.0	40.0	9	29.0	44.4	55.6
Palhi	14	45.2	57.1	42.9	6	19.4	33.4	66.6	11	35.5	36.4	63.6
Ramnagar	11	35.5	54.5	45.5	4	12.9	75.0	25.0	16	51.6	43.8	56.2
Total	42	45.2	61.9	38.1	15	16.1	53.3	46.7	36	39	41.7	58.3

Source: Field Survey, 2015/16

7.9 Land Intensification

Agricultural land intensification is the process whereby land use activity is heightened through an increase in production on a plot. That is, production can be stimulated by an increase in the amount or kind of labour or the use of a new technology invested in the integration of crops that yield more food (Scarborough, 2012). Agricultural intensification is likely to meet the increased food demands of the increased population (Schroeder, 1985). It is also preferable when there is very little scope for expansion of cultivation of land due to the pressure of increased

population (Pingali & Rosegrant, 2001). Agricultural intensification is considered as a major agricultural development opportunity for developing countries like Nepal. Hence, intensification practices have been rising specifically in semi-urban areas of Nepal for more than two decades (Raut, Sitaula, & Bajracharya, 2010).

There are two types of changes found in the study sites: change from one crop to another and change in the varieties within the particular crop. The study found changes in crops and its varieties in 57.1 percent of total cultivated land in the study sites within study period. Moreover, it has been changing in the varieties of paddy from local to improved (*Mansuli, Janaki, Sabitri, Gorakhnath to Radha-7, Radha-14, Hardinath-2, Gorkhnath-509*) or from one species of local to another species of local seeds or from one species of improved to another species of improved seeds in about 61.1 percent of land in the study sites. Such change in varieties has also been reported in 23.9 percent area in wheat (*Gautam, Aditya, Bhirkuti, UP 262, Tilottama*) (Plate 6) and 11.1 percent area in maize (*Rampur-2, Rampur Composite, Manakamana-4, Khumal Hybrid-2*).

The study found that farmers have practiced to cultivate many crops than the past to increase production even in the same area of land. Further, respondents informed that 16.1 percent of agricultural land holdings used to grow three and more crops during agriculture year in Jahada (Plate 9), which was only 11.8 percent before 10 years (Figure 7.3). Similarly, 48.4 percent of holdings are reported to grow three and more crops during agriculture year in Ramnagar now which was only 13.6 percent during 2005/06 (Figure 7.5). Whereas 16.5 percent of land holdings are reported to grow three and more crops during agriculture year in Palhi, which was only 3.7 percent area of total cultivated land during 2005/06 (Figure 7.4). The participants during FGD and KII also further reported that farmers have tried to explore new varieties of seeds from neighboring districts and applied within two to three years' interval. Sometimes they used to repeat their own local seeds. They depended on the season and availability of irrigation facilities as well as other modern inputs like machineries, organic and chemical fertilizers, pesticides etc.

Table 7.15 shows that 28.4 percent of total respondents (35.1 percent in Jahada, 33.3 percent in Palhi and 19.6 percent in Ramnagar) have used intensive farming in the parcels close to residence/house than some farther location.

Table 7.15: Crop Intensification/Diversification Conditions by Parcels (area in ha)

Study sites	Total parcels	Area	Identified parcels	Area	Intensified* parcels	Area	Diversified** parcels	Area
Jahada	59	28.60	37	21.4	13	9.61	5	3.31
Palhi	76	40.70	42	17.5	14	8.71	6	5.60
Ramnagar	88	14.35	51	10.3	10	2.54	14	4.48
Total	223	83.65	130	49.2	37	20.90	25	13.40

Source: Calculated from Field Survey Data

Note: * Plots with 3 crops per year and repeated the same crops in a plot.

** Plots with crop cycle and many crops in a plot and crops are usually change in the successive year.

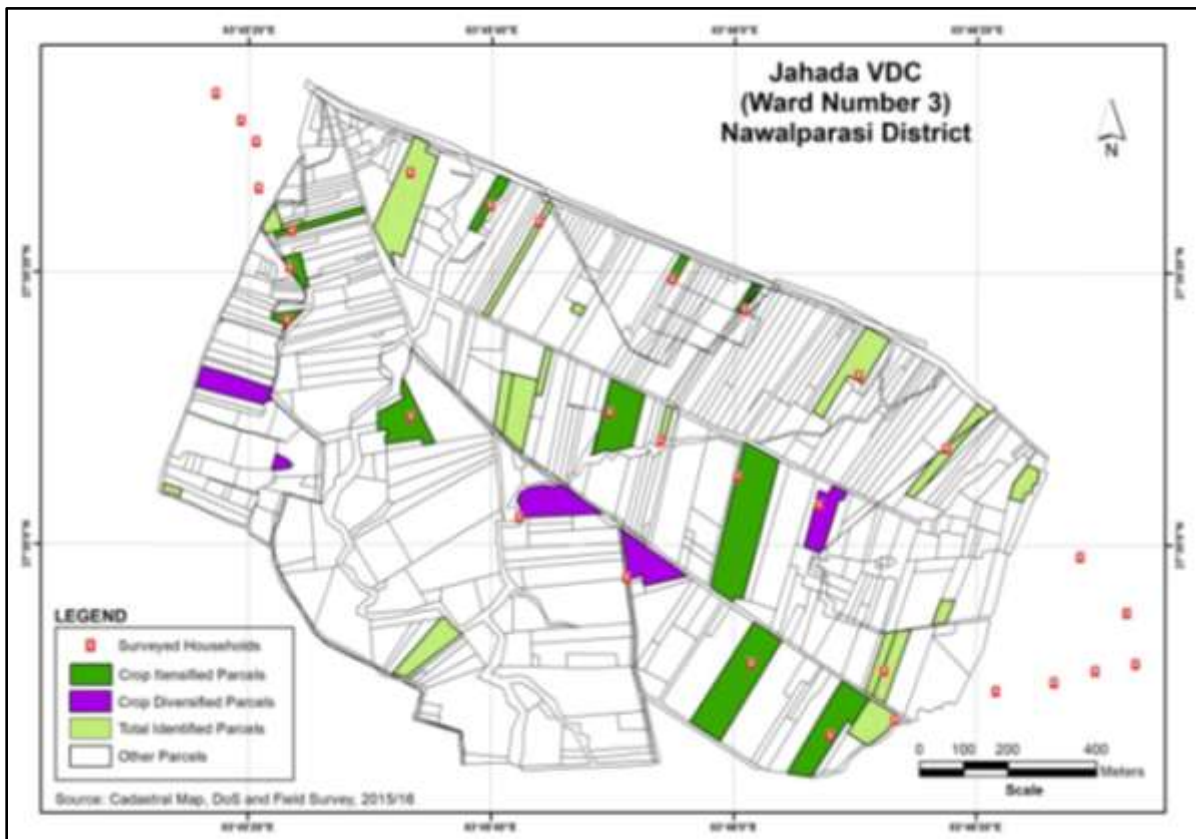


Figure 7.3: Crop Intensification/diversification Conditions by Parcels in Jahada

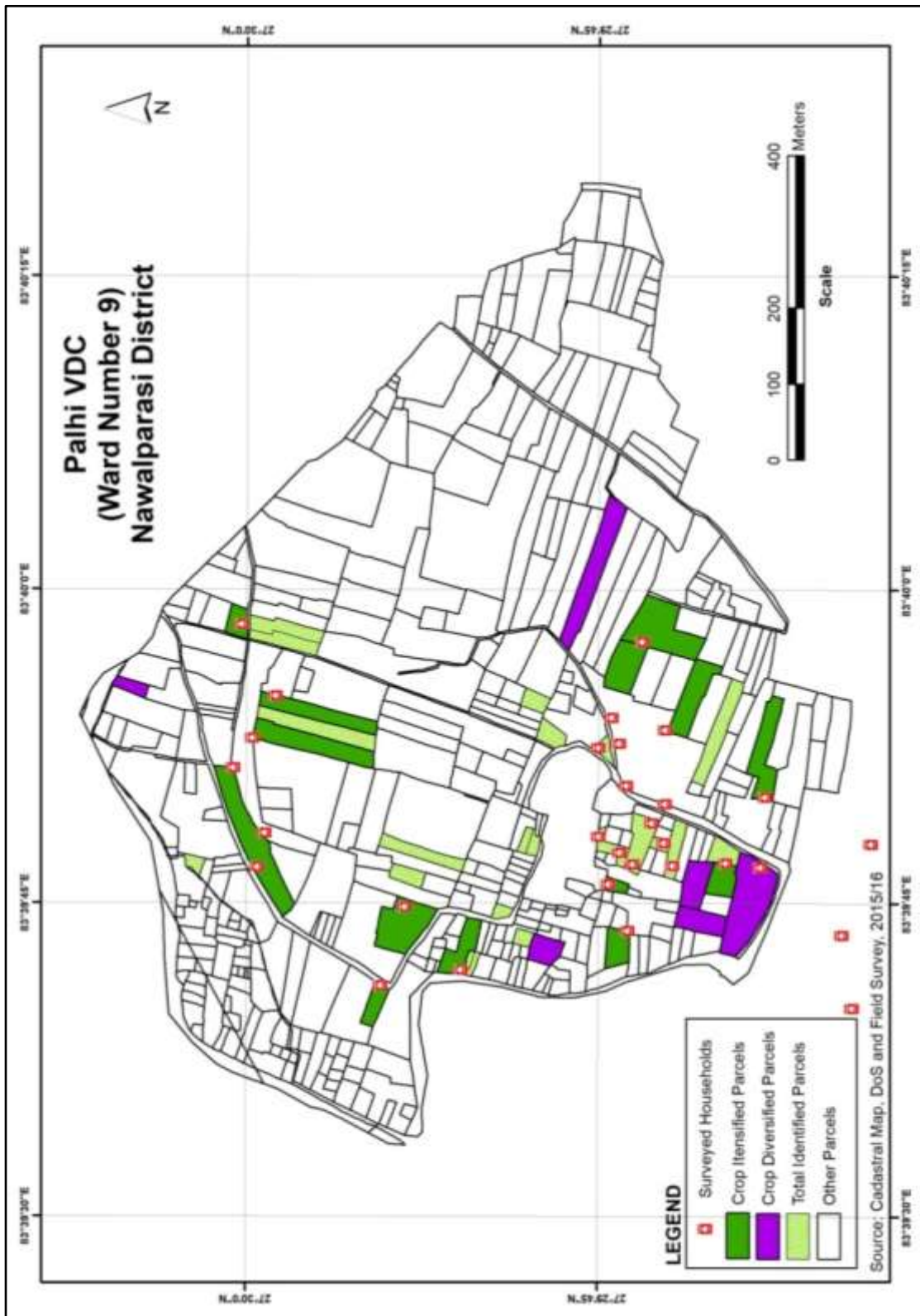


Figure 7.4: Crop Intensification/diversification Conditions by Parcels in Palhi

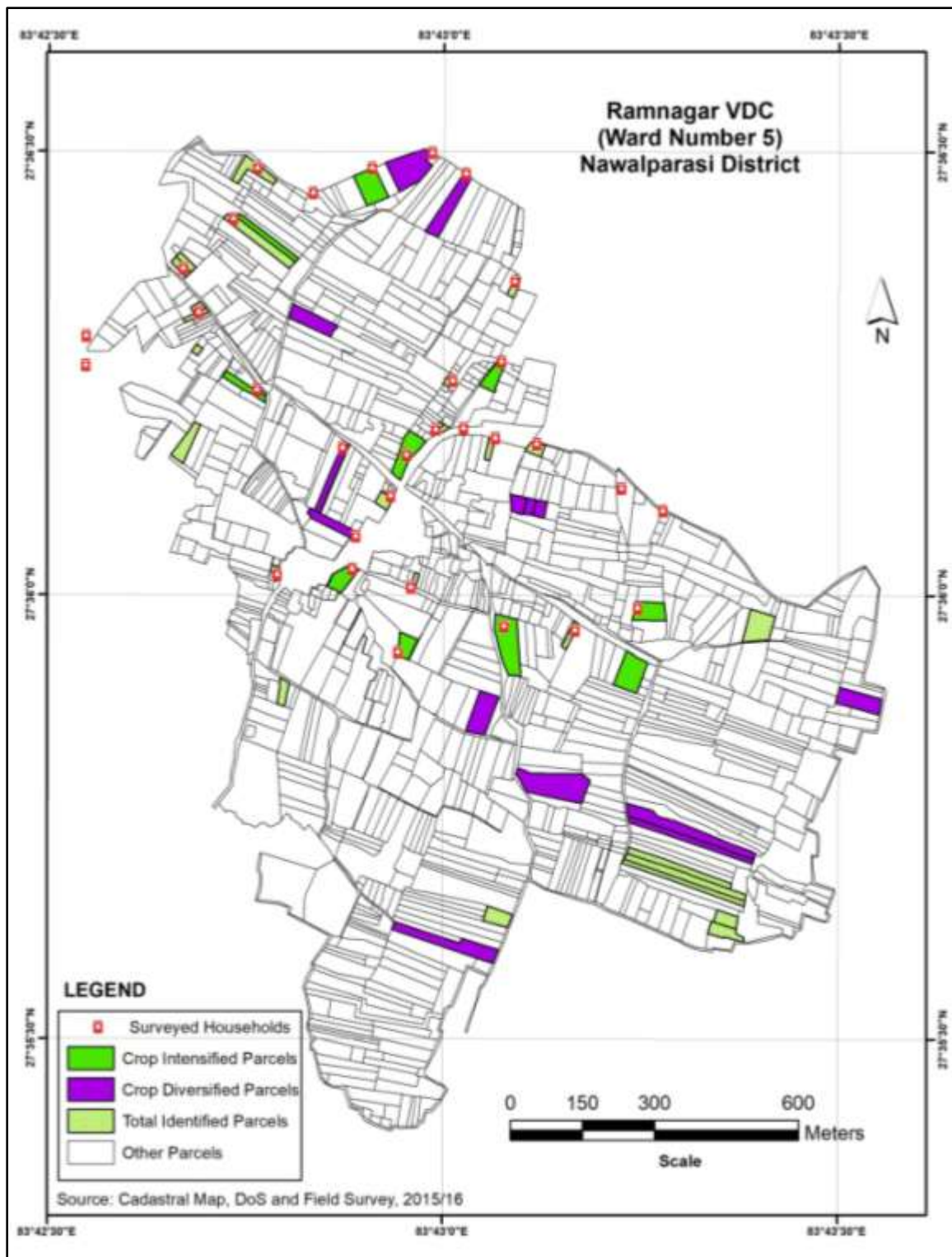


Figure 7.5: Crop Intensification/diversification Conditions by Parcels in Ramnagar

Increasing irrigation facilities indicates an improvement in cropping intensity (Figure 5.13 and Annex IX) over the period. Intensification is an important strategy in agricultural development and uplifting economic and social conditions of farmers (Mozumdar, 2012). Farmers have adopted intensification practices in the study sites to increase agricultural production. Similar findings are reported from South Senegal (Wood et al., 2004), Yangtze Delta of China (Wu et al., 2009), Ghana (Braumoh, 2009) and Dhankuta district of Nepal (Virgo & Subba, 1994).

During the FGD, some of the farmers expressed their farming practice in their own words which are listed below:

Senior citizen and farmer reported that:

When I started farming, I used to plant only paddy, wheat and somewhere maize. Whereas, now many crops with different varieties are being grown, such as vegetables, potato, oilseeds, pulses etc. Similarly, we had not access to market, even not developed road networks, irrigation facilities like now. (Male, aged 67 years, Jahada-3). (Plate 1)

Similarly, another farmer expressed that:

Intensification is possible in small land areas (up to 1 ha of land). To perform intensive cultivation in larger areas is difficult due to insufficient fertilizers and shortage of labour. The vegetables like tomatoes and potatoes need more pesticides and fertilizers, but the net profit yielded is high as compared to other crops. Cereal crops are now growing only for local consumption. After the adoption of cash crop cultivation, the socioeconomic status of farmers is improved. Income from food production is now sufficient for the whole year while previously the same farmer may have experienced a food deficit for about six months. (Female, aged 56 years, Ramnagar-5). (Plate 2)

Another participant shared that:

Irrigation has enabled the cultivation of more than two crops and has improved the socio-economic condition of farmers like me. Farmers are now able to save earnings by selling surplus crops, as compared to a food deficit situation earlier. The pest attacks, soil productivity loss, and cost of chemicals increased after the late 2000s. (Male, aged 60 years, Palhi-9). (Plate 3)

Another respondent added that:

I started cultivating hybrid varieties of wheat since 3-4 years ago. I eagerly await the arrival of irrigation facilities to cultivate vegetables and other cash crops. I believe that intensification is a positive trend to uplift livelihood of farmers. I felt that raising cattle for milk production could also improve economic conditions. I do not believe that these intensive activities could cause soil loss, degradation or other negative impacts on the environment. (Female, aged 65 years, Jahada-3). (Plate 4)

In addition, KI (Retired school teacher) added that:

Neighbours were cultivating only paddy and wheat at that time when I was 18 years old. Chemical fertilizers were introduced in my field in 1995. In addition to paddy and wheat, maize, pulses, oilseeds, potato, tomato and green vegetables are being cultivated at present. I started cultivating potatoes only six years ago. The cultivation of potatoes, tomatoes and other vegetables gives more profit if one can invest on the essential chemical fertilizers, pesticides and labour. I do not know about the loss or improvement of soil or overall environmental conditions, but I am benefited due to intensification. (Male, aged 79 years, Ramnagar-5). (Plate 5)

7.10 Crop Diversification

Crop diversification is a popular strategy to maximize the use of land, water and other resources. It can meet different requirements of people's food supply to generate earnings for farmers. Crop diversification does not only address the food security but also is a process for extensive use of land, water and other resources (Sharma, 2001). Crop diversification implies diverse use of crop production and shifting of agricultural workforce to other allied activities such as livestock, poultry, and fishery, bee-keeping etc and non-agricultural sector (Makate, Wang, Makate, & Mango, 2016).

Diversified farming systems (such as crop-livestock integration, agro-forestry, intercropping, crop rotation etc.) enable farmers to broaden the base of agriculture, to reduce the risk of production failure, and attaining a better balanced diet, and use labour more efficiently, to procure cash for purchasing farm inputs, and to add value to produce (Dixon, Gulliver, & Gibbon, 2001).

Diversification is therefore a dynamic process through agricultural land use and its associated activities are tuned to maximization of production and effectiveness of land.

Singh and Dhillon (1984) have found diversification in crop in India by developing of Crop Diversification Index (CDI) (see equation in Chapter III). It is based on the principle that if the total cultivated area in a region is devoted wholly to one crop (i.e., specialization), the index value will be zero (0) and if it is evenly distributed among all crops (i.e., maximum diversification), the index value approaches one (1).

Table 7.16 shows that all index values are higher than 0.5, and it seems closer to 1 which means there is a great diversity in crops in the study area during the study period. Whereas it is also noticed that the crop diversity index has increased in all study sites within the study period. It means that farmers were adopting crop diversification strategy on land management for more output from agricultural land in the study area.

Table 7.16: Crop Diversification Index (CDI)

Study Sites	2005/06	2015/16	Diversified parcels	Area (ha)
Jahada	0.62	0.71	5	3.3
Palhi	0.62	0.64	6	5.6
Ramnagar	0.68	0.76	14	4.5

Source: Compiled from Field Survey Data

During the FGD and KII, participants shared that farmers have been utilizing their cropping land with other crops when they get loss in the production of major crops like paddy, wheat and maize continually since two-three years. The research study found that 19.2 percent (13.5 percent in Jahada, 14.3 percent in Palhi and 27.5 percent in Ramnagar) of the total crop land in the study area has been used for crop diversification (Figure 7.3, 7.4 and 7.5). That is, they have been changing their crops, usually potato, vegetables, oilseeds and pulses with wheat in previous wheat monoculture area in the study sites (Plate 7). This type of practice is also found in the Bishnupura VDC of Rupandehi district (DoA, 2011), where farmers had practiced substitute of crops or crop rotation practice when the farmers got loss in production.

There are two kinds of diversification at farm level: horizontal diversification and vertical diversification. Horizontal diversification refers to the growing of different kinds of crops i.e., vegetables and fruits along with paddy, maize and wheat at farm level by farmers. Vertical diversification occurs when farmers are engaged in different value added activities at farm level

or adopt some other enterprises i.e. livestock, poultry farming, fish farming and bee-keeping (Plate 8) along with growing of crops at farm level.

This study found an increasing trend in manure use with chemical fertilizer in the study areas, similar type of findings has been reported by Sen et al. (2002); Semwal et al. (2004) in India, and Carswell (2002) in Uganda where there farmers have increased manure use to increase agricultural production and manage pressure of growing population in agricultural land. Farmers are adopting intensification practices in study area, which is also noted by MacLeod and Moller (2006) in New Zealand through increased practices in farm fertilizer and pesticide inputs. Similarly, Wu et al. (2009) in China through changing in cropping pattern from two crops to three/four crops and inter-cropping is applied. Similar findings are also reported by various researchers in different parts of Nepal. Poudel (2002) has found intensified agricultural land in Western Hills of Nepal with an adoption of new crops to increase farm production and income. This is to change cereal crops to livestock husbandry, vegetables and other cash crops in the accessible foothills, particularly along the road. Similar types of findings are also reported by Khanal (2002). He has noticed a significant change in the use of manure, chemical fertilizers, and high yielding varieties of seeds and irrigation for land management and increase production level of different crops in Mid-Hills of Nepal. Dahal et al. (2009) have found intensification of land by an input use of chemical fertilizers, pesticides, high yielding varieties of seeds and use of machineries in rural areas of Nepal. Similarly, Nepal and Thapa (2009) have noticed an increase in input use such as, manure, chemical fertilizers, pesticides, and farm machines, including tractors and pump-sets in their farms in Morang district. Besides, (Paudyal, 2010) has identified that farmer to have used higher quantity of agriculture inputs such as fertilizer, hybrid seeds, insecticides, pesticides as well as modern agriculture tools like tractor, power tillers and threshers and input of irrigation facilities in the cropping area in Kanchanpur district. Bhandari and Ghimire (2016) have notified the increasing trends in use of inputs such as, modern farm technologies like tractors and threshers, chemical fertilizers, irrigation and hybrid seeds in Chitwan district. These examples manifest that there is a correlation of intensification of farming supplemented by modern tools and techniques.

Population growth together with technological change facilitates people in applying different things which are similar with the Boserup's theory of agricultural development. Boserup highlighted the intensification to enhance more investments in land improvement such

as, irrigation, high yielding variety of seeds, chemical fertilizers, pesticides etc. There are two types of changes found: change from one crop to another, and change in the varieties within the particular crop that has been observed in the study sites. Such types of practices have also been observed by Thapa and Yila (2012) in Nigeria through intercropping and crop rotation. Miheretu and Yimer (2017) have noticed mixed cropping, crop rotation, use of manure and chemical fertilizer as the land management practices in Ethiopia.

This study has found the crop land status of individual farmer. Land owner cum farmers invest more than share cropper in the study sites. Similar view is also found in the study of Skonhott (1999) in resource exploitation model. He stated that perception of farmer to be driving in a dynamic setting of investment in the land, and farmers invest more in land for the economic benefit. Similarly, this study has found cropping pattern and crop intensity as well as intensive use of manure and agricultural labours which is related to conservation agriculture model (Ruttan, 1985). In addition, study has found the market oriented production of agricultural commodities like vegetables, gardening, and livestock rising. It is reported to have influenced techniques and intensity of cultivation appropriate with the location model of von Thunen which explains the geographical variation in the location and intensity of agricultural production.

Further, this study found that farmers have adopted new innovation and technologies in their farm to increase productivity of different crops. Moreover, farmers have used varieties of seeds and chemical fertilizers in farm management and production appropriate with the diffusion model of Hagerstrand (1976). He argued that diffusion of better crop and livestock varieties has been the major source of productivity in agriculture. That is, a significance relation on area and productivity has observed in the study area.

This present study, however, has found that variation in input use, according to size of land holdings, land ownership and decision making status of farmers in their farms. The productivity is comparatively higher in small size of land holdings in major crops in the study sites as compared to other cases. The high-payoff input model (Schultz, 1964) also assumes inverse relation between farm size and land productivity. Increasing farm size is the key to improve incomes in agriculture because it allows use of modern machineries thereby involving increasing returns at higher profitability per hectare. In addition to farm size, property and user rights are also found determinant factors for agricultural productivity. Tenants have paid a fixed rent or sharecropping through transferring part of their harvest to the landlord for agricultural land use.

Furthermore, the study has identified the economic condition of farmers' capabilities to use machineries and use of inputs in different circumstances like ownership of land and decision making on their behalf. It is also relevant to the theory of economic growth (Lewis, 1954) in which farmers are rational to choose options to get the highest level of well being and gain with the available resources and technology, and their ability to absorb risk.

7.11 Summary

Agricultural land management is the use of available inputs such as, labour, manure, improved seeds, chemical fertilizers, pesticides, and irrigation facilities to obtain more production. For the maximization of production, use of labour, manure, chemical fertilizers and pesticides in major crops, land intensification and crop diversification for agricultural land management practices are considered to be conducive in the study sites. It has been found that the increasing trend of use of manure in the study sites is reciprocal to production. Beside, intensification and crop diversification practices are commonly observed that intend to meet the increasing demand of food. Change from one crop to another and change in the varieties within the particular crop have been observed in the study sites. The farmers are found to have been using intensive farming in the parcels close to residence/house than those farther from the house location. Similarly, farmers have reported to have been adopting crop diversification strategy on land management for maximum benefit of land in the study area.

Besides, the variation has found in the use intensity of labour in crops by land holding size. It is noticed that labour input has high in small sizes of land holdings for paddy cultivation in Jahada and Palhi whereas labour input is higher in large size of land holdings in Ramnagar for paddy cultivation. But labour input is found to have increasing in all study sites for paddy, vegetables and oilseeds cultivation but decreasing in other crops cultivation. It is also found that use of manure input in paddy cultivation has increased in all study sites even in different sizes of land holdings. This is to say, the trend of input use of chemical fertilizer has increased in all crops by different size of land holdings in Jahada, but it has decreased in paddy cultivation under small sizes (less than 0.5 ha) of land holdings in Palhi. Similarly, the trend of input use of chemical fertilizer has increased under all crops and sizes of land holdings in Ramnagar. Use of pesticides is practiced only in paddy cultivation. Furthermore, the study has found that there exists variation in amount of use by land holdings size. The amount is higher in small land holdings size in Jahada and Palhi, whereas it is reverse in Ramnagar.

To conclude, it is noticed that the average productivity of paddy has increased in all study sites in irrigated area. The ratio on changing trend of productivity is increasing from small size of land holding to large size of land holdings in Jahada, whereas productivity is decreasing from small size of land holding to large size of land holdings in Palhi and Ramnagar because of intensive cultivation practices in small size of land holdings than large size of landholdings in Palhi and Ramnagar.

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 Summary

Land is a very essential element of nature on which all living things directly or indirectly depend on. Human beings depend on land to produce basic necessities which include food, clothing and shelter. Moreover, land is the principal resource of human beings in general and agrarian society in particular. In the context of the growing population, pressure on cultivated land, is increasingly unavoidable that the proper and efficient utilization of land resources is the answer to the problems faced by the country. In this context, Nepal faces two of the major problems of development; the need to increase agricultural productivity for food and the need to relieve population pressure on the land (Ashby & Pachico, 1987).

Land use is considered dynamic by space and time. Agricultural land and built-up area has increased and forest area decreased significantly in Jahada and Ramnagar. While, area under built-up and water bodies has increased and agricultural land has decreased in Palhi within the 51 years of time interval. Further, it is found that crop land has decreased in all study sites and mostly converted to built-up areas. Agricultural land has increased during 1958 to 1994 but it has decreased from 1994 to 2009 in the all study sites.

Built-up area has the highest Change Intensity Index (T_i) and Dynamic Index (K_i) in Jahada and Ramnagar. Where, land under water bodies, has the highest Change Intensity Index (T_i) and Dynamic Index (K_i) in Palhi. Further, built-up area has found highest Rate of Change (A_i), and Integrated Index (I_{d_i}) in Jahada and Palhi. Similarly, bush/shrub land has the highest Rate of Change (A_i) and Integrated Index (I_{d_i}) in Ramnagar. Agricultural land has followed second in terms of Rate of Change (A_i) and Integrated Index (I_{d_i}) in Jahada and Ramnagar, but agricultural land has the lowest Integrated Index (I_{d_i}) and has decreased by 45.9 percent in Palhi. It indicates that magnitude of changing pattern, trend of change, rate of change and overall change is higher in built-up area and followed by agricultural land in Jahada. Whereas magnitude of changing pattern and trend of change is higher in area under water bodies whereas rate of change and overall change is higher in built-up area in Palhi. Similarly, magnitude of changing pattern and trend of change is higher in built-up area, whereas rate of change and overall change is higher in area under bush/shrub land and followed by agricultural land in Ramnagar.

The overall landholding size owned by agricultural holding has decreased in study sites. Landholding size was 0.297 ha per capita in 2005/06 and decreased to 0.150 ha in 2015/16 in Jahada. Similarly, it has decreased from 0.325 ha to 0.189 ha in Palhi and it has also decreased from 0.098 ha to 0.066 ha in the same period in Ramnagar. Furthermore, there is a variation in pathways and magnitude of agricultural land use change in the study sites. Area under crop land has converted into other area particularly to built-up area in all study sites. It has changed agricultural land to built-up area by 18.6 percent in Jahada, by 31.5 percent in Palhi and by 10.9 percent in Ramnagar. It is found that the variation in agricultural land use change with size of land holdings and study sites. Agricultural land area has decreased in Jahada in all categories of land holdings size. Whereas, area under small size of land holding has increased by 7.7 percent due to the fragmentation of land parcels, but area under large size of land holdings has decreased in Palhi. In addition, area has increased by 5.7 percent under large size of land holdings however, it has decreased under small size of land holdings in Ramnagar.

Paddy, maize, wheat, potato, pulses, oilseeds and vegetables are the major crops grown in the study sites. Area occupied by paddy, oilseeds and pulse has been decreasing, whereas area occupied by wheat, potato, maize and vegetables has been increasing in Jahada. Whereas area occupied by paddy, wheat, oilseeds and vegetable has been increasing, but the area occupied by pulses, potato and maize has been decreasing in Palhi. Moreover, area occupied by maize, wheat, potato, vegetables and oilseeds has been increasing and cropping area occupied by paddy and pulses has been decreasing during the study period in Ramnagar.

Cropping pattern has changed in the study area. Area under single crop has decreased in all three study sites, whereas area under two and three crops has increased in Jahada and Palhi but area under two crops has decreased in Ramnagar. Contrarily, area under three crops has significantly increased in Ramnagar. The study is found cropping intensity has increased in Palhi and Ramnagar but decreased in Jahada because of availability of better irrigation facilities and land management practices in Palhi and Ramnagar than Jahada. The average Crop Productivity Index (CPI) is found 1.072 in study sites, which has changed by 0.035 during the study period. The highest CPI is found in Palhi (1.347) which indicates the productivity of different crops in Palhi has improved comparatively than other sites. This study has also found changes in crop calendar. Paddy, wheat, and oilseeds shifted one month earlier than before whereas maize, potato and pulses cultivation has been shifted from its earlier scenario one month later than before.

There are three major drivers of agricultural land use change. These are demography, infrastructural and technological development. In-migration and population change have found the main reasons for agricultural land use change in study sites during the study period. It is also found that the pressure of population on agricultural land has increased due to the population growth by in-migration and natural growth. The man-land ratio on agricultural land has changed from 4.6 persons/ha to 7.5 persons/ha during the study period in the study sites. Similarly, farmers' involvement in off-farm activities such as business, services, foreign employment are the important drivers of agricultural land use change. Out of which, increasing trend of foreign employment results the shortage of agricultural labour (working age group population) during the planting and harvesting time of crops. Infrastructure development is the determinant factor on the loss of agricultural land in the study sites. Development of roads, market centers and service centers are also caused the change in agricultural land during the study period. Two types of change have observed due to the development of infrastructure in the study sites. With the development of road access and expansion of services, market centers have encouraged farmers for agricultural land intensification. Apart from this, agricultural land has decreased due to the construction of roads, new residential buildings and public institutions like school/colleges, temples and play grounds. In addition, increasing trend on use of modern technology such as, chemical fertilizers, varieties of seeds, pesticides, irrigation facilities and machineries like tractors affected crop productivity in all the study sites. It has further noticed that the highest modern input users have increased by 34.3 percent in Palhi, by 22.6 percent in Jahada and 15.2 percent increased in Ramnagar. Land ownership status and availability of agricultural land has also played a major role on the use of inputs. Altogether 45.5 percent of land owner farmers have used modern technologies like machineries and other inputs (chemical fertilizers, high yielding varieties of seeds and pesticides), whereas only 31.1 percent of sharecroppers have used such inputs.

Similarly, different agricultural land management practices are observed in the study sites. Among them, a few of such are the input of labour, manure, chemical fertilizers and pesticides in major crops. Use of machineries, development of irrigation facilities, land intensification and crop diversification are the major land management practices observed in the study sites. There is an increasing trend of manure use by crops and land holding size in paddy. Further, the variation has been found in the use of labour by land holding size. There are more

numbers of farmers with small size of land holdings in Jahada and Ramnagar than Palhi. There are different types of labour used in study sites. These are family members, hired labour and exchange labour. Among them family labour are higher in Palhi than Jahada and Ramnagar because of large family size and availability of working age group of family members. Whereas, hired labour are higher in Jahada and Ramnagar due to the unavailability of adequate agricultural labour from family member. In addition, the practice of exchange labour system also found in Jahada and Ramnagar particularly in paddy, wheat and potato cultivation. Compared to the situation of root job, labour input has increased in major crops such as, wheat, pulses and oilseeds by different land holdings size in all study sites. However, labour input has decreased for potato cultivation by different land holdings size in Jahada. It has happened due to the decreased potato production in last year in Jahada. Similarly, labour input has decreased only in small size of land holdings in Palhi for vegetables cultivation. The labour input is higher in small size of land holding in major crops such as, paddy and wheat in all study sites. However, it has been found that higher number of labour inputs in oilseeds cultivation in large size of land holdings in all study sites. Similarly, labour input has been found higher in small size of land holdings in Palhi for potato cultivation. It is also found that variation in labour input and output intensity by crops and study sites. Labour input intensity is highest in potato cultivation in Jahada (81 persons/ha) and Palhi (70 persons/ha) followed by paddy cultivation. Whereas, it is highest in paddy cultivation in Ramnagar (95 persons/ha) followed by potato cultivation. However, the highest productivity is found in paddy cultivation (7511 kg/ha in Palhi, 6494 kg/ha in Jahada and 6153 kg/ha in Ramnagar) followed by potato in all study sites. Similarly, highest output intensity is found from paddy production, followed by potato in Jahada and Ramnagar and by vegetables in Palhi. In addition to labour and manure inputs, chemical fertilizer has also been used in paddy, wheat and oilseeds in all study sites. The trend of chemical fertilizer use has been increased in all crops by different size of land holdings in Jahada and Ramnagar. However, it has been decreased in paddy cultivation under small land holdings sizes (less than 0.5 ha) in Palhi. Farmers use pesticides only in paddy cultivation in study sites. The trend of pesticides use has increased by different sizes of land holdings during the study period. Furthermore, it has been noticed that the intensity of pesticides use is higher in small size of land holdings in Jahada and Palhi but it has increased from small size of land holdings to large size of land holdings in Ramnagar.

The productivity of paddy and wheat has been increased, whereas productivity of maize has decreased by different sizes of land holding in all study sites. However, the productivity of potato, vegetables, oilseeds and pulses has increased in Palhi whereas the productivity of potato, and vegetables in Jahada and productivity of oilseeds and pulses has decreased in all sizes of land holdings in Ramnagar. Similarly, the productivity of all crops is higher in small and medium size of land holding in Jahada due to inadequate use of inputs such as, manure, chemical fertilizers, and seeds in large size of farms as claimed by farmers. The trend of change in productivity by crops is varied with size of land holdings. In general, the changing trend of productivity has been observed higher from small size of land holdings to large size in paddy and wheat, whereas it has reversed in other crops. However, the ratio of change has been found higher in medium size of land holdings in most of the crops in Palhi during the study period. In addition, use of varieties of seeds has also played an important role in the productivity of crops in study sites. Productivity of paddy has increased in both condition of areas where local and improved seeds were used in Palhi and Ramnagar whereas it has decreased in the area where local seeds were used in Jahada due to inadequate water availability in time and comparatively poor irrigation facilities in Jahada. Furthermore, decisive role of farmer by land tenure status and education level have also found impact on agricultural production. There are 45.2 percent land owner households have adopted modern inputs whereas only 16.1 percent sharecropper households to have adopted the modern inputs in their farms. Similarly, it has been found that 61.9 percent of total households with educational level SLC and above have adopted modern inputs in their farms, whereas only 38.1 percent of total households with educational level below SLC have adopted modern inputs in their farmlands.

Farmers have adopted intensification and crop diversification practices in study sites through the changes in crops from one type of crop to another type of crop and also changed in the varieties within the particular type of crop. There are 16.1 percent of agricultural land holdings used to grow three and more crops in Jahada, 48.4 percent in Ramnagar and 16.5 percent in Palhi during agriculture year. Farmers have been using intensive farming in the parcels closer to residence/house than some farther location. There are 19.2 percent area (13.5 percent in Jahada, 14.3 percent in Palhi and 27.5 percent in Ramnagar) of the total crop land in the study area has been used for crop diversification practices. They have been changing their crops, usually potato, vegetables, oilseeds and pulses with wheat in previous wheat monoculture

area in study sites. Crop Diversity Index (CDI) values are higher than 0.5 and which seems closer to 1.0 (0.71 in Jahada, 0.64 in Palhi and 0.76 in Ramnagar) which indicates greater diversity in crops in the study area. The CDI values are also increased during the study period. It means farmers have adopted crop diversification practices in agricultural land management for more output in the study area.

8.2 Conclusion

Agricultural land use change is a complex and dynamic process. Initially, agricultural land increased at the cost of forest land while later built-up area has increased at the cost of cultivated land which is mainly resulted by population pressure. Cropping land is controlled by biophysical, socio-economic and cultural conditions of the area. Crop land has decreased in the study sites during the study period. The production cost has increased due to the increasing trend of fragmentation of crop land and increasing number of parcels in the study sites. It has been observed a shift from subsistence farming towards vegetable-based farming in the situation of population pressure and infrastructure development. Due to the loss in crop land and production, farmers started to adopt other sources of income from different ways. Shifting in occupation from crop cultivation to livestock raising and dairy product, business and services with agriculture has been developed after the improvement in the infrastructure and access to market centers. The decision making process regarding selection of crop varieties, adoption of new technologies and marketing led by household head has been changed to consensus-based household decision making process.

Area under crop land has decreased and has changed to other areas, particularly to built-up area in all study sites. With increasing number of households, agricultural land further fragmented and holding size further decreased. Furthermore, there is a variation in pathways and magnitude of agricultural land use change. Area under all size of land holdings has decreased in Jahada, as it is the resettlement program implemented area. While large land holdings size has decreased in Palhi where there is Tarai origin population. However, small size of land holdings has decreased in Ramnagar and it is the area predominantly occupied by Hill migrants. Paddy, maize, wheat, potato, pulses, oilseeds and vegetables are the major crops grown in the study area. Cereal crops, particularly paddy cultivated area, has increased where there is better irrigation facility, such as in Palhi where the area under such crop has decreased when there is no sufficient irrigation facility i.e. Jahada and Ramnagar.

Demography, infrastructural and technological development are the major drivers of agricultural land use change in the study sites. Migration has also effected in intensity of cultivation. With higher magnitude of migration, there is small landholding size and higher cropping intensity i.e. in Ramnagar, while Crop Productivity Index (CPI) is higher where there is better irrigation facility i.e. in Palhi. Similarly, farmers' involvement in off-farm activities such as business, services, foreign employment are the important drivers of agricultural land use change. With the development of road access, expansion of services and market centers have encouraged farmers for intensification on agricultural land.

Increasing use of agricultural input has positively effected on agricultural production. Increasing trend on use of modern technology such as, chemical fertilizers, varieties of seeds, pesticides, irrigation facilities and machineries, like tractors effected crop productivity in all the study sites. The amount of application of input is affected by landholding size, land tenure system and level of education. Land tenure status and availability of agricultural land has also played a major role in the use of inputs in the study sites. Use of labour, manure, chemical fertilizers and pesticides, use of machineries, development of irrigation facilities, land intensification and crop diversification are the major land management practices observed in the study sites. Hired labour and exchange labour are also used in addition to family members in their farmlands. Labour input has increased in major crops such as, wheat, pulses and oilseeds by different land holdings size. The labour input is higher in small size of land holding in major crops such as, paddy and wheat cultivation. This way, labour intensity is highest in potato cultivation in Jahada and Palhi whereas, it is in paddy in Ramnagar where there is a small holding. However, the highest productivity is found in paddy which is followed by potato in all study sites. Similarly, highest output intensity is found from paddy production, followed by potato in Jahada and Ramnagar and by vegetables in Palhi. The intensity of pesticides use is higher in small size of land holdings in Jahada and Palhi where they grow marketable crops but it is higher in large size of land holdings in Ramnagar where farmers grow cereal crops.

The trend of change in productivity by crops varies with size of land holdings. In general, the changing trend of productivity has been observed higher from small size of land holdings to large size of land holdings in paddy and wheat, whereas it has reversed in other crops. Improved seeds and productivity are also closely related as productivity is higher in improved seeds application in Palhi and Ramnagar as compared to local seeds application in Jahada.

Emerging market and demographic pressure also lead to crop diversification. Farmers have adopted crop diversification practices in study sites through the changes in crops from one type of crop to another type and also changed in the varieties within the particular type of crop. They have been changing their crops, usually potato, vegetables, oilseeds and pulses with wheat in previous wheat monoculture area in study sites.

8.3 Recommendations for Further Study

This research study is recommended for further research on time series studies on large areas on agricultural land management. Likewise, there are numbers of government policies related to agricultural development that are implemented. But this study has not covered the impact of government policies so it is recommended to carry out further research on the impact of government policies on agricultural development.

APPENDICES

Annex I

Households Questionnaires

1. Background information:

Date of Survey: 2072/.../.....

District: Nawalparasi VDC:..... Ward No: Village:.....

Name of the Respondent:..... Ethnicity:.....

Religion:..... Mother tongue:.....

2. Family size:

Total family members.....Member present..... Member absent.....

SN	Family members	Age	Sex	Marital Status	Education	Occupation		Migration status		Remarks
						Primary	Secondary	Year	Place	
1	Head									
2										
3										
4										
5										
6										
7										
8										
9										
10										

Note:

Age Group: 1 = Below 4, 2 = 4-14, 3 = 15-59 and 4 = Above 59

Sex: 1 = Male, 2 = Female and 3 = Others

Marital status: 1 = Unmarried, 2 = Married, 3 = Widow/widower, and 4 = Divorced

Education: 1 = Illiterate, 2 = Primary (1-7), 3 = Secondary (8-10), and 4 = Higher (SLC & above) 5 = Others

Occupation: 1 = Agriculture, 2 = Agri. Labor, 3 = Business, 4 = Service, 5 = Foreign Service, and 6 = others (specify).....

Migration: 1 = within district, 2 = within country, 3 = Abroad and 4 = others (specify).....

Migration (*family*): i) Native:..... ii) Migrant:.....(If migrant): a) Year of in-

migration: b) Place of Origin:.....

c) Reasons for migration: i) Relatives ii) Easy/better lifestyle

iii) Government land distribution iv) Natural disasters v) others (specify).....

3. Land distribution by ownership (in kattha)

Ownership	Crop land		Plantation		Pond		Abandoned land		Degraded land*		Others	
	Now	10 yrs ago	Now	10 yrs ago	Now	10 yrs ago	Now	10 yrs ago	Now	10 yrs ago	Now	10 yrs ago
Own land												
Land rented in												
Land rented out												
Total land												

(*Degraded land means: land occupied by river cutting/flood/landslides)

4. What types of crops are you farming?

Traditional:

Food Crops (paddy/ wheat / maize /potato/vegetables/ pulses / oilseeds /others.....)

Modern:

Cash Crops (sugarcane/high value crops like off season vegetables/ horticulture/ flori-culture/seed plants/ green house farming/tunnels/plastic sheet and others.....)

5. What is the purpose of production?

- a) Home consumption b) processing c) marketing d) others...

6. Sources of Irrigation for Agriculture

Sources	Irrigated area			Canal/ pipe distance	Adequacy	If inadequate Reasons
	Year round	Summer	Winter			
Surface irrigation						
Shallow Tube well						
Deep Tube well						
If any other, specify						

7. Do you use fertilizer? Yes / No

8.1 If yes, which types of fertilizer do you use?

- a) Compost b) Urea/DAP c) Potash d) All e) others

8.2 What factor determined to use fertilizer/pesticides in your lands? (major)

Note: 1 = JTA 2 = Neighbors 3 = Observation at neighbors' farms

4 = Visit to government farms 5 = Radio/FM 6 = TV; and

7 = any others (specify).....

8. Area and production of major crops by irrigation status (*last year and 10 years ago*)

(Area in kattha/bigha and production in kg/quintal)

Crops	Irrigated area				Non irrigated area				Reasons for change (if changed)
	Local seed		Improved seeds		Local seed		Improved seed		
	Area	Production	Area	Production	Area	Production	Area	Production	

Note: Reasons: 1 = Irrigation, 2 = HYV seeds, 3 = Use of manure, 4 = Chemical fertilizers, 5 = Pesticides

6 = Market/road access, 7 = Agricultural innovation, 8 = Agricultural services, 9 = others

9. Area by cropping intensity and irrigation status (in kattha)

Irrigation facility	One crop (Name of crop)	Two crops (Name of crops)	Three crops (Name of crops)
Throughout the year			
Only in rainy season			
Only in winter season			
No irrigation at all			

10. Do you have access to agriculture service center? Yes / No
- 11.1 If yes, How far is it? (in km)
- i) At present a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above
- ii) Ten years ago a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above
11. Do you have service access to JTAs? Yes / No
- 12.1 If yes, when was the last time visit of JTA in your farm?(year)
12. Is there any subsidies given by government to invest in agriculture last year? Y / N
- 13.1 If yes, what is the condition? (kind /cash).....
13. What is the condition of inputs (seeds, fertilizer, pesticides, machineries, labour etc.) availability?
- a) At present: i) Timely (Yes / No) ii) in quantity (Yes / No)
- b) Ten years ago: i) Timely (Yes / No) ii) in quantity (Yes / No)
14. Which method/equipment do you use for land preparation?
- a) At present: i) Machine/tractor ii) animals/plough iii) digging iv) others
- b) Ten years ago: i) Machine/tractor ii) animals/plough iii) digging iv) others
15. Which method/equipment do you use for crop harvesting?
- c) At present: i) Machine/thresher ii) animals iii) labour iv) others
- d) Ten years ago: i) Machine/thresher ii) animals iii) labour iv) others
16. What type of labor do you use in cultivation?
- a) Family member b) relatives c) hired labour d) others
- (If family member: Age..... sex.....and education level.....)

17. Use of agricultural inputs by irrigation status (kg/kattha):

Major crops	Labour (Number)			Manure		Chemical fertilizer				Pesticides	
	M	H	E	Irrigated	Non-irrigated	Urea/DAP		Potash		Irrigated	Non-irrigated
						Irrigated	Non-irrigated	Irrigated	Non-irrigated		
Paddy											
Wheat											
Maize											
Potato											
Sugarcane											
Vegetables											
Fruit /orchards											
Pulses											
Oilseeds											
Others											

(Note: M = Family members, H = Hired and E = Exchange labour)

Remarks (if any):.....

18. How far is your market center? (in km)

- i) At present: a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above
 ii) Ten years ago: a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above

19. Do you have road access in your land? Yes / No

19.1 If yes, which types of Road?

- i) At present: a) Blacktop b) gravel c) earthen d) others
 ii) Ten years ago: a) Blacktop b) gravel c) earthen d) others

19.2 How far is the road? (in km)

- i) At present: a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above
 ii) Ten years ago: a) 0 - 1 b) 1 - 2 c) 2 - 4 d) above

19.3 Food sufficiency by own production (in months)

- i) At present: a) < 3 b) 3-6 c) 6-9 d) 9-12 e) surplus
 ii) Ten years ago: a) < 3 b) 3-6 c) 6-9 d) 9-12 e) surplus

19.3.1 If changed, what are the causes of change?.....

19.3.2 If deficit, how do you manage? (Alternate to agriculture/farming)

19.3.3 If surplus, how do you use?

- a) Exchange with other goods b) store for next year.
- c) Sale in local markets: Place..... d) Others uses (specify).....

19.4 Have you taken loan for investing in agriculture? Yes / No

22.1 If yes, what is the source?

- a) Bank b) merchant c) relatives d) cooperatives e) others

22.2 What is the interest rate? (in percentage).....

20. What are the major problems in farming?

- a) Lack of capital b) labour shortage c) high inputs costs
- d) Low production e) shortage of land f) lack of irrigation water
- g) High transportation cost h) lack of improved seeds i) weeds/diseases
- j) Poor cultivation methods k) storage facility l) poor weather
- m) Agricultural services n) Others...

21. What do you prefer to improve farming and more production?

- a) Cultivate in more land b) Use high value crops(HVCs)
- c) Put more effort into agriculture d) Cultivate different types of crops
- e) Encourage family in farming f) Others...

22. Livestock population (Number by types)

Types	Number		Types	Number	
	Local	Hybrid		Local	Hybrid
Cow			Pig		
Oxen			Chicken/Duck		
She buffalo			Pigeon		
He buffalo			Others (specify)...		
Goat					

27. Investment during last year (in Rs.)

- | | |
|---|---------------------------|
| a) Land purchase..... | b) Land improvements..... |
| c) Irrigation..... | d) House |
| e) Education (abroad)..... | f) Business..... |
| g) Foreign employment..... | h) Cottage industry..... |
| i) Vehicle (Cycle/bike/car/bus/trucks etc...) | j) Loan to others..... |
| k) Others (specify)..... | |

28. What types of house/building do you have?

- a) Tile/Muddy (Kachchi) () b) Cemented (Pakki) () c) others

29. Do you have toilet facility at your home? Yes () No ()

If yes, what types of toilet facility do you have?

- | | |
|------------------------------|----------------------------------|
| a) Cemented/Pakki (attached) | b) Cemented/Pakki (Non-attached) |
| c) Temporary (Kachchi) | d) others |

30. Sources of family income (last year)

Source	Yes/No	Annual income (in Rs)
Crop production		
Fruits		
Vegetables		
Livestock		
Industrial production		
Business (shops)		
Tourism /hotel/ lodge		
Wages/Portage		
Service		
Remittances		
Pensions		
Rent (house and other)		
Sale of forest products		
Other sources.....		

31. Where do you get following forest products?

Forest Products	Government forest	Community forest	Private forest	Leasehold forest	Others
Firewood					
Fodder/grass					
Timber					
Medicinal herbs					
Fruits					
Thatching grass					
Leaf litter					
Others					

32. In your view what are the causes of agricultural land use change?

- a) Population pressure/immigration
- b) Government policy
- c) Market
- d) Road
- e) River
- f) Irrigation
- g) Natural disaster
- h) others

33. What types of changes have you found now than in past 10 years?

.....

- a) Using more intensive farming
- b) using more lands than past
- c) Farming new crops
- d) have enough resource to use technology
- e) Fallow time is becoming shorter
- f) others.....

34. Please give your opinion in the following issues?

a) Impacts of agricultural land use change in land use intensity?

Recently:.....

10 years before:

Issues:

b) Impacts of agricultural land use change in employment?

Recently:.....

10 years before:

Issues:

c) Others.....

35. Use of innovative (change) time line

Name of new varieties introduced

S N	Crops(species)	When first used			10 Years ago		Current	
		Year	Area	Production	Area	Production	Area	Production
1	Paddy.....							
2	Wheat.....							
3								
4								
	Animals(species)	Year	Number		Number		Number	
1								
2								
	Fruits(types)	Year	Number	Production	Number	Production	Number	Production
1								
2								
	Vegetables	Year	Area	Production	Area	Production	Area	Production
1								
2								
	Irrigation/types	Year	Area	Production	Area	Production	Area	Production
1	Surface							
2	Ground							
	Mechanization/tools	Year	Number/hr	Area	Number/hr	Area	Number/hr	Area
1	Tractor(hour/bigha)							
2	Thresher(hours)							
3								
	Use of HYV seeds	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1								
2								
3								
	Chemical fertilizer	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1	Urea							
2	Potash							

3								
	Use of pesticides	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1								
2								
	Labour	Year	Number	wages	Number	wages	Number	wages
1	Own							
2	Hired							
3	Relatives							
4	others							

36. How many numbers of parcels do you have in your total land?

1. 2. 3. 4. 5. 6. 7.

More

Size: Smallest (.....kattha.) Largest (.....kattha.)

Distance: Nearest (.....meters) Farthest (.....meters)

Parcel number (if possible).....

(According to lalpurja provided by district land revenue office)

37. What are the causes of land fragmentations in your area?

1. Population increase
2. Inheritance
3. Infrastructure development
4. Land tenure system
5. Others...(list out):

38. What are the consequences of land fragmentations in your area?

1. Decreasing productivity
2. Increasing use of inputs ((labour, fertilizer and pesticides)
3. Problem for mechanization
4. Others

39. What are your suggestions regarding the well development of agriculture?

.....

Thank you very much for your valuable time!

Annex II

Checklist for Focus Group Discussion (FGD)

Agricultural Land Use Change

1. How long have you been/lived in the area?
2. What crops were grown during your childhood? Or 10 years ago?
3. What new crops have been introduced in recent years and so forth?
4. How do you perceive agricultural intensification?
5. When it was started and why do you believe in intensification?
6. What were the preferred crops for intensification?
7. What area the benefits/drawbacks of intensification?
8. Do you notice any change in socio-economic and water/soil conditions before and after intensification?
9. What sorts of changes are occurring?

- a)
- b)

Area:.....

Crops:.....

Cropping pattern:.....

Cropping intensity:.....

Spatial distribution of change (where?):.....

10. Process of change:

From which crop to which crop?.....

How much?.....

When and how?.....

11. Drivers of change:

What are the causes of changes?

- a.
- b.
- c.

(Population pressure, immigration, Government policy, Market, Road, River, Irrigation, Natural disaster, Agricultural innovation, Agricultural services, others)

12. Management (Current and 10 years before)

Inputs and outputs	How it is changing	Implication to land use change	Benefits	Issues	Remarks
Irrigation					
Machinery use					
Use of seeds					
Chemical fertilizer					
Pesticides					
Labor use					
<i>Production</i>					
<i>Productivity</i>					

Note:.....

13. Impact

a) What types of impacts of agricultural land use change occurring in land use intensity?

Recently:.....

10 years before:

Issues:

b) What types of impacts of agricultural land use change occurring in employment?

Recently:.....

10 years before:

Issues:

c) Are there any impacts of agricultural land use change in food security?

Recently:.....

10 years before:

Issues:

d) Others.....

Issues:.....

14. Linkages of different types of land use.

- Forest – agriculture
- Grazing land – agriculture
- Built-up area – agriculture
- River cutting – agriculture
- and so on.....

Issues:

15. What are the farmers’ most important problems in this district (or this village)?

.....

16. Today what is the amount of forest resources here compared to 10 years ago?

.....

17. Today what is the amount of water resources here compared to 10 years ago?

.....

18. Today what is the condition of access to followings from here compared to 10 years ago?

Road: (at present).....(Ten years before).....

Markets: (at present).....(Ten years before).....

Agricultural service centers: (at present).....(Ten years before).....

1. Use of innovative (change) time line

(Name of new varieties introduced)

S N	Crops(species)	When first used			10 Years ago		Current	
		Year	Area	Production	Area	Production	Area	Production
1	Paddy.....							
2								
3	Wheat.....							
4								
5	Maize.....							
6								
Animals(species)		Year	Number		Number		Number	
1								
2								

	Fruits(types)	Year	Number	Production	Number	Production	Number	Production
1								
2								
	Vegetables	Year	Area	Production	Area	Production	Area	Production
1								
2								
	Irrigation/types	Year	Area	Production	Area	Production	Area	Production
1	Surface							
2	Ground							
	Mechanization/ tools	Year	Number/hr	Area	Number/hr	Area	Number/hr	Area
1	Tractor (hour/bigha)							
2	Thresher(hours)							
3								
	Use of HYV seeds	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1								
2								
	Chemical fertilizer	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1	Urea							
2	Potash							
3								
	Use of pesticides	Year	Quantity used	Area	Quantity used	Area	Quantity used	Area
1								
2								
	Labour	Year	Number	wages	Number	wages	Number	wages
1	Own							
2	Hired							
3	Relatives							
4	others							

Annex III

Checklist for Key Informant Interview (KII)

Agricultural Land Use Change

1. What sorts of changes are occurring?
 - a)
 - b)
 - c)

Area:.....

Crops:.....

Cropping pattern:.....

Cropping intensity:.....

Spatial distribution of change (where?):.....

(To be plot on map if applicable)

2. What are the major problems of land use change?
 - a)
 - b)
 - c)

3. How it is changing? (Process of change) :
 - From which crop to which crop?.....
 - How much?.....
 - When and how?.....

4. What are the causes/ drivers of agricultural land use change?
 - a)
 - b)
 - c)

(Population pressure, immigration, Government policy, Market, Road, River, Irrigation, Natural disaster, Agricultural innovation, Agricultural services, others)

5. What are the socio-economic impacts of agricultural land use change in your surrounding?
 - a)
 - b)
 - c)

6. Have you observed the change in parcel number now than before (ten years)?

Yes.....No.....(If yes.....Q7)

7. What are the causes of land fragmentations in your area?

- Population increase
- Inheritance
- Infrastructure development
- Land tenure system
- Others...(list out):

- a)
- b)
- c)

8. What are the consequences of land fragmentations in your area?

- Decreasing productivity
- Increasing use of inputs ((labour, fertilizer and pesticides)
- Problem for mechanization
- Others

- a)
- b)
- c)

20. How long have you been/lived in the area?

21. What crops were grown during your childhood? Or 10 years ago?

22. What new crops have been introduced in recent years and so forth?

23. How do you perceive agricultural intensification?

24. When it was started and why do you believe in intensification?

25. What were the preferred crops for intensification?

26. What area the benefits/drawbacks of intensification?

27. Do you notice any change in socio-economic and water/soil conditions before and after intensification?

.....

Thank you very much for your valuable time!

Annex IV

Development of Road Network in Nawalparasi district

Type of road (distance in km)	2001	Road Density	2015	Road Density	Change
Black topped	129	0.060	302.11	0.140	0.080
Gravel	573	0.265	918.31	0.425	0.160
Earthen	662.2	0.306	681.75	0.315	0.009
Total	1364.2	0.631	1902.2	0.880	0.249

Source: DTMP, Nawalparasi, 2001 & District Profile, DDC, 2015

Annex V

Demographic Characteristics of Respondents

SN	Sex	FGD		KII		Household's Head	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
1	Male	77	61.1	11	73.3	70	75.3
2	Female	49	38.9	4	26.7	23	24.7
Total		126	100.0	15	100.0	93	100.0
SN	Age group						
1	15-49	67	53.2	9	60.0	49	52.3
2	50-59	53	42.1	4	26.7	32	34.4
3	Above 59	6	4.8	2	13.3	12	13.3
Total		126	100.0	15	100.0	93	100.0
SN	Education level						
1	Illiterate	17	13.5	2	13.3	12	13.1
2	Primary(1-7)	20	15.9	4	26.7	33	35.7
3	Secondary(8-10)	47	37.3	2	13.3	21	22.9
4	SLC and above	31	24.6	4	26.7	23	24.2
5	Others	11	8.7	3	20.0	4	4.0
Total		126	100.0	15	100.0	93	100.0
SN	Primary Occupations						
1	Agriculture	49	38.9	8	53.3	46	49.1
2	Agri+ Business	21	16.7	3	20.0	6	6.2
3	Agri+ Services	39	31.0	2	13.3	32	34.0
4	Others	17	13.5	2	13.3	10	10.7
Total		126	100.0	15	100.0	93	100.0

Annex VI

Mean Monthly Maximum, Minimum, Average Temperature (in °C) and Mean Monthly Precipitation (in mm) recorded at Semari, Nawalparasi District (2002-2011)

Months	Minimum temperature	Maximum temperature	Average temperature	Precipitation
January	7.9	20.5	14.2	22.95
February	11.6	25.2	18.4	17.90
March	15.2	31.4	23.3	13.60
April	21.2	36.6	28.9	44.95
May	23.4	37.5	30.5	164.36
June	25.2	37.7	31.5	217.61
July	24.4	35.0	29.7	611.35
August	24.4	34.7	29.6	605.40
September	23.7	33.9	28.8	210.00
October	19.7	31.9	25.8	89.90
November	13.9	27.6	20.8	4.70
December	9.5	22.8	16.2	6.00
Annual	18.34	31.23	24.81	167.39

Source: Department of Hydrology and Meteorology (DHM), 2016

Annex VII

Migration Status in the Study Sites

Place of origin	Number of households				Percent
	Jahada	Palhi	Ramnagar	Total	
Syangja	5	0	18	23	39.0
Parbat	7	0	6	13	22.0
Kaski	5	0	0	5	8.5
Baglung	2	0	2	4	6.8
Palpa	5	0	1	6	10.2
Gulmi	4	0	1	5	8.5
Arghakhanchi	1	0	0	1	1.7
Rupandehi	0	0	1	1	1.7
Dhading	1	0	0	1	1.7
Native	1	31	2	34	36.6
Total	31	31	31	93	

Source: Field Survey, 2015/16

Annex VIII

Land Cover Condition in the Study VDCs

Study area	Land cover class	1958		1994		2009	
		Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent
Jahada	Cultivated land	793.07	55.3	1322.71	92.3	967.43	67.5
	Forest area	505.04	35.2	15.31	1.1	38.72	2.7
	Bush/Shrub area	78.55	5.5	0.00	0.0	74.99	5.2
	Builtup area	12.64	0.9	55.11	3.8	287.00	20.0
	Waterbodies	6.23	0.4	0.30	0.0	42.09	2.9
	Sandy area	0.00	0.0	0.93	0.1	14.52	1.0
	Barren land	37.92	2.6	39.09	2.7	8.7	0.6
	Total	1433.45	100.0	1433.45	100.0	1433.45	100.0
Palhi	Cultivated land	542.78	84.6	567.43	88.4	506.04	78.8
	Forest area	0.00	0.0	2.32	0.4	8.80	1.4
	Bush/Shrub area	18.29	2.8	0.00	0.0	13.22	2.1
	Builtup area	31.21	4.9	17.32	2.7	91.67	14.3
	Waterbodies	6.67	1.0	12.45	1.9	20.37	3.2
	Barren land	42.84	6.7	42.27	6.6	1.70	0.3
	Total	641.79	100.0	641.79	100.0	641.79	100.0
Ramnagar	Cultivated land	1276.05	43.3	1721.49	58.4	1612.50	54.7
	Forest area	1398.58	47.5	877.00	29.8	468.65	15.9
	Bush/Shrub area	95.41	3.2	0.00	0.0	436.71	14.8
	Builtup area	29.64	1.0	60.54	2.1	214.21	7.3
	Waterbodies	90.41	3.1	51.50	1.7	110.29	3.7
	Sandy area	56.91	1.9	211.20	7.2	63.53	2.2
	Barren land	0.00	0.0	25.26	0.9	40.96	1.4
	Total	2947.00	100.0	2947.00	100.0	2946.84	100.0

Source: Topographic Map, Surveyor General of India (1958), Topographic Map, DoS, GoN (1994) and Satellite images, World View-2 (2009)

Annex IX

Changing Trends of Cropping Intensity (in percent)

Study Sites	2005/06	2015/16
Jahada	160	141
Palhi	178	193
Ramnagar	162	226
Average	167	187

Source: Calculated from Field Survey Data

Annex X
List of Respondents (Household Survey)

48	Indira Pandey	Ramnagar	5	60	F	Primary(1-7)	Agriculture	2072 Karthik 22
49	Megh Bdr Palani	Ramnagar	5	47	M	Primary(1-7)	Agriculture+Business	2072 Karthik 23
50	Sita Kumwar	Ramnagar	5	60	F	Illiterate	Agriculture	2072 Karthik 23
51	Himadri Bhattachari	Ramnagar	5	44	M	Illiterate	Agriculture	2072 Karthik 23
52	Khem Prd Laxmichand	Ramnagar	5	68	M	Illiterate	Agriculture	2072 Karthik 23
53	Hem Narayan Chandhari	Ramnagar	5	44	M	Higher (SLC & above)	Agriculture	2072 Karthik 23
54	Dadlikala Bhattachari	Ramnagar	5	65	F	Illiterate	Agriculture	2072 Karthik 23
55	Sanswati Subedi	Ramnagar	5	54	F	Secondary(8-10)	Foreign Service	2072 Karthik 24
56	Haimanya Ram	Ramnagar	5	64	F	Secondary(8-10)	Agriculture+Business	2072 Karthik 24
57	Purna Bdr Thapa	Ramnagar	5	61	M	Secondary(8-10)	Agriculture+Business	2072 Karthik 24
58	Tara Bdr Ram	Ramnagar	5	66	M	Illiterate	Agriculture	2072 Karthik 24
59	Khem Prd Chapagain	Ramnagar	5	43	M	Primary(1-7)	Agriculture	2072 Karthik 24
60	Atanaram Acharya	Ramnagar	5	60	M	Illiterate	Agriculture	2072 Karthik 25
61	Padam Bdr Kumwar	Ramnagar	5	39	M	Secondary(8-10)	Agriculture	2072 Karthik 25
62	Chandri Bhawal Datta	Ramnagar	5	48	M	Primary(1-7)	Agriculture	2072 Karthik 25
63	Gopal Prd Misra	Palhi	9	67	M	Primary(1-7)	Agriculture	2072 Falgun 21
64	Madan Prd Harjan	Palhi	9	72	M	Secondary(8-10)	Agriculture	2072 Falgun 21
65	Mahesh Tharu	Palhi	9	62	M	Primary(1-7)	Agriculture	2072 Falgun 21
66	Mira Dhandi	Palhi	9	68	F	Illiterate	Agriculture	2072 Falgun 21
67	Shrawda Pasi	Palhi	9	32	F	Illiterate	Agriculture	2072 Falgun 22
68	Mansuri Pasi	Palhi	9	35	F	Illiterate	Agriculture	2072 Falgun 22
69	Gyanwati Paswan	Palhi	9	29	F	Primary(1-7)	Foreign Service	2072 Falgun 22
70	Rajkumar Sumer	Palhi	9	41	M	Primary(1-7)	Agriculture	2072 Falgun 22
71	Kanti Harjan	Palhi	5	69	F	Illiterate	Agriculture	2072 Falgun 22
72	Sayada Nisu Pathan	Palhi	4	35	F	Illiterate	Agriculture	2072 Falgun 22
73	Ramesh Pathanwar	Palhi	5	66	M	Primary(1-7)	Agriculture	2072 Falgun 23
74	Wajid Ali Pathan	Palhi	5	43	M	Primary(1-7)	Agriculture	2072 Falgun 23
75	Suprem Barai	Palhi	5	61	F	Primary(1-7)	Agriculture	2072 Falgun 23
76	Kishor Koiri	Palhi	9	41	M	Secondary(8-10)	Agriculture	2072 Falgun 23
77	Rajendra Koiri	Palhi	9	45	M	Illiterate	Agriculture	2072 Falgun 24
78	Mann Koiri	Palhi	9	64	F	Illiterate	Agriculture	2072 Falgun 24
79	Bansdev Thapa	Palhi	9	67	M	Secondary(8-10)	Agriculture	2072 Falgun 24
80	Ram Bhurosh Kucala	Palhi	9	55	M	Secondary(8-10)	Agriculture	2072 Falgun 24
81	Rishi Raj Chandhari	Palhi	9	52	M	Secondary(8-10)	Agriculture	2072 Falgun 24
82	Nabin Prd Chandhari	Palhi	9	42	M	Secondary(8-10)	Foreign Service	2072 Falgun 24
83	Sunil Chandhari	Palhi	9	46	M	Higher (SLC & above)	Service	2072 Falgun 25
84	Nann Prd Chandhari	Palhi	9	65	M	Primary(1-7)	Agriculture+Business	2072 Falgun 25
85	Dipendra Prd Chandhari	Palhi	9	56	M	Illiterate	Agriculture	2072 Falgun 25
86	Kishor Prd Tharu	Palhi	9	67	M	Primary(1-7)	Agriculture	2072 Falgun 25
87	Mira Chandhari	Palhi	9	42	F	Secondary(8-10)	Agriculture	2072 Falgun 26
88	Pratap Prd Chandhari	Palhi	9	66	M	Primary(1-7)	Agriculture	2072 Falgun 26
89	Narayan Prd Chandhari	Palhi	9	71	M	Primary(1-7)	Agriculture	2072 Falgun 26
90	Ash Narayan Yadav	Palhi	9	35	M	Secondary(8-10)	Agriculture	2072 Falgun 27
91	Chhotelal Yadav	Palhi	9	61	M	Secondary(8-10)	Agriculture	2072 Falgun 27
92	Jahir Thakur	Palhi	9	66	M	Illiterate	Agriculture	2072 Falgun 27
93	Swarna Kumar Kurmi	Palhi	9	43	M	Primary(1-7)	Agriculture	2072 Falgun 27

Annex XI
List of Key Informants (KII Survey)

SN	Name of Respondent	VDCs	Ward	Age	Sex	Education	Main Occupation	Date of Consultation
1	Ganesh Kumar Prudel	Jalsoda	3	52	M	Higher (SLC & above)	Agriculture + Service	2072 Kartik 10
2	Gita Bhundari	Jalsoda	3	39	F	Secondary (8-10)	Agriculture	2072 Kartik 11
3	Hari Prasad Sharma	Jalsoda	3	51	M	Others	Agriculture	2072 Kartik 11
4	Khem Narayan Tamrakar	Jalsoda	3	44	M	Primary (1-7)	Agriculture	2072 Kartik 12
5	Bhagirath Chappagan	Jalsoda	3	31	M	Secondary (8-10)	Agriculture+Business	2072 Kartik 15
6	Laxmi BK	Ramnagar	5	33	F	Higher (SLC & above)	Others	2072 Kartik 18
7	Jaylal Pandey	Ramnagar	5	65	M	Illiterate	Agriculture	2072 Kartik 19
8	Khemal Lamichhane	Ramnagar	5	41	M	Primary (1-7)	Agriculture	2072 Kartik 22
9	Durga Bhantel	Ramnagar	5	37	F	Illiterate	Others	2072 Kartik 23
10	Pharwanan Neupane	Ramnagar	5	58	M	Others	Agriculture+Business	2072 Kartik 26
11	Hem Narayan Chandhari	Ramnagar	5	67	M	Primary (1-7)	Agriculture	2072 Kartik 26
12	Jayanti Das Patel	Palla	9	55	F	Others	Agriculture	2072 Falgun 28
13	Ankit Giri	Palla	9	34	M	Higher (SLC & above)	Agriculture + Service	2072 Falgun 28
14	Nandlal Kumar	Palla	9	47	M	Higher (SLC & above)	Agriculture + Service	2072 Falgun 29
15	Shamardan BK	Palla	9	44	M	Primary (1-7)	Agriculture+Business	2072 Falgun 29

Annex XII
Field Survey Scenarios



Plate 1: Questionnaire Survey in Jahada



Plate 2: Questionnaire Survey in Ramnagar



Plate 3: Questionnaire Survey in Palhi



Plate 4: Questionnaire Survey in Jahada



Plate 5: KI Interview in Ramnagar



Plate 6: High Yield Variety of Wheat (*Gautam*) Cultivation in Palhi



Plate 7: Diversified Cropping (Vegetable, Pulses and Wheat) Practice in Palhi



Plate 8: Bee Keeping Practice in Jahada



Plate 9: Inter Cropping Practice in Palhi



Plate 10: Vegetable (Onion) Gardening in Palhi

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