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SPATIAL STRUCTURE, TRANSFORMATION AND PERFORMANCE OF AGRICULTURE UNDER DIFFERENT IRRIGATION SYSTEM

(A Case Study of Balaha Village, Sunsari District, Nepal)

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RECOMMENDATION LETTER

This is to certify that the Dissertation submitted by **Mr. Upendra Dawadi** entitled **"Spatial Structure, Transformation and Performance of Agriculture under Different Irrigation System (A Case Study of Balaha Village, Sunsari District, Nepal)"** has been prepared under my supervision for partial fulfillment of the requirements for the Master's Degree in Geography. I recommend this dissertation to the evaluation committee for examination.

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APPROVAL SHEET

The Dissertation entitled **"Spatial Structure, Transformation and Performance of Agriculture under Different Irrigation System (A Case Study of Balaha Village, Sunsari District, Nepal)"** submitted by **Mr. Upendra Dawadi** has been accepted as a Partial Fulfillment of the Requirements of the Degree of Master of Arts in Geography.

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Abstract

This paper examines the spatial structure, transformation and performance of agriculture under different irrigation system (1985 – 2011) in Balaha village, Inaruwa Municipality, Sunsari District. It analyzes the change in cropping pattern and cropping intensity in rainfed and irrigated agriculture systems with reference to the impact of climate change on agriculture and farmers decision making process on agricultural land use. To fulfill the objectives, field visit was conducted on January 20th to February 19th 2011. Farmer practices the traditional subsistence agricultural system and focus mainly on cereal crops production. A sign of climate change is prevailing in study area and is affecting agricultural production. However, the availability of improved seeds, irrigation and maximum use of chemical fertilizer has increased the crop yield. Farmer have begin to practice modern agro-machinery like thresher, tillage by tractors and other agro-tools but insufficient irrigation facilities and labour shortage is problem in Balaha village. But the yield of crops is higher than national level. Regression of cropping intensity vs plot size reveals a weak positive relationship between the cropping intensity and plot size. Chi-square (χ^2) test on cropping intensity according to land ownership type/irrigation zone shows there is a significant difference in cropping intensity according to land ownership type/irrigation zone. Farmers' decision on agricultural land use is influenced by socio-economic and geo-physical conditions of the study area. Factors such as farm size, farm's spatial location, market and input related concerns seems more decisive for farmers' actual choice of crop type in the study area. Similarly, the distance from house to farm also affects the use of inputs, cropping intensity, cropping pattern and the protection of crop. A lack economic development and some other anomalies at policy maker's level are major hindrance for the development of commercial agriculture in the study area.

Key word: *agricultural land use change, cropping pattern, cropping intensity, rainfed and irrigated system, climate change, farmers' decision making process, yield*

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Abbreviation and Acronyms

AIC:	Agricultural Input Corporation
APO:	Asian Productivity Organization
APP:	Agricultural Perspective Plan
APROSC:	Agricultural Project Service Center
CBS:	Central Bureau of Statistics
CSRC:	Community Self Reliance Centre
FAO:	Food and Agricultural Organization
GDP:	Gross Domestic Product
GIS: -	Geographic Information System
GON:	Government of Nepal
Ha:	Hectare
HYV:	High Yield Variety
ICIMOD:	International Centre for Integrated Mountain Development
IWMI:	International Water Management Institute
INGO:	International Non-governmental Organizations
MAB:	Man and Biosphere
MOAC:	Ministry of Agriculture and Cooperatives
MOE:	Ministry of Environment
MOF:	Ministry of Finance
MOPE:	Ministry of Population and Environment
Mt:	Metric Tons
NGO:	Non-governmental Organizations
NGIIP:	National Geographic Information Infrastructure Project
NPC:	National Planning Commission
NSCA:	National Sample Census of Agriculture
PRA:	Participatory Respondent Appraisal
Rs:	Rupees
SMIDB:	Sunsari Morang Irrigation Development Board

SMIP:	Sunsari Morang Irrigation Project
SPSS:	Statistical Package for Social Science
UN:	United Nations
UNDP:	United Nation Development Programme
UNFCCC:	United Nations Framework Convention on Climate Change
USAID:	United State Agency for International Development
VDC:	Village Development Committee
WB:	World Bank

Glossary

Abbal:	Land in the first category in administrative classification.
Bari:	Un-irrigated land
Bigha:	A unit for measuring land (one Bigha equals 0.68 hectare)
Dhur:	A unit for measuring land (20 Dhur equals one Kattha)
Doyam:	Land in the Second category in administrative classification.
Goraha:	Manure bricked
Guthi:	Land which is own by a group of community or institutions like temple, school etc.
Kattha:	A unit for measuring land (20 Kattha equals 0.68 hectare)
Khet:	Irrigated land (Generally paddy land)
Kola:	Land plot
Maan:	Measuring unit (one Maan equals 40 kg)
Paini:	Traditional canal

Chapter I
INTRODUCTION

1.1 Background of the Study

Land is a basic natural resource to human being. It is the most important natural resources which provides basis for other abiotic and biotic natural resources such as soil, water, flora and fauna. Land plays a vital role to determine the economic, social and cultural progress of the human beings.

Land use implies the manner in which human beings employ the land and its resources. It deals with the spatial aspect of all human activities on land. Land use can be categories into cultivated land, forest, grazing land, barren land, urban land etc.

Land use refers to the land which is used for specific purpose with some sorts of management practices. And the change of land use is the shift in the intent and management practices or the use pattern. It covers the change in input both in frequency and quantity. Land use change clearly indicates the existing condition of the land and changing trend / condition.

Land resources are limited and finite. If human populations continue to increase at present rate there will be twice as many people in the world in about 60 years. There is therefore an increasingly urgent need to manage land cover and land uses in the most rational way possible, in order to maximize sustainable production and satisfy the diverse needs of society while at the same time conserving fragile ecosystems and our genetic heritage (FAO, 2003).

Land use / land cover in an area is the cumulative outcome of historical events, the interaction of economic forces with the natural resources available in the environment and the value of society. Man has been using land for one purpose or another from time immemorial and the systematization of knowledge relating to land use data as far back as the imposition of taxes on land according to its use and quality (Singh and Dillon, 1995).

The concept of changing land use pattern is often considered a holistic approach of the land surface which is related to the use of land in a certain region of a certain time. It is a kind of permanent or temporary phenomenon to satisfy the human needs either material or spirituals or both. Moreover it is an applicable method of human controls in a systematic manner within any ecosystem (Vink, 1975).

The pattern of land use and land cover is influenced by two main factors – physical and human. Physical factors include topography, climate, and soil which set the broad limit upon the capabilities of land. And human factors include density of population, occupation of people, level of technology and socio-economic institutions. These factors determine the extent to which the physical capacity of the land is utilized (Kumar, 1986). Even though the most important aspect of land use in relation to man and his livelihood, man has played an important role in modifying the land cover / land use pattern.

Land use pattern is a dynamic phenomenon because it changes with time as well as geographical unit. Generally, the time and geographical unit is dominated by physical and infrastructural environment. In the recent years the land use pattern is also changed due to the government policy and technological development (Chauhan, 1966).

Agriculture land use implies land under net sown area, fallow land excluding uncultivable land. The cultivated area is called net sown area, which is also known as agriculture land. In short, agriculture land-use means a cropping pattern. Cropping pattern represents the proportion of area under various crops (or spatial arrangement of crops and fallow on a given area) at a point of time or yearly sequence.

Cropping pattern is a dynamic concept as it changes over space and time. The cropping pattern of a region is closely influenced by the geo-climatic, socio-cultural, economic, historical and political factors. The agriculture land use is the result of the direct application of efforts applied and is related to decisions made by farmer regarding the actual use of land. These decisions are based on his appreciation of the available land resources, his response to these resources as conditioned by the knowledge passed from generation to generation and his appreciation of demand for various agriculture commodities in the

market. The cumulative effect of farmer's decision regarding the choice of crops, the method of tillage and his appreciation of the land resources is reflected in the spatial as well as temporal variation in agriculture land use (Todkari et al, 2010).

Cropping systems of a region are decided by and large, by a number of soil and climatic parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crop or set of crops for cultivation. Nevertheless, at farmers' level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop/cropping system. These decisions with respect to choice of crops and cropping systems are further narrowed down under influence of several other forces related to infrastructure facilities, socio-economic factors and technological developments, all operating interactively at micro-level (Das, 2002).

Cropping system vary greatly in Nepal. The cropping systems adopted by farmers are decided by the climatic, physiographic and socioeconomic factors. These factors include altitudes, rainfall and temperatures, irrigation and transport facilities, turn-around period between two crops, labour availability, input-output prices & the ethno-social behavior of the farmers. Agriculture in Nepal is mostly subsistence in nature and household food security is the major factor determining the crop choices (Shrestha, 2004).

Recent developments in infrastructure and adoption of modern technology, particularly in the Terai region, have contributed to the change in agricultural land use. Besides other factors, the malaria eradication programme of 1950's is also responsible for the land use change, which made possible to inhabit and practice agriculture in the low lying areas of river basins and flood plains. Cropping pattern and use of agricultural land have changed over time and space in Terai and lower river valleys as a result of change in settlement pattern, population size, road network, irrigation facilities, market for input and output. Moreover, recent climate change is also responsible and it has several consequences.

Land use management and sustainable agriculture is today's burning issues. Land is basic resource of the country like Nepal where one of the major uses of land is for agriculture. Agriculture is the basic source for the economic uplift of the country. It is most important

sector in terms of income and employment generation. More than 65 percent of the economically active people are engaged in agricultural activities (CBS, 2001), 39.3 percent of gross domestic product (GDP) depends on it (CBS, 2001). It also provides necessary raw materials to most of the agro based industries in the country.

Land use play vital role in determining of man's economic, social and cultural development and it is important for men's existence. Proper utilization of land is essential to sustainable agricultural production and economic development. The growing industrialization and improvement in technology reduces men's dependency on land whereas increasing economic progress, infrastructural buildings, railways, road etc lead to excessive encroachment of agricultural land. Since the Land use change is directly related with the man's economic, social and cultural progress, the land use change encompasses the greatest environmental concerns of human populations today, including climate change, biodiversity loss and the pollution of water, soil and air. Monitoring and mediating the negative consequence of land use and land cover while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world. It is in this context that this study is purposed.

1.2 Statement of Problem

Agriculture is the backbone of Nepal's economy. It provides a livelihood for the majority of the population, employing four-fifths of the total labour force and accounting for over 80% of the export sector (NESAC, 1998). The agricultural sector contributes 34.9% of the county's GDP (MOF, 2010/11).

Nepalese agriculture has been confronting low return depriving farmers from their improvement in livelihood. Although the eastern Terai belt is regarded as the most fertile and productive region, the crop yield per hectare is not as high as attainable (MOF, 2010/11). In most of the areas agriculture practice is still handicapped by uncertain rain fed irrigation, timely unavailability of HYV seed and chemical fertilizer, poor crop-protection measure, traditional agricultural practice and conventional agri-instruments, meager technological knowledge and underdeveloped agri-market.

In recent year a notable change in agricultural land use has occurred in Terai region. Excessive growth of population has forced the people to cultivate on the marginal lands. Likewise, encroachment of forest area for agricultural activities and changing use of fertile land into residential area has disturbed the ecological balance badly, hence resulted into the adverse effect on the environment like land degradation, extinction of bio-diversities, climate change etc. Similarly the lack of proper planning and management, unscientific agricultural practices and fragmentation of land holding into small size has further worsened the problems.

Today the major challenge is to increase the production level or productivity by managing land types and land uses in the most rational way possible, to maximize sustainable production and satisfy the diverse needs of society while at the same time conserving fragile ecosystems and our genetic heritage. This could be achieved if and only if; we succeeded in cultivating the appropriate crops with proper use of inputs and employing adequate cropping patterns.

The farmers' perception about chemical fertilizers, pesticides and its proper use is another important issue in the rational use of land resources. The way they use these agro-chemicals will affect the soil fertility, crop yields, and the environment.

Thus the changing pattern and overall aspect of agriculture is of first concern for the researcher, planners and the people. Various relevant national issues in this context are - how rapid population growth contributed for the agricultural land use change? How the physical phenomenon plays the role for agricultural land use change? How infrastructural development play role for agricultural land use change etc.

For the formulation of effective land management plan and implementation of sustainable agriculture it is essential to understand the pattern of past and present agriculture land use, its changing factors and consequence. This study attempts to answer the following research questions;

- What are the existing agricultural land use patterns and irrigation status?
- How the agriculture land is structured in terms of type, ownership and distance?

- How the agricultural land use pattern of the study area has been changed?
- How agriculture is diversified in terms of crop type, intensity and diversity?
- What are the types and magnitude of agricultural inputs used?
- What is the level of performance in terms of productivity with focus on climate change?
- What are the responsible factors for changing agricultural land use pattern?

1.3 Objective of the Study

The overall objective is to study comprehensive temporal and spatial information related to the change in agriculture. The Specific objectives are as follows;

- To discuss the current major agriculture land use
- To trace out the temporal and spatial changes in agricultural land use
- To analyse the cropping patterns, cropping intensity, productivity, agricultural inputs use and returns
- To examine the impact of climate change on agriculture

1.4 Significance of the Study

The Nepalese economy is characterized by a dominant agricultural sector. Agricultural productivity is a prevalent issue in Nepal with the agricultural sector struggling to keep pace with ever increasing demands.

Terai region (including the Inner Terai) covers 70 percent of the total agricultural land of country and 44.43 percent of the total population (CBS 2001). Terai region is regarded as food grains store of the country, however the yields per hectare is differ greatly from place to place. The low return from agriculture has deprived the improvement in livelihood of farmers.

This study of spatial structure, transformation and performance of agriculture under different irrigation system not only delineate the existing land use classification and agricultural activities but also indicates the trend of agricultural land use change, their

causes and consequences. Previously much study has been done focusing only on household level information ignoring the spatial location of plot and changes at plot level. But this study tries to analyse the different type and quantity of inputs used in agriculture crops and its effects in output within the individual parcel. This research consists of both rainfed and irrigated area of Terai region to demonstrate a role of irrigation in crop production and cropping intensity. These issues are very relevant, rational and important and the results would help to formulate appropriate policies for achieving sustainable agriculture in Nepal.

1.5 Organization of the study

This study has been organized into nine different chapters. The first chapter contains background information where the subject is introduced, problem is stated and the objectives of the study have been presented. Besides, the significance and the limitation of the study are also discussed.

The second chapter is focused on review of the available literature. The literature consists of books, study reports, journals, seminar papers relating to the land use change and it is divided in theoretical prospective and review of empirical studies.

The third chapter contains research methodology adopted in this study. In this chapter, a brief description about the research design, nature and sources of data, sampling procedure, technique of data collection and method of spatial data analysis are given.

Chapter four provides an introduction to the study area. The bio-physical, socio-economic and spatial setting of the study area is described. A brief account of the present agricultural situation and local people's perceptions about climate change and its impact on agriculture on the study area has been given and the interrelationship between agriculture and environment has been discussed. Likewise, socio-economic condition of the people living in the study area is discussed on the basis of population density, education and occupation, food sufficiency, house type, location and function of market, development of transport and communication in that area.

In fifth chapter farm, crop and cropping pattern of the study area is discussed. It describes about the different categories of cultivated land according to different land type and their distribution, land holding size, status of land ownership, plot's spatial location. Likewise, a description about cropping pattern, crop calendar and cropping intensity of the study area has been made.

Chapter six focuses on change in agriculture land use of the study area during 1985 and 2010. The different crops grown in the study area, inputs used by plots, productivity and returns are discussed in this chapter. Ranking of economically most efficient crop is done and the productivity of different crops and its determinants has been analyzed. Similarly, a description of agriculture-related problems and their prioritization has been made. Besides, the process and the perception of farmer's decision making on agriculture land use pattern on the study area have been discussed.

Finally in chapter seven, the summary of the whole study along with major conclusions are presented. On the basis of conclusions the recommendations have been made.

Chapter II

LITERATURE REVIEW

Agricultural land use change is outcome of the farmer's decision making which is influenced by numerous bio-physical and socio-economic factors in any place and any time. Various studies have been made in the context of different aspects of land use change by different scholars. Some of the relevant studies are mention ahead.

2.1 Agriculture and its Contribution

Agriculture still comprises a significant share of overall growth and household income, and provides essential food security, in many of the poorest countries. Improved agricultural performance can lead to dramatic improvements in the incomes of the poor, provide affordable food, and spur structural transformation (World Bank, 2009). Agriculture in the 21st century faces multiple challenges: it has to produce more food and fiber to feed a growing population with a smaller rural labour force, more feedstock's for a potentially huge bio-energy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more efficient and sustainable production methods and adapt to climate change (FAO, 2009).

The utilization of agricultural land is related to the time and geographical units which are dominated by physical and infrastructure as well as soil, altitude, slope, human agricultural inputs etc (Chauhan, 1966). Since the emergence of agriculture farmers have developed techniques to overcome the biological and physical constraints that climate and land pose for the production of crops, including irrigation, land terracing and fertilization. Despite these agricultural management practices, crops remain ultimately dependent on ecological conditions, such as the intra-seasonal distribution of precipitation and temperature, soil fertility and length of growing season (Cramer & Solomon, 1993).

The sustainable development in agriculture is a global key issue. The five major issues for sustainable development in agricultural production system are - policy and management, energy and inputs, genetic resources, climate, soil and water (Bassam, 1999). The

application of these key elements contributes to long term economic growth under condition, which are acceptable for crop production and environmentally sound and economically viable.

Rainfed systems dominate world food production, but the uses of water in rainfed agriculture have been neglected over the past 50 years. Upgrading rainfed agriculture promises large social, economic, and environmental paybacks, particularly in poverty reduction and economic development. Rainfed farming covers most of the world's cropland (80%) and produces most of the world's cereal grains (more than 60%), generating livelihoods in rural areas and producing food for cities (IWMI, 2007). Despite large strides made in improving productivity and environmental conditions in many developing countries, a great number of poor families in Africa and Asia still face poverty, hunger, food insecurity and malnutrition where rainfed agriculture is the main agricultural activity (Wani et al, 2009).

There is an immense importance of rainfed agriculture in Nepal. Agriculture is the backbone of the Nepalese economy and rainfed areas comprise 71 percent of the total cultivated land. The major share of agricultural production comes from rainfed land. So priority should be given to efficient rainwater management and integrated nutrient supply system in rainfed areas and appropriate technology should be developed for sustainable agricultural development (Pandey, 1997).

Nepalese agriculture is one of small family farms that is mainly subsistence oriented and yet not capable of supporting the adequate subsistence of the farm families. Agriculture production is heavily inclined to food grains production, paddy being the pervasively cultivated crop. However, the food self sufficiency is not ensured. The sector performance records a virtual stagnation with 2.7 to 2.8 percent average annual growth rates during past two decades (Karkee, 2008). Poor performance of Nepalese agriculture reflects two underlying problems. The first is that there is little arable land that is not presently farmed, so the any expansion of cultivated area is either at the expense of forest (which is inherently unsustainable) or onto marginal lands with inherently low production potential. The result is

reducing average farm size and increasing fragmentation, leading to growing poverty. The second problem is that agricultural productivity is low (FAO/UNDP, 2003).

Historically agriculture land has been unequally shared - with 40% of agricultural households accessing only 9 percent of the total agricultural land and owning less than 0.5 ha per household; while 6 percent controls more than 33 percent of the total agriculture land available in Nepal (Buchy and Sapkota, 2010). In the Tarai typically a small farmer owns a bit more than 0.33 ha of land, which is not sufficient to ensure grain self sufficiency, and he will complement his income through wage work. A medium farmer who owns about 0.66 ha may produce just enough food depending on the land quality. A family with about 2 hectares would be considered as a landlord family and represent a minority in the village. Women do not own land and have to access land through a male relative when in widowhood.

2.2 Structure of Land Use Change

The pace and intensity of land cover change have increased over the past three centuries—and, more particularly, over the last three decades—due to climate change and increasing human activities, including migration, land use conversion, and agricultural intensification (Lambin and Geist, 2006).

The socio-economic factors which have impacts on the change in land use can be examined from different aspects such as, the demand for the product of land, investment on land, the degree of urbanization, the extent of land intensification, the ownership of land, the policies on the usage of land, and the attitude on the protection of land resources. Indirect factors consist of six aspects: changes in demographic, development on technology, growth in economic, political and economic policies, wealth and value orientation. These indirect factors work through the direct factors on the land (Zhang and Wang, 2009).

The study of urban area of Nepal (Madhyapur Thimi Municipality during 1978 to 2008) shows decreasing of agricultural land at the cost of increasing built up area (Bhusal, 2010). Change in land use pattern of Phokhara valley shows the decrease in cultivated land and increase in built-up area due to urbanization process. The barren land is decreasing in the

valley but sandy and gravel land is increasing due to over flooding (Poudel, 2000). Study of land use change and landslide hazard mapping of the Kulekhani watershed area within the 14th year's periods (1978/79 to 1992) shows expansion of agricultural land from forest and grazing land (Chapagain, 1996).

The trend of land use change in Kathmandu valley during 1984 to 1998 has showed significant decline in forest area, remarkable increase in urban area and a slight decline of agricultural area (Koirala, 1999). The growth of urban area in Kathmandu valley during 1970 to 1990 has taken place in an uncontrolled manner and most of the agriculture land is being used for urban purposes. The agriculture and forest land have decreased by 40 percent and 13 percent respectively (Pradhan, 2004).

Many socioeconomic and political factors are involved in the change of land use pattern which make land use unsustainable. The two major factors namely – human factors and physical factors are directly responsible for bringing change in land use pattern (Shrestha, 1997). Human factors: density of population, occupation of people, the technological development and socioeconomic institutes determine the extent to which physical capacity of land is utilized and physical factors: topography, soil and climate will set the broad limit upon the capability of land area. The consequences of decrease in agriculture land and forest land implies the increase in the number of non-farm agricultural occupation.

Nepal also has been following the problem due to migration from rural to urban centres like other developing countries of the world. The problem exerted a heavy pressure on the fertile land at the peripherals of city areas and caused changes in cropping systems in these areas (Ranjit, 1983). The effect of the eradication of malaria has encouraged migrants from the Hill to Terai which ultimately changed the land use pattern. The increasing population pressure and technological improvement are the major contributing factor to the land use change (Shrestha, 1986). Beginning of the 20th century, between 1950 and 2000 farmland expansion occurred all across the range, with the greatest increase being recorded in Nepal's lowland Terai region. The increase in Terai farmland is due to the rapid migration of people onto the lowlands, which begins in the 1960s when Nepal initiated a malaria eradication programme and introduced a planned resettlement scheme. This policy shifted

population density from the crowed hill areas onto the unsettle plains, resulting in significant new pressure on the Terai lands.

The highly increasing trend of change in built up area delineate the necessity of the introduction of appropriate regulation regarding land management and proper implementation of land use policy and amendment of the existing laws, rules and regulation (Bhusal, 2010). The designation of municipality's extension facilities establishment of government offices and links of highways with the Kathmandu Valley and Terai brought significant changes in land use pattern in Pokhara Valley. The major causes of land use change are population increase, agricultural development, tourism development, infrastructure development, changing perception of people's living standard, government policies etc (Poudel, 2000). The causes of decreasing forestland are high pressure of population; it is the resources of fuel wood, fodder, timber building materials grazing and more demand of agriculture land (Chapagain, 1996). The reasons for land use change in Kathmandu valley are: the massive in-migration and natural growth in the Kathmandu Valley, main political and administrative centre, Major tourist gateway, cultural and economic hub, considered to have the most advanced infrastructure among urban areas in Nepal (Koirala, 1999). Agriculture also in peri-urban area has been encroached for settlement and built up areas as well as the land value is also skyrocketing (Sapkota, 2005). The study of land use change in Kirtipur shows that the agriculture land has reduced due to government decision to exquisite land for Tribhuvan University and establishment of Horticulture Research Centre have reduced the agriculture land (Manandhar and Shrestha, 1992).

2.3 Agriculture Pattern and Productivity

Study in the Damodar Saraswati Doab area shows that availability of irrigation plays a vital role in crop diversification (Roy, 1972). By developing irrigation scheme and use of high yielding seeds, proper use of manure and fertilizer has augmented agricultural production. The change in socio-economic profile of Nihalgarh village (Harayana, India) is due to mechanization of agriculture, thereby increased the agricultural productivity (Yadav, 1998). The temporal developments in land use efficiency are linked with the modifications, initiated by the man made activities, in rainfall, flood and agronomic hazards. The changes in

agricultural outputs are directly related to the changing socio-economic, cultural and organizational controls, and the rainfall, flood and agronomic hazards. The double or triple cropping is adopted increasingly as a result of the availability of irrigation, technical and organizational facilities (Singh, 1972).

The application of modern agriculture technology has caused to rapidly changing in land use pattern. The improved seeds and improved varieties of crops have brought a considerable increase in yield (Roy, 1970). Cropping systems of a region are decided along with a number of soils and climatic parameters which determine overall agro-ecological setting for nourishment and appropriateness of a crop or set of crops for cultivation. Nevertheless, at farmers' level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop/cropping system (Das, 2002). The decisions with respect to choice of crops and cropping systems are further narrowed down under influence of several other forces related to infrastructure facilities, socio-economic factors and technological developments, all operating interactively at micro-level.

No cropping pattern can be good and ideal for all times because it changes with time, space and emergence of new technology. Cropping pattern depends largely upon the socio-economic practices and differs from macro region to micro region. An efficient cropping pattern must ensure highest efficiency of fertilizer, irrigation and other inputs (Niroula, 1997). The factors affecting the change in cropping patterns in hills and Terai regions are plot size, distance, family size, profit from the crop, and market opportunities (Shrestha, 2009). The variables plot size and distances have negative effect on change in cropping patterns from modern to traditional crops. Profit is the main significant factor of change in crop in Terai.

Agricultural low productivity in Nepal may be due to numerous factors such as depletion of human and financial resources in rural areas, lack of youth interest in farming and traditional methods of cultivation. The measures to improve agriculture sector in Nepal include: land revenue for equality and efficiency; consolidation of land records; facilitating land leasing and contract farming; provision of credit institutions; encouraging land consolidation; discouraging land sub-division; land pricing in capital market; commercial

land for land market; institutional provision; legislative provision for capital market; and simplified tax proposal (Pant and Shrestha, 2003).

2.4 Climate Change and Agriculture

Global change in climate and the agriculture land use change are closely interrelated. Agriculture affects atmosphere by releasing green house gases and get affected in turn, from climate change. Climate change is a phenomenon due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization and industrialization resulting variations in solar energy, temperature and precipitation (Upreti, 1999). Climate change is the present burning issue of the world. It is real threat to the lives in the world that largely affects water resources, agriculture, vegetation and forest, ocean etc. It has long-term effects on food security as well as in human health.

Agriculture is sensitive to short-term changes in weather that effects the production of crops. Weather is an atmospheric condition at the surface timescale from minutes to weeks and has an important impact on agriculture (ICIMOD/UNEP, 2007). Insufficient rain and increasing temperature cause drought, whereas intense rain in short period reduces ground water recharge by accelerating runoff and causes floods. Both the situation induces negative effects in the agriculture (Malla, 2008).

Precipitation is other major parameter of climate change and changed in precipitation pattern directly affect on agricultural activities and production. Precipitation is more importance for rainfed agriculture which is more sensitive towards the change of time and quantity of rain. Weather variability associated with rising temperature and changing pattern of precipitation is expected to have utmost adverse impact on various components of agricultural system. Decreasing total rainy days and increasing number of drier days (evapotranspiration>precipitation) and days receiving over 100 mm rain (MOE, 2010b).

Climate change affects crop and livestock production practices and yields. Negative effects are projected to be more prominent than the positive effects (Pant, 2009). The climate changes potentially increases the costs of crop production. The costs of irrigation water will increase due to increased water shortage and costs of drought resistance variety seeds will

be higher than those of the ordinary variety seeds. Longer spells of drought, increased water shortage and soil degradation can aggravate the effects of climate change and force large areas of marginal agriculture land out of production (Mendelson et al, 2000). Increased heat stress is one of pathway affecting the livestock farming. The increased heat stress alters heat exchange between animal and environment affecting the feed intake and metabolism (Madar and Davis, 2004).

The impacts of climate change on crop production are geographically unevenly distributed. Developed countries experience for all variants of the emissions scenario an increase in productivity. In contrast, developing regions suffer a loss in cereal productivity in all estimates (Fischer et al, 2002). South Asia will experience the worst effects of climate change on cereal production by the year 2050. The decrease in the production due to the climate change will be greater in developing countries than that in the developed countries and greater in South Asia as compared to those in other developing countries (Nelson et al, 2009). Large proportions of farms in South Asia are small, fragmented and rainfed exposing them to the vagaries of extreme weathers resulting from the climate change.

Climate change is likely to result in changes to long term climate trends and an increase in the variability of an already variable climate. The potential impacts of these climate changes on the agriculture and forestry sectors include increased fire danger, damage to crops and soils due to flooding, land degradation, crop failure and livestock heat stress and even death. The potential productivity losses in the agriculture and forestry sectors as a result of climate change are likely to lead to a fall in gross regional product, and farm incomes in some regions (Howden et al, 2007).

Initial National Communication of Nepal to the UNFCCC notes that there will be growing negative impacts on ecosystems and people's livelihoods with predicted increases in temperatures and changes in rainfall patterns in the future (MoPE, 2004). Nepal's agricultural sector is highly dependent on weather, particularly on rainfall. Given the low productivity increase of the last few years compared to population growth, climate change is likely to have serious consequences for the agriculture. Most of the population is directly dependent on a few crops for food such as rice, maize and wheat. The predicted decrease in

precipitation from November to April would adversely affect the winter and spring crops, threatening food security. Higher temperatures, increased evapo-transpiration and decreased winter precipitation may bring about more droughts in Nepal (Alam and Regmi, 2004). Increased water evaporation and evapo-transpiration may also mean that crops will require more water through irrigation.

The major process of climate change can be summarized as increase in temperature, weather variability, evapo-transpiration and uncertainty of precipitation. This will affect both crop and livestock production technologies particularly choice of variety/breed, sowing time, disease/pest management and water management.

2.5 Decision Making Process and Perceptions

Agriculture activities are fully dependent on farmer's decisions. A famer is considered as an autonomous decision-maker of a specific lot of land. They are the agents who communicate, select and adopt suitable management strategies. Main factors impacting on farmer's decision making on land use change are biophysical, economic and social. These include soil types/texture, slope, rainfall and temperature, environmental risk perception and management, the introduction and uptake of new technologies, market location/price, state and local policies and social values.

Current land use and land cover are the consequence of decisions made by farmers and policy makers in the past. The decisions of agricultural land use is made at different levels ranging from individuals, household, community and different levels of political/administrative, institutional and spatial scale ranging from plot to landscape and regional levels (Khanal, 2002). Normally in agriculture sector individual household's takes decision on crop selection, fertilizer use etc. Similarly community also plays an important role in crop selection, water management, fertilizer use etc. Likewise, organization and government decision in the development of irrigation, road and other infrastructure facilities plays a vital role in changing agricultural land use of that region.

Farmer's decision making process is directly related with his family concern. Since a healthy family is in first priority, his primary goal is to increase food production and welfare. Thus,

mostly decisions concerning land use management and conservation are made by farmer in the context of family concerns and priorities (Burton et al, 1990).

To arrive at a land use change decisions a farmer would consider his income from current land use as well as income from other sources and compare this income with what might be generated from other possible land use (Ahamed et al, 2011). Here the land use change is assumed as any of the follows: a) Crop selection/combination and b) Crop intensification. The farmer would select a new cropping pattern i.e. change his/her existing land use if he/her is benefited from this decision as well as a minimize the risk that is associated with the change. An experienced farmer always considers soil erosion that is associated with new land use.

The decision makers must weigh the positive and negative consequences of the decision. Effective decision-making requires good information, sound judgment, and flexibility. Decision-making is not a guessing game (Doye and True, 2007). The choices to grow crop are limited among self-sufficient farms. Each crop grown is needed to meet its need and couldnot replace each other. So, the farmer doesnot have choice to other crop options, whereas in situation with market, money can be used to meet family needs and different options can be choosen and agricultural decisions and family farm sources are allocated according to which options gives the highest return to labour (Chayanov, 1966). The level of physical assets, human capital, access to productive resources, risk attitudes, agro-ecosystem and types of technology, the particular farming season, as well as chance factors such as their neighbours and village colleagues influenced the farmers' adoption-decision. Therefore, individual farmers seem to show unique adoption behaviour. This also makes conceptualizing the farmers' decision making pattern difficult (Sambodo, 2007). The introduction of the insurance program with full decoupling of income payments from agricultural production in Portugal has positive effects in the agricultural production. This alternative has the decision makers' preference too (Serrao and Coelho, 2005).

In Nepalese context decision making in the household is primarily guided by person's 'position' in the social hierarchy and the extent of economic contribution in the household (Subedi and Rajbanshi, 2005). Local people internalize their environment and utilize

available resources based on longstanding tradition, place specific production constraints and their own dietary habits. The variation in application of inputs such as labour, manure, irrigation and selection of crops are based on their knowledge and worldviews being established from time immemorial (Subedi and Chapagain, 2008). Tiwari et al (2008) explain that the decision making pattern has been changing now a days. They added that the autonomous decision making process led by household head has been changed to consensus-based decision making process together with all family members. The decision making particularly in selection of crop varities, adoptation of new technologies and marketing of farm produces has changed.

2.6 Policies and Strategies

The government policies are also governing factors for land use and land cover change. The country should develop an integrated land use policy for its overall economic and environmental development (Khanal, 1999).

The government of Nepal has made increasing efforts, especially in the past decade, to adopt policies appropriate to addressing the poverty and food insecurity problems, particularly through two agriculture and poverty-focused programmes, the Agricultural Perspective Plan (APP, 1995-2014) and the Ninth Five Year Plan (1997-2002). These have been supported by a general programme of macroeconomic reforms aimed at achieving sustained economic growth through a transition to a more market-oriented and increasingly private sector-based economy.

The Agriculture Perspective Plan (APP, 1995-2014) is one of a series of long-term plans in the agricultural sector. This plan focuses on a small number of priorities to create economies of scale for commercialisation. The main aim of the plan is to enhance productivity and encourage commercialisation and diversification. The plan identifies dual ownership of land and land fragmentation as major constraints for agricultural development and recommends terminating dual ownership and curbing fragmentation while initiating land consolidation based on the recommendations of High Level Commission on Land Reform (HLCLR, 1995). The plan notes that dual ownership discourages investment in land development but

hitherto there are no signs that any practical initiatives have been taken to achieve land reform and land consolidation.

Emphasis was given to achieve higher economic growth based on social justice and employment opportunities by increasing investment of public, private and co-operative sectors for commercialization of agriculture, rehabilitation of industries and expansion of service sector. (Budget speech 2010/11, http:// www.mof.gov.np)

CSRC (2009) states that the government receive billions of rupees through land taxes and transactions each year but reinvests less than 10 % of this revenue in land management issues. Little is done to improve agricultural productivity and ensure food sufficiency, consequently productivity is in decline, food imports are increasing and the contribution of the agricultural sector to GDP is decreasing. Progressive land reform needs to be addressed alongside productivity and their interdependence recognised and prioritised. Without land reform there will be no investment in farming technology, no improvement in agricultural productivity and no evolution from subsistence farming to surplus farming. Land reform leading to improved agricultural productivity will stimulate the economy as a whole by creating employment, producing raw materials for other industries and reducing social unrest.

These studies provided the basis to develop an integrated framework for the study of continuity and change in agricultural land use. But most of the studies above were carried out in the 1970 and 2000 and have discussed major pathways and drivers either at micro or macro level but lack micro level quantitative information on the effect of water availability and use of inputs on the yields and their role in changing agricultural land use pattern. Besides, the difference in methodologies adopted by different researchers made it very difficult to compare and generalize the results. Spatial context of land use and land cover change has not got priority in research.

The methodology adopted for this study is discussed in next chapter.

Chapter III

METHODOLOGY

3.1 Background

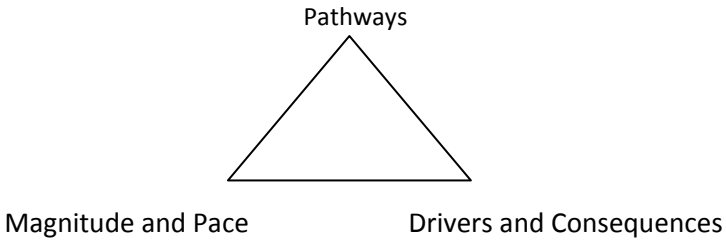
Agriculture land use change is a dynamic process which is closely interrelated with time. Thus, change in agricultural land use, cropping pattern and productivity has many dimensions – pace of change, drivers of change and its consequences. Thus, to understand it, a holistic approach with clearly designed research methodology has been adopted.

3.2 Research Approach and Strategies

3.2.1 Conceptual Framework of the Study

This study adopts a holistic approach and analysis from different perspectives. A study framework is prepared to identify the pathways of land use change, its magnitude and pace structure and drivers and consequences.

Figure 3.1: Study Framework



3.2.2 Selection of Study Area

The study area Balaha village, Inaruwa, Sunsari was selected purposively. It consists of both rainfed and irrigated agriculture system. To understand the impact of water in crop production and cropping pattern, the study area has been divided into four zones according to mode of irrigation. They are as follows;

Zone A = Previously rainfed area and still rainfed

Zone B = Previously rainfed and now irrigated by SMIP

Zone C = Previously irrigated by old canal and now with SMIP

Zone D = Previously irrigated by old canal and still irrigated by it (with some change in the water supply, i.e. some water drained from fields getting water from the SMIP).

Zone A, B, C corresponds to ward 9 of Inaruwa Municipality, and the area is collectively called Balaha whereas, Zone D corresponds to ward 10. Zone D area is known as Chadbela farmland where no village or even a single farmhouse exists (figure 3.2). Spatially,

Zone A = lies between West of Chaudhaurytol and Trisultol,

Zone B = lies between West of Sharadatol and SMIP Shankharpur Minor main canal,

Zone C (in North to Dhubi Road) = lies between East of Chaudhaurytol and Dhanuktol,

Zone C (in South to Dhubi Road) = lies East and South to Shresthatol,

Zone D = lies on the Western bank of Gaurun Dhar Khola, Far East from Shresthatol

Water in Zone B (Sarada Tole) of Balaha is distributed through the tertiary canal called Balaha Minor and its gate lies at Titribon Minor of Shankharpur Canal, near Paudeltol about 1.25 km North from Sharadatol. Likewise water in Zone C of Balaha is fed through the tertiary canal called Balaha Branch Canal and its gate lies at Titribon Minor of Shankharpur Canal at Titribon about 5 km North from Chaudhaurytol Balaha.

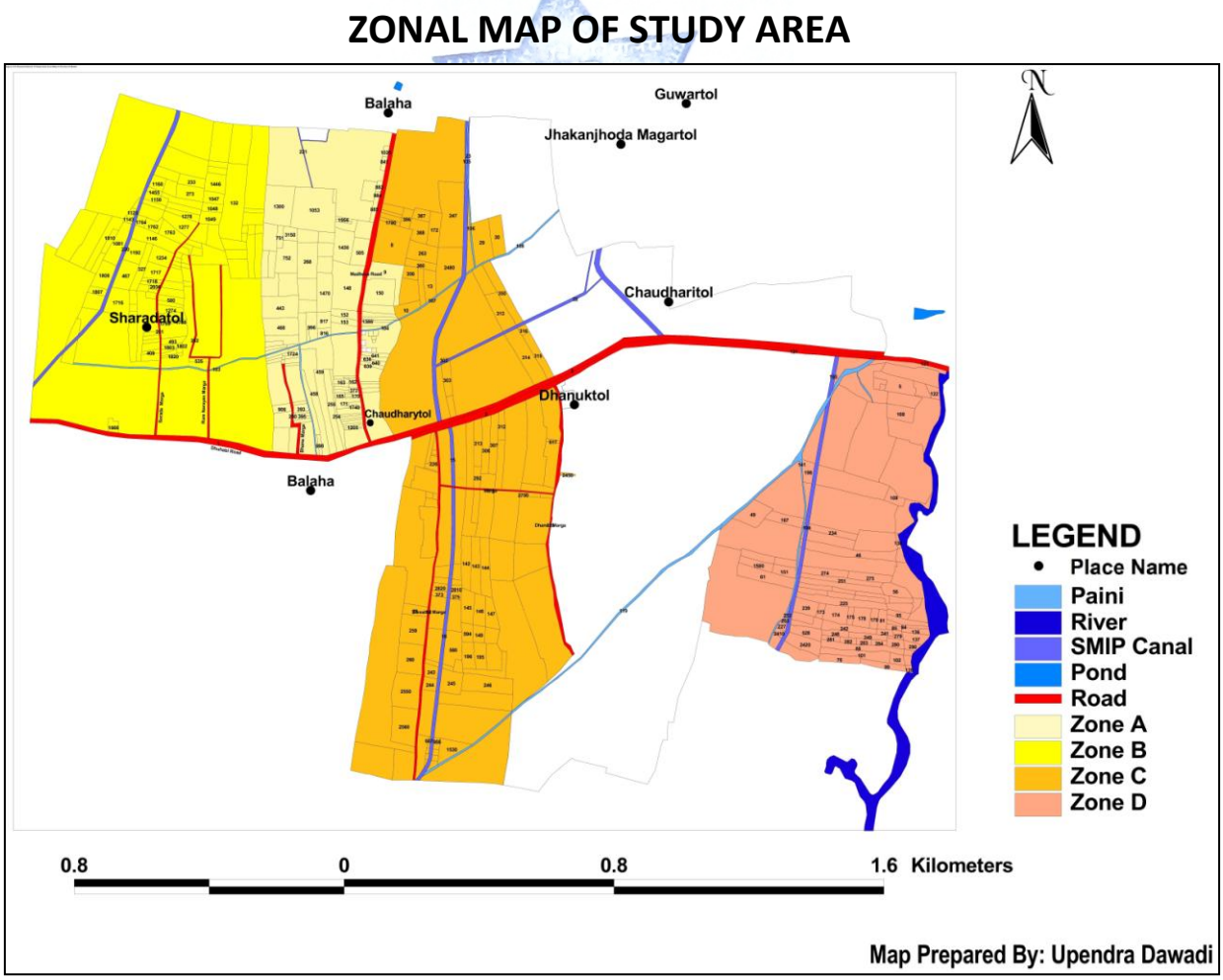
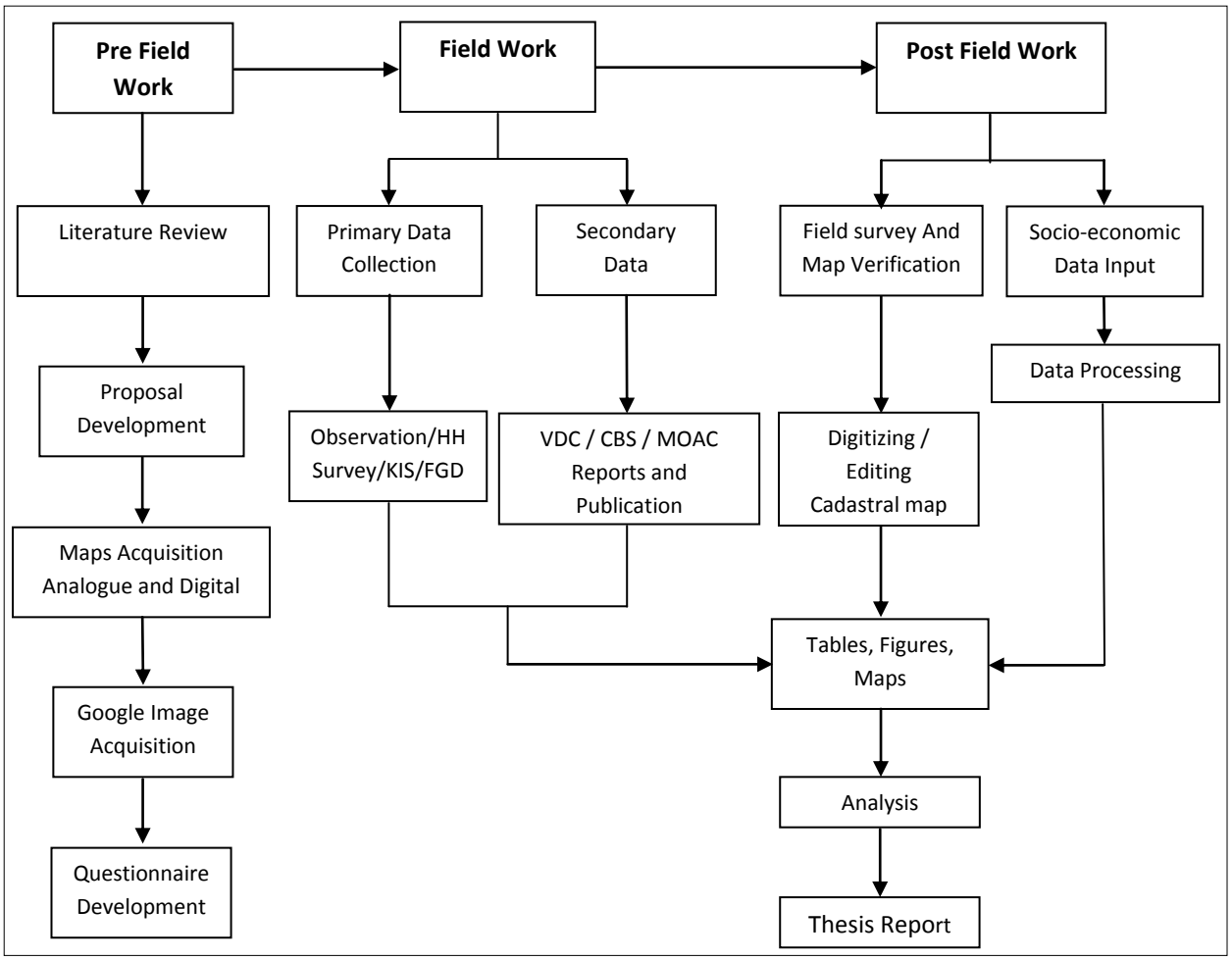


Figure 3.2: Physical Division of Study Area According to Mode of Irrigation

3.2.3 Research Activities

The whole research work has been divided into three major parts. First part considers the desk work which includes literature review, proposal development, map collection and preparation of field data collection tools. The second part is related to field work. During the field work, primary and secondary data were collected and field observation was made. The third part of the study is the input, processing and analysis of data. Figure 3.3 shows the different activities carried out.

Figure 3.3: Sequence of Activities



3.2.3.1 Desk Work

The study started with a review of previous research about agriculture land use pattern and related aspects. Research proposal was developed based on the review thus made. Analogue and digital maps, including cadastral sheets were collected. Google image of study area were acquired to use in field. Questionnaire and check lists were prepared.

3.2.3.2 Field Work

The field work is divided into two parts, primary data collection and secondary data collection. For primary data collection, one month long field study was conducted. During the field survey irrigated and rainfed agricultural area was identified and traced in cadastral map collected from District Cadastral Office, Sunsari. Thereafter the general socio economic data such as agricultural data, cropping rotation, agricultural input and output etc from household survey was collected. Information about climate change and its impact on agriculture was collected with the help of key informant interview and focus group discussion. Other related secondary data were collected from the District Agriculture Office Inaruwa and Sunsari Morang Irrigation Project office, Biratnagar.

3.2.3.3 Post Field Work

The agriculture parcel map was prepared by digitizing the existing cadastral map of Balaha using Arc View GIS 3.2a. In GIS each agricultural land parcel was separated and numbered with its unique identity assigned during the field survey. All attribute information of the households were entered in SPSS format and converted in to excel file to link in GIS data base file for the GIS format and joined to the attribute table. And the agriculture land use pattern, land area, cropping intensity, agriculture input and output were also analyzed.

3.3 Nature/Sources of Data and Collection Techniques

This study is based on primary and secondary data. The primary data has been collected from the field survey and field observations while the secondary data has been acquired from various sources. The primary data is the main body of this study. Qualitative methods and techniques of data collection have been employed to collect primary data.

3.3.1 Primary Data

The primary data are collected by using different methods of collecting qualitative data i.e. field observation, informal interviews, key informant interview as well as in-depth interview, field note, group discussion.

3.3.1.1 Field Observation

Observation implies the use of the eyes rather than the ears and voices (Moses and Kalton cited in Pokhrel, 2003). Direct field observation is an important method of geography in real data collection which reinforces the reliability of collected information. Researcher had observed the settlement pattern, agricultural land and agricultural system, existing irrigation system, people's everyday activities directly during the period of fieldwork.

3.3.1.2 Household Survey, Sampling Procedure and Sample Size

This study is focused on the agriculture practice in Balaha village and Chadbela farmland within rainfed and irrigated condition. Total area of 56.7312 ha under four different categories were identified and information regarding agricultural practice plus socio-economic information were collected by household survey from respective landowner or farmer. Total number of household in Balaha is 180 from which 57 households were selected randomly. Thus this study is based on a minimum sample size of 57 households, 31.67 percent of total households, with total number of 214 parcels under different irrigation conditions. It is expected that the sample size is enough to perform statistical analysis at plot level.

Table 3.1: Number of Household and Parcel under Different Irrigation Zone

Irrigation Zone	Number of Parcel	Number of Household
A	58	21
B	44	14
C	57	22
D	55	-
Total	214	57

Source: Field Survey, 2011

3.3.1.3 Interview with Key Informants

The detail qualitative as well as quantitative data about the study area were obtained from the key informants. During the fieldwork, researcher selected some farmers who belong to the study area to acquire knowledge on the present and past condition of socio-economic and agricultural status as well as the impact of climate change. This method also helped to check the information collected through household survey and FGD. It was conducted after the completion of the household survey. An elderly person who knows a little bit more,

person living for many years in the same area, people who are more engaged in social organization was given more priority.

3.3.1.4 Focus Group Discussion

Information regarding the present and past condition of agricultural crops, production, input and output, impact of climate on agriculture and impact of farmer's decision on agriculture pattern was gathered from focus group discussion. To obtain these information two focus group discussions were conducted in two places of the study area. Among them one group discussion was held among the over 40 year age group of people from Tharu community. Another FGD was conducted involving people from mix community including teacher and farmer.

3.3.2 Secondary Data

Secondary data and information are based on published and unpublished document from different related books, journals, newspapers as well as thesis obtained from government, non government, international non government organization and library of various institutions. Internet was other important sources of data/information for this study.

The major sources of secondary data are as follows:

- Population census 2001, CBS, Government of Nepal
- Climatic data (1985-2010), Department of Hydrology and Metrology
- Some attribute data from Inaruwa Municipal Office Sunsari
- Research reports, journals and other documents from Ministry of Agriculture
- Project reports from Sunsari Morang Irrigation Project, Biratnagar

3.3.3 Archival Data/Map Data

The data stored by some authorized organizations and which have their own original nature are categorized as archival data. Map is very important tools for research purpose. The four major map data used for identify and analyze agricultural land pattern and change in study area are as follows:

- Topographical map (1994) of scale 1:25000 base on aerial photographs of 1992 prepared by Survey Department of Nepal Government and FINIDA.

- Ward-wise map of Inaruwa Municipality from NGIIP, Kathmandu
- Cadastral map (scale 1:2400) of the study area, Cadastre Survey Branch, Inaruwa Sunsari
- Recent Google Image of the study area

3.4 Data Collection Tools

Tools used to gather base line information, socio-economic condition and agricultural condition of study area are mainly structured questionnaire and checklist.

3.4.1 Household Survey Questionnaire

Questionnaire is an important tool of obtaining the both qualitative and quantitative information in a particular field of inquiry. In this study, it has been used in the collection of base line information, socio-economic condition and agricultural condition of Balaha village.

3.4.2 Field Note and Audio Record

Field note is used to record necessary information observed during field survey. Details of the important incidence, events and discussion which were not included in either structural or unstructured question were found to be important for the study. So, some of information were written on field notes while informants' comments on people's activities, attitudes towards their environments and other aspects were records on their own voice using audio recorder.

3.5 Data Processing and Analysis

Different attribute data were collected from household survey, key informants interview, focus group discussion and from different reports. All attribute information were then converted into standard units and entered into computer and suitable tables were prepared according to the need or research contents, using SPSS and MS-Excel software program.

Preparation of different thematic map and spatial data analysis is done using GIS software; likewise tabular data is handled with using SPSS, MS-Excel. Some statistical tools and human judgment are used to seek the factor and consequences of the land use change. To prepare

this thesis report ArcGIS9.2, ArcView Gis3.2a, SPSS, Microsoft Word, Microsoft Excel software/programmes has been used.

3.6 Limitations

Spatial change in agriculture land of study area has been defined using existing island cadastral map. Thus, reliability of map depends on positional accuracy of cadastral map plus digitizing and processing error.

This study is limited to small area of one village in Sunsari district, so the results may not be enough to make generalization for the whole Terai region of Nepal. Nevertheless, this study provides a general picture of Nepalese agriculture in Terai region both on rainfed and irrigated condition. The majority of information used in this study is recalled data reported by the household member (mostly the household head). So the reliability of findings also depends on the reliability of the information provided by these household members.

Chapter IV

INTRODUCTION TO THE STUDY AREA

This chapter describes the bio-physical and socio-economic settings of the study area. The following are the bio-physical and social context according to which, the agricultural land use has been changing.

4.1 Location

The study villages Balaha and Chadbela lie in Inaruwa Municipality, the headquarters of Sunsari district (in Koshi Zone) of Nepal. Balaha village lie in the ward no. 9 while Chadbela correspond to the ward no. 10. Geographically, these two wards lie between 87^0 9' 18" to $87^0$11' 19" N latitude and 26^0 55' 13" to 26^0 36' 55" E longitude.

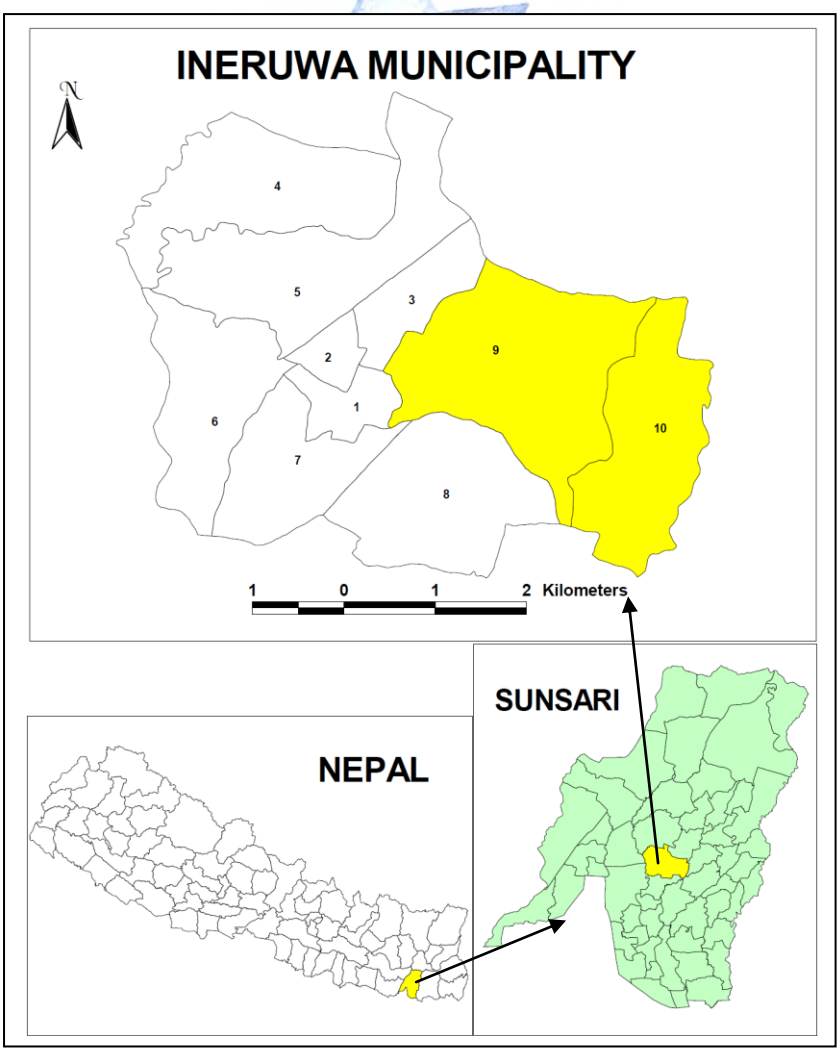


Figure 4.1: Study Area

4.2 Historical Development

Existing Tharu Tole in Balaha is found to be the oldest settlement. At present, Balaha is inhabited by in-migrants Brahmin, Chhettri, Newar (i.e. collectively called Pahade community) and the native ethnic Tharu community.

Agriculture system in Balaha has gone through revolutionary change during past 25-30 years. In the past, up to 1985 A.D. they used to cultivate mostly paddy, lentil, mustard, maize, millet, and jute using local seeds. In 1986 A.D. the Sunsari Morang Irrigation Project (SMIP) sub minor canal was completed and with the introduction of irrigation facilities they are inclined towards modern agriculture. They are interested in using high yielding improved seed and chemical fertilizer. Likewise, instead of cultivating maize, millet and jute they focus on paddy and wheat until recently some of them are attracted towards the cultivation of sunflower, hybrid mustard and sugarcane. HYV seeds have reduced the growing season period (4-5 months instead of 6 months for paddy) and increased the yields. Nowadays, transplantation of paddy is done one month earlier in area with SMIP canal (Balaha) as compared to the past while in Chadbela one or two week earlier. But due to various reasons the tradition of cultivating maximum two crops per year has not been changed yet.

At present, Tharu people are mostly involved in agriculture but the trend has changed, now they do not have large agriculture field like in earlier period. Some socio-economic aspects such as single family concept, increasing land value and land trade etc has influenced to fragment the land into many small pieces. Tharu people are slowly involving in other non-farm activities that assist to change the pattern of agriculture of this area.

4.3 Bio-Physical Condition

4.3.1 Topography

The study area is a flat low land, which is the northern extension of Indo Gangetic Plain. Here the relief variation is insignificant. The elevation of study area is 84 m above mean sea level.

4.3.2 Geology and Soil

The geology of the area resembles to that of Gangetic alluvium. The soil in this area has been formed from the old and new alluvium deposits. Differences in micro-topography, rainfall and temperature have created local diversity in soil.

The main soil types of the study area, in terms of texture are loam, sandy loam, clay loam. The colour of the soil varies from grey-brown to olive brown and its reaction over most of the area is slightly acidic with a pH range 4.5 to 7.5 (2009, District Agriculture Development Office, Sunsari).

4.3.3 Climate, Its Component and Climate Change

The study area lies in a subtropical climatic region with two distinct season summer and winter. June–July is the hottest month and December-January is the coldest month of the year. The meteorological station Tarahara, situated 15.5 km away North-East from study area, at 200 m altitude records mean annual temperature 24.31^0 C and annual precipitation 2309.1mm (2010). Likewise, maximum amount of precipitation occurs in July (703.8 mm) while Dec, Jan, Feb and Mar appear to be the driest months.

People of Balaha reported that they are feeling steady change in climatic conditions in past 10 – 12 years. Impact of climate change has also seen on agriculture of study area. They recognized that impact of climate change has influenced in the production, timing of agricultural activities of Balaha as compare to that of 1980s. Some of the changes observed in component of climate of study area are as follows:

4.3.3.1 Temperature

Figure 4.2 and 4.3 indicates (refer Annex- A) the trends of mean temperature of Sunsari from the year 1990-2010. Yearly mean of maximum and minimum temperature is 29.97^{0}C and 18.49^{0}C. Mean maximum temperature 31.33^{0}C, 30.83^{0}C, 30.78^{0}C was recorded respectively in the year 1995, 1996 and 2000. Likewise, mean minimum temperature 17.58^{0}C, 17.70^{0}C, 18.11^{0}C was recorded respectively in the year 1997, 1991 and 1992. Table in Annex-A reveals the irregular trend of temperature at Sunsari during 1990 - 2010.

Figure 4.2: Mean Maximum Temperature at Tarahara, Sunsari (1990-2010)

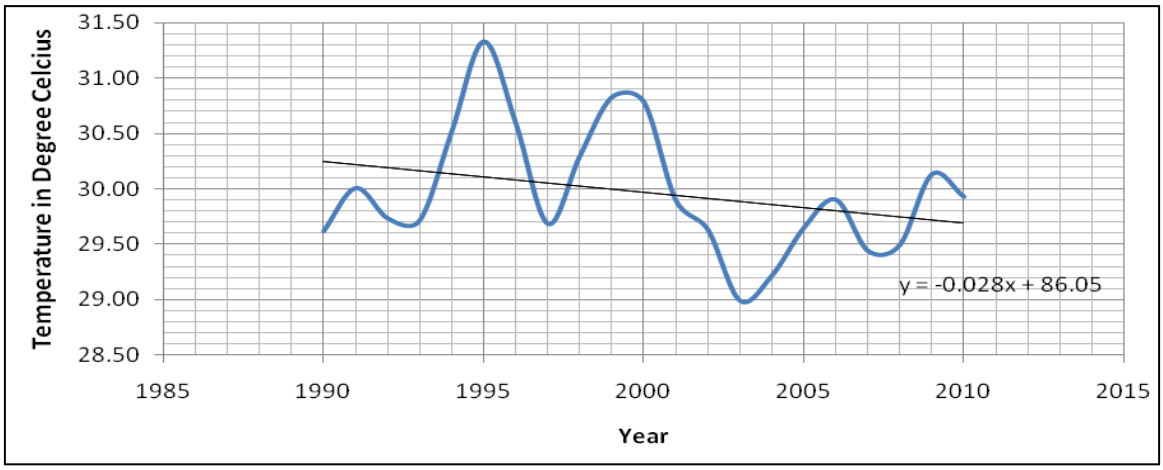
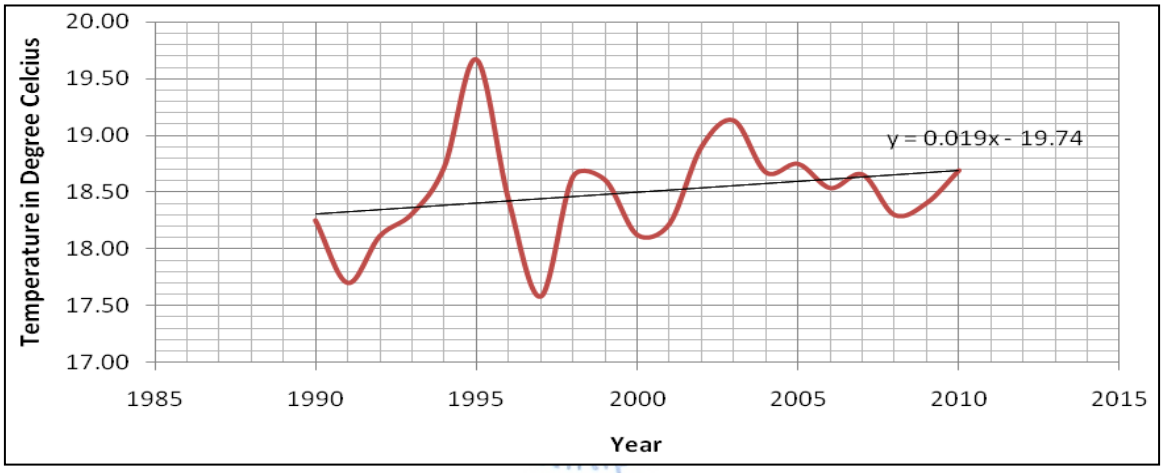


Figure 4.3: Mean Minimum Temperature at Tarahara, Sunsari (1990-2010)



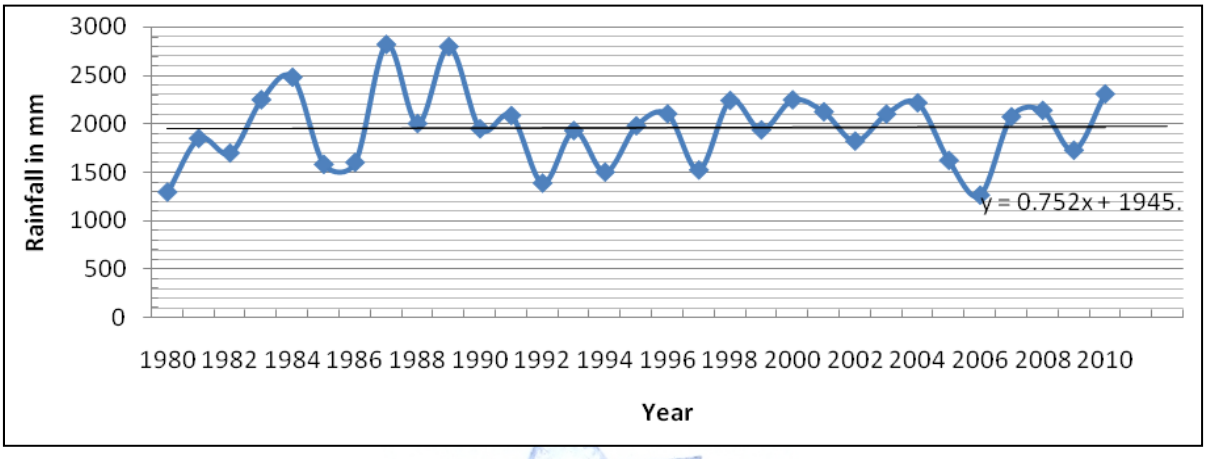
People of Balaha sense the steady increased in temperature over last ten years. Intensity of cold in winter has increased but total period of winter has decreased. Presently, people are feeling intense cold in January than ten years before. As a result of maximum cold more numbers of people are getting sick annually in winter and death rates of livestock in winter are increasing. Seeding time of wheat has change due to temperature change. Before 10 years farmers used to seed wheat crops within 1st week of January but nowadays people seeds it within November last week to December 1st week. Besides, the ripening time of mango has been shortened by a month.

4.3.3.2 Precipitation

Figure 4.4 shows the tendency of rainfall of Sunsari during 1980 – 2010 (refer Annex- A). Yearly mean rainfall is 1957.25 mm. Minimum rainfall 1264.1 mm, 1295.5 mm and 1388.6 mm was recorded respectively in the year 2006, 1980, and 1992. Likewise, the year 1987,

1989, 1984 and 2010 witnessed a maximum rainfall of 2820.2 mm, 2797.5 mm, 2480.4 mm and 2309.1 mm respectively. Currently, erratic rainfall events (higher intensity of rains but less number of rainy days and unusual rain) is being more prominent in last few years with no decrease in total amount of annual precipitation. Such events increase possibility of climatic extremes like irregular monsoon pattern, drought and floods.

Figure 4.4: Average Rainfall at Tarahara, Sunsari (1980-2010)



People from Balaha admit that in recent year they are experiencing sign of erratic rainfall. There is a strong indication of occurrence of high rainfall during monsoon and winter is becoming drier with less amount of rainfall. In the year 2005/06 paddy productions in Balaha was reduce by 30 percent as 20 percent agricultural land were left fallow.

4.3.3.3 Windstorm

Cold and heat wave is another climatic phenomenon related with climate change. These types of wave also effect negatively on agriculture. Agriculture of Balaha is also affected by heat wave blowing between March to July which was locally known as Paschimi Hawa (Western Wind). Farmers claimed that this heat wave affects on wheat and pulses production. Mostly its affect to grains of crops, the size of grain are small due to the wave. Similarly high windstorms do have negative effect on mango, betel nuts (Supari) and coconuts at flowering time.

4.3.3.4 Fog

Magnitude of fog is increasing since 5-6 years. People believed that rapidly increasing number of vehicles and growth of unmanageable industries are reason for increasing rate of

fog. Similarly, frost also seems more frequent since 4-5 years. Fog affects on agriculture, livestock and human health.

4.3.3.5 Other Negative Effects

Climate change not only affects in the agricultural production but also effects on all vegetation and animals ecosystem. Increase climate extremes may promote plant disease and pest outbreaks. Many new diseases and pests are rising in terai region due to climate change which has adversely affected the agricultural production and livestock. Due to increasing temperature, People in Balaha say that nowadays they are experiencing mosquitoes even in winter season.

Climate change is likely to have significant negative impact on species, ecosystem and ecosystem services unless mitigation and adaptive measures are taken. The field survey reveals that some important animals have been disappeared from the study area whereas others are continually decreasing in numbers. According to them, the number of snake is decreasing and vulture is not seen at Balaha, nowadays. Herons, Swan, Parrot, Bat, Dove, Garud, Jackal are not seen in Balaha which used to appear notably before 10-12 years. Nowadays, Crow and Sparrow are seen in small number.

Another major issue is the availability of water for agriculture both for rain-fed and irrigated system. People in the study area admit that water quantity on stream and water level of underground water both are decreasing since 5-6 years. Before 15 years underground water was available on 30-40 feet depth from ground level in summer season which has shrunk to the depth of 55-60 feet nowadays.

4.3.4 Vegetation

The Sal, Sisau, Khayar, Bamboo, Bakaino, Badahar, Ipil-Ipil etc are the most prominent tree species of the area, with high commercial timber value and some with fodder value as well.

4.3.5 Drainage Pattern and Existing Irrigation System

A canal from Sunsari Morang Irrigation Project and river Garaun Dhar is the main source of water for irrigation in Balaha. The trributories which join Garaun khola to form Garaun Dhar

are: Suryamukhi Khola, Ghondaha Khola and Mudaha Khola. Besides, small ponds and swamps at north Balaha are also an important drainage of Balaha (refer Topographical Map of Study Area, Annex-C).

In past, farmer in Balaha used to depend mainly on the river called Garaun Dhar. A part of old canal called "Budhiya Paini" (old lady canal) is still visible at North Balaha; certain part of it (only in Zone C) is now supplied by the SMIP water. Old canal constructed by Bhekh Bahadur is named as Bhekh Bahadur Paini which is now abolished as water flowing from it has flooded many parcels in Zone C of North Balaha. Birta Paini is still used in Zone D but now the water released from the upstream fields (supplied by SMIP) is diverted instead of water from the Garaun Khola (refer figure 4.5).

Chatra Canal Irrigation Project was designed and constructed by the Government of India between 1964 - 1972 as compliance by the Koshi treaty held between Nepal Government (The then His Majesty's Government of Nepal) and the Government of India in 1954. It was designed to commands a potential cultivated area of about 58,000 ha in Morang and Sunsari districts. After completion of commission, it was handed over to the Government of Nepal in 1975.

Water is taken from the river Sapta Koshi via the Chatra Main Canal head regulator sited near the village of Chatra, just south of the narrow gorge where the Sapta Koshi leaves the foot hills. The Chatra Main Canal is 53 km long with a design flow in the upper reach of 45.3 m^3/s (now upgraded to 60 m^3/s) and as originally constructed, served 12 secondary canals with a total length of 227 km long and 36 tertiary canals (minors) totalling 105 km.

Chatra Canal Irrigation Project has undergone progressive development after its hand over to Nepal Government. The project is now known as Sunsari Morang Irrigation Project (SMIP). It is constantly working for the proper management of water and command area development. At the initial stage, the main canal, secondary canals and tertiary canals (minors) of Chatra Irrigation Project could properly irrigate only 25% to 35% land of its command area. The insufficiency of secondary canal and minors, problem of sediment intrusion at the intake and deposition in canals, drainage problem in irrigated area etc has

been persistently addressed by SMIP under different project plan stage. SMIP, the largest Irrigation Project in Nepal now commands cultivated area of about 68000 ha.

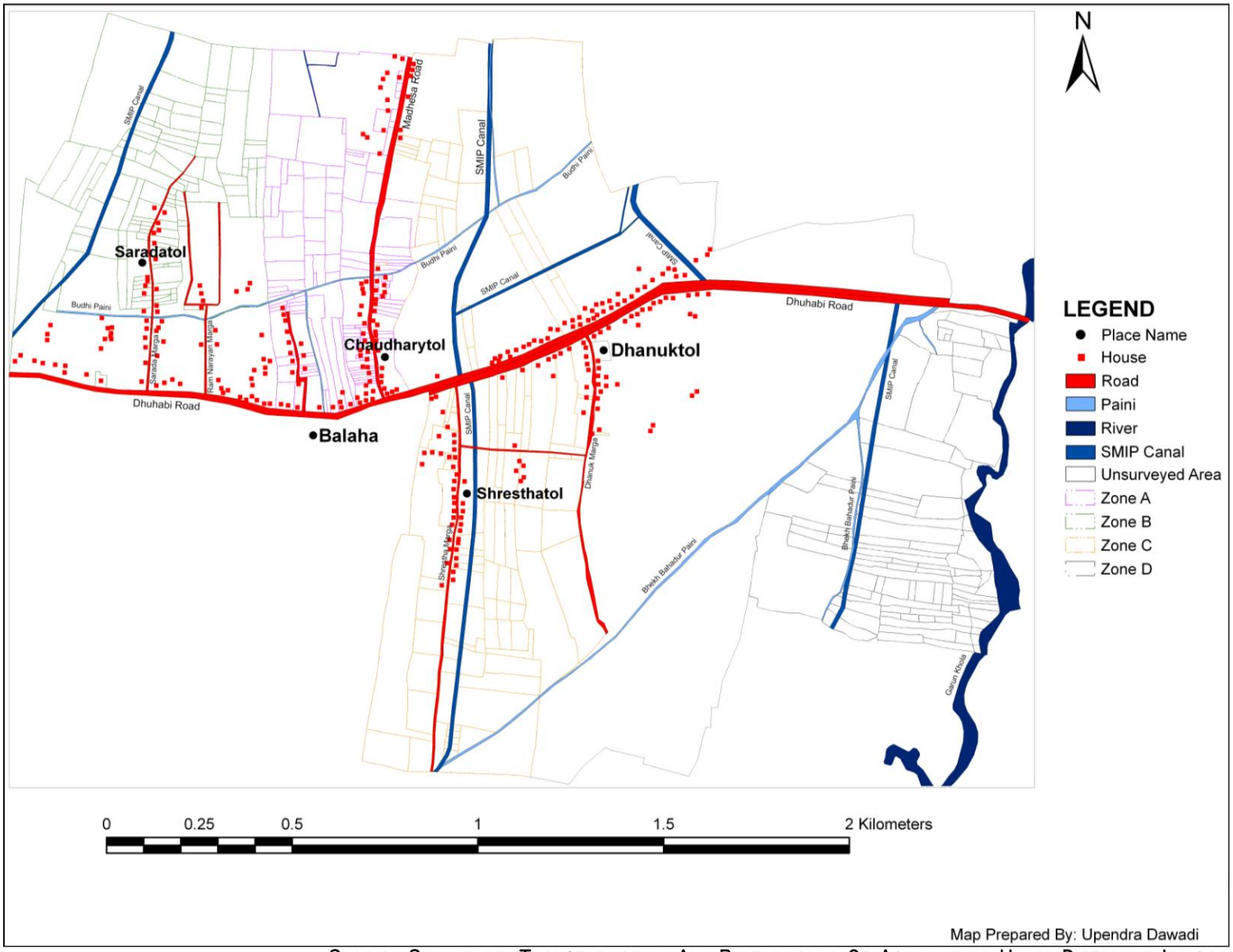
Administratively, Sunsari Morang Irrigation Project (SMIP) is organized into four Divisions, 10 Sub-divisions and 6 sections in which 76 official are working in different levels. Besides Sunsari Morang Irrigation Management Division also exist separately. Likewise, a five tier organisation of the water user association (Water course level, Tertiary level, Sub-secondary level, Secondary level and Chatra Main Canal level) has been employed for the effective participant of user in project handling and management.

Present annual cost of Project handling and maintenance of SMIP is Rs 1470 per ha. Total agriculture production of the area was 113345 metric tons in 1985 which has been increased by 92% (i.e. 218371 metric tons) after the development of command area and present total annual returns is Rs 1,403,000,000/- (Present Status Report 2011, SMIP, Biratnagar).

At present, some of the old structure at intake has undergone damage but SMIP is facing financial hardship in the maintenance and restructuring. Likewise, SMIP is facing the problem of siltation, due to which in many command area problem of little water exist. As a result, recently some farmer has denied paying water taxes.

The study area Balaha was selected and developed as the command area of SMIP during fiscal year 2035/36 B.S. to 2042/43 B.S. During this period, about 9750 ha has been developed into command area by extending the Shankarpur canal from Shukhasena canal and constructing minors and water courses. The work was commenced by Hydraulic Engineering Corporation of China (HECC) in mid March 1983 and completed on mid June 1986. At peak, a typical breakdown of the contractors' workforce was 200 Chinese workers and 1750 Nepalese worker (Project Completion Report, SMIDB, 1987).

Figure 4.5: EXISTING IRRIGATION SYSTEM AND ROAD NETWORK OF BALAHA



4.5 Demographic Condition

4.5.1 Population

There are about 180 household in Balaha village. A random survey of 57 household reveals total 354 family members with average family size of 6.2 which is greater than that of Inaruwa municipality average (5.2). Population composition shows that 50.8% of total population is male and remaining 49.2% is female. Besides, 16.9% of total family members are absent. Most of them have gone for over-sea employment; few others are residing at Kathmandu for study purpose.

Table 4.1: Family Size of Study Area

Household Information	Number	Percentage
Household Surveyed	57	31.67
Number of Male	180	50.8
Number of Female	174	49.2
Total number of family member	354	100
Family member present in the village	294	83.1
Family member absent from the village	60	16.9
Average Family size	6.2	-

Source: Field Survey, 2011

The total population of sampled household is 354 and the area is 44.5554 hector (excluding zone D). It shows that the population density of the study area is 7.9 persons per hectare.

4.5.2 Population Distribution by Ethnicity

Table 4.2 shows the population of different ethnic groups. Balaha is mainly inhabited by Brahmin, Chhettri, Newar (i.e. collectively called Pahade community) and the native Tharu community. Out of 57 households surveyed, Brahim comprises 64.13% of total population, Tharu take in 24.01% of total population, Newar 4.52%, both Kusbaha and Roy 1.41% and other 4.52%. Figure 4.6 demonstrates composition of population of different ethnic group.

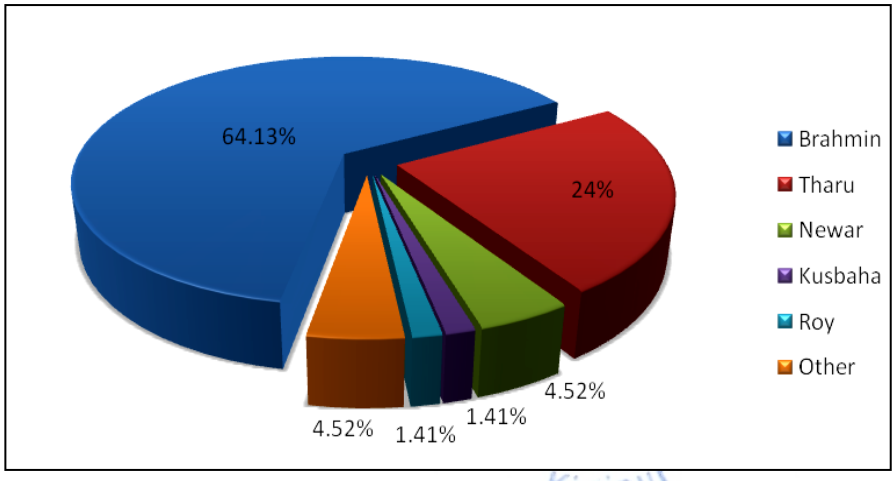
Out of 57 households surveyed, 31 houses are of Bramin, 20 are of Tharu, 2 are from Newar, 1 of Kusbaha, 1 of Roy, and 2 houses by other ethnic group.

Table 4.2: Population by Ethnicity

Ethnicity	Households	Male	Female	Total Pop^{n}.	Total Pop^{n}. Percent
Brahmin	31	112	115	227	64.13
Tharu	20	47	38	85	24.01
Newar	2	8	8	16	4.52
Kusbaha	1	3	2	5	1.41
Roy	1	2	3	5	1.41
Other	2	8	8	16	4.52
Total	57	180	174	354	100.0

Source: Field Survey, 2011

Figure 4.6: Composition of Population by Ethnicity



4.5.3 Age and Sex Composition

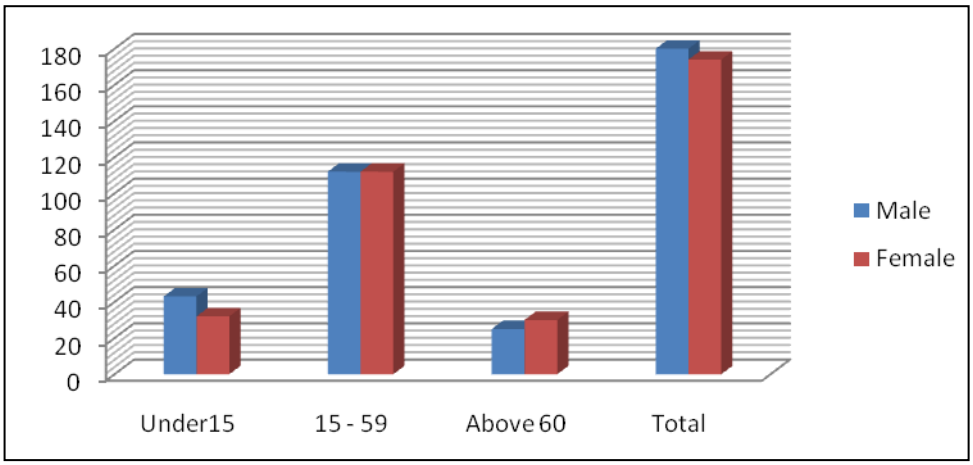
Sampled population are further divided into three age groups viz. under 15 years, 15 – 59 years and above 60 years. The percentage of economically active population in age between 15-59 groups is 63.28 percent. Likewise, 21.19 percent of sampled population is constituted by children of age under 15 years and 15.54 percent of total sampled population is comprised by elderly people of age above 60 years (Table 4.3 & figure 4.7).

Table 4.3: Age and Sex Composition of Population

Age Group	Male	Female	Total	Percentage
Under 15	43	32	75	21.19
15 - 59	112	112	224	63.28
Above 60	25	30	55	15.54
Total	180	174	354	100.00

Source: Field Survey, 2011

Figure 4.7: Age and Sex Composition of Population



4.5.4 Migration

At present, Balaha is inhabited by in-migrant Brahmin, Chhettri, Newar (i.e. collectively called Pahade community) and the native ethnic Tharu community. According to the Tharu community, their ancestors from Saptari District came to settle there when the permission of the forest clearing was given by the Ranas, in 1925 A.D. Settlement has been rapidly growing after 1932 A.D. Most of the recent in-migrant is Brahmin from Khotang, Okhaldhunga and other neighbouring district. Tharu community, who in the past own more than 240 ha lands in Balaha are the pioneer farmers of the study area.

Survey shows that 61.4 percent of sampled households are in-migrant from Eastern hilly districts of Nepal. Out of total in-migrant 65.7 percent families migrated from Khotang district, 14.3 percent from Okhaldhunga and others from Udayapur, Saptari and Solukhumbu district. The migration trend had begun since 1932 A.D. and is continuing at present. Availability of plain fertile agriculture land, infrastructure facilities and comfortable lifestyle of Terai are the most important pulling factors for in-migration, whereas service and the political situation are other factor to promote both in-migration and out-migration. Currently 16.95 percent of total sampled population is migrated to other place for study and employment. Likewise 4.24 percent of sampled population migrated to foreign countries. Most people migrated in gulf country such as Qatar, Saudi Arabia and U.A.E. Similarly people are also migrated in India, Malaysia, USA and England. In the case of internal migration, 12.7 percent of total sampled population is migrated to Kathmandu, Jhapa, Rajbiraj, Dang etc for service purpose. Both internal and international migration has impacts on agriculture.

4.6 Socio-economic Conditions

4.6.1 Education

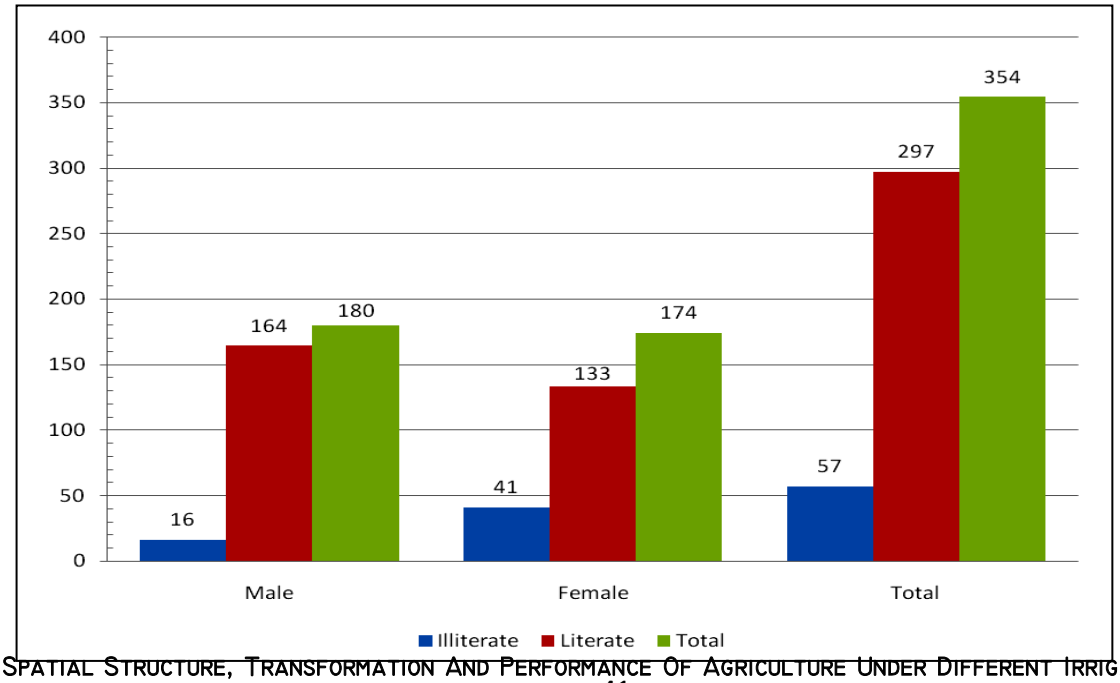
The percentage of literate population in the study area is found to be higher than that of the country average. Out of the total sampled population, only 16.1 percent are illiterate. Table 4.4 reveals that, maximum 15.25 percent of sampled population have Primary education while only 3.96 percent of sampled population have Graduates level education. Likewise, number of people holding SLC and Proficiency Certificate level education are 13.84 and 14.12 percentage respectively.

Table 4.4: Level of Education of Sampled Population

Education Level	Male	Female	Total	Percent
Illiterate	16	41	57	16.10
Literate	164	133	297	83.90
Primary	32	22	54	15.25
Lower Secondary	12	16	28	7.91
Secondary	18	15	33	9.32
SLC	25	24	49	13.84
PCL	33	17	50	14.12
Undergraduates	22	10	32	9.04
Graduates	9	5	14	3.96
Total	180	174	354	100

Source: Field Survey, 2011

Figure 4.8: Literacy Status



4.6.2 Occupation

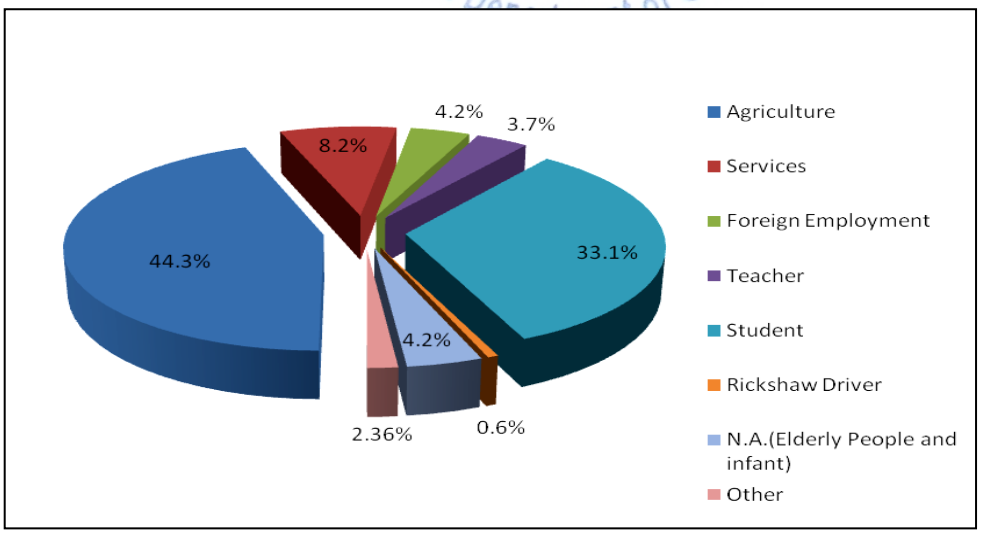
Table 4.5 shows that, out of total sampled population 44.3 percent have agriculture as main occupation. This can be rose up if population under student categories (33.1 percent) are also added for most of them actively take part in agricultural activities. The percentage of people engaged in services, foreign employment, teaching, rickshaw driver and others are 8.2, 4.2, 3.7, 0.6 and 1.7 respectively.

Table 4.5: Occupation of Sampled Population

Main Occupation	Number	Percent
Agriculture	157	44.3
Services	29	8.2
Foreign Employment	15	4.2
Teacher	13	3.7
Student	117	33.1
Rickshaw Driver	2	0.6
N.A.(Elderly People and infant)	15	4.2
Other	6	1.7
Total	354	100

Source: Field Survey, 2011

Figure 4.9: Occupation of Sampled Population



4.6.3 Income and Expenditure

Income as defined in the survey, measures the flow of resources or goods in a household during the last twelve months preceding the survey provides the information on quantity harvested, quantity sold, and sale price by crop. The basis for the measures are crops

income, non-farm income, income from wage employment, trade, income from livestock farming and its product and other income.

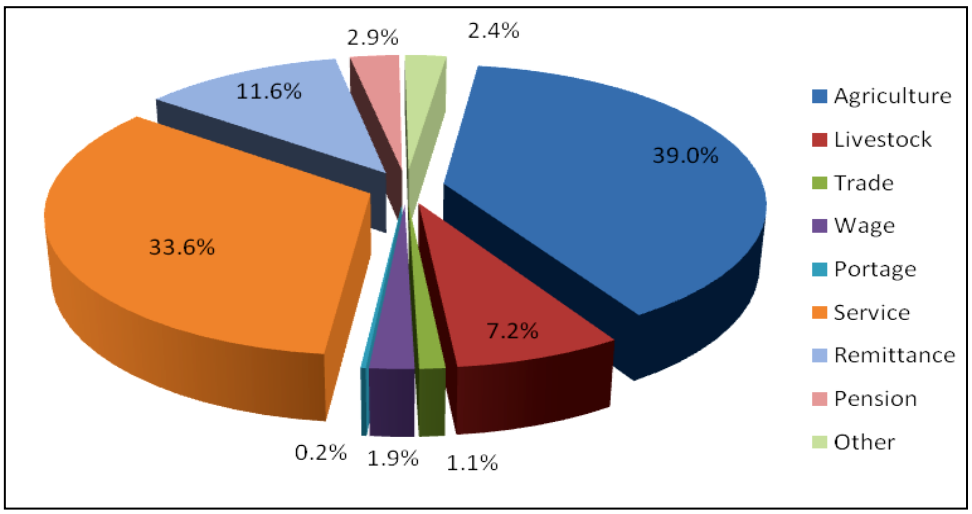
Table 4.6: Average Annual Income of Household by Sources

Sources	Average Income Rs	Percentage
Agriculture	135903.9	39.0
Livestock	25172.8	7.2
Trade	3894.7	1.1
Wage	6701.8	1.9
Portage	789.5	0.2
Service	117122.8	33.6
Remittance	40421.1	11.6
Pension	9994.1	2.9
Other	8422.8	2.4
Total	348423.5	100.0

Source: Field Survey, 2011

The Table 4.6 reports that the main source of income of the people in the study area comes from agriculture crops production (39.0 percent) followed by service sector salary (33.6 percent). Revenue from foreign employment holds 11.6 percent share of total income source. Likewise livestock (7.2 percent) and pension (2.9 percent) are also small but important income source. The negligible share of this income is contributed from wages (1.9 percent) followed by other sources (2.4 percent) and income from trade (1.1 percent).

Figure 4.10: Income Sources of Sampled Household



Study of annual average expenditure pattern per household of the study area in Table 4.7 shows that, maximum 52.22% of total expenditure is spent in non food categories, 43.02%

of total expense is exhausted in food and beverage and remaining 4.76% of total sum is used up in investment.

This data illustrates that people spent 23.19% of their total expenditure in food grains, 7.81% in meat, 5.78% in milk and 3.30% in vegetable. On non food categories people spent 17.86% of their total expenses for education. This shows that people in Balaha are highly aware about the importance of education. Likewise people expended 9.87% of total outlay for clothing. Other major sector for expenditure is health (5.72%), social ceremonies (5.22%), transport (3.30%) and loan repayment (4.32%). About 4.76 percent of total expenditure goes to investment mainly: land improvements (0.31%), irrigation (0.14%), house service (0.81%), agro inputs (0.25%), chemical fertilizer (3.18%) and livestock (0.06%).

Table 4.7: Annual Average Expenditure of Household

Category	Expenditure (Rs)	Percentage
a.Food:		
Food grain	63226.70	23.19
Milk	15747.37	5.78
Sugar	3388.25	1.24
Meat	21294.74	7.81
Beverage	631.58	0.23
Fruit	2521.32	0.92
Vegetable	9000.53	3.30
Drinks	85.26	0.03
Cigarette & Tobacco	1407.37	0.52
Total	**117303.11**	**43.02**
b. Non food:		
Clothing	26903.51	9.87
Education	48693.33	17.86
Health	15587.72	5.72
Transport	9003.51	3.30
Taxes	3175.00	1.16
Wages	2742.11	1.01
Social Ceremony	14240.35	5.22
Firewood	1521.93	0.56
Electricity	4118.77	1.51
Miscellaneous	4619.30	1.69
Loan Repayment	11789.47	4.32
Total	**142395.00**	**52.22**
c. Investment:		
Land Improvements	845.61	0.31
Irrigation	392.11	0.14
House Service	2205.26	0.81
Agro Input	670.18	0.25
Chemical Fertilizer	8684.21	3.18
Livestock	175.44	0.06
Total	**12972.81**	**4.76**
Grand Total	**272670.91**	**100.00**

Source: Field Survey, 2011, Sunsari

4.6.4 Food Sufficiency at Household Level

Food sufficiency is defined as food availability for a family in a year from the production of own farm sources e.g.: crops, vegetables, fruits and livestock.

Table 4.8 shows the past and present status of food sufficiency of sampled household. In 1985 about 87.72 percent of the total households used to have surplus food throughout year, 3.51 percent had enough food for 6 – 8 months. Likewise, 7.02 percent of total sampled household had enough food for only 3 to 6 months while 1.75 percent household had enough food for 3 months only.

In 2010, about 89.47 percent of the total households produce surplus food, 1.75 percent has enough food for 9 to 10 months, and 3.51 percent has enough food for 6 – 8 months. Likewise, 3.51 percent of total sampled household has enough food for only 3 to 6 months while 1.75 percent household has enough food for 3 months only.

Table 4.8: Distribution of Household by Food Sufficiency Status (1985 – 2010)

Status in month	1985		2010	
	Households	Percent	Households	Percent
> 12	50	87.72	51	89.47
9 – 10	0	0	1	1.75
6 – 8	2	3.51	2	3.51
3 – 6	4	7.02	2	3.51
< 3	1	1.75	1	1.75
Total	57	100	57	100

Source: Field Survey, 2011

Figure 4.11: Food Sufficiency Percentage (1985 – 2010)

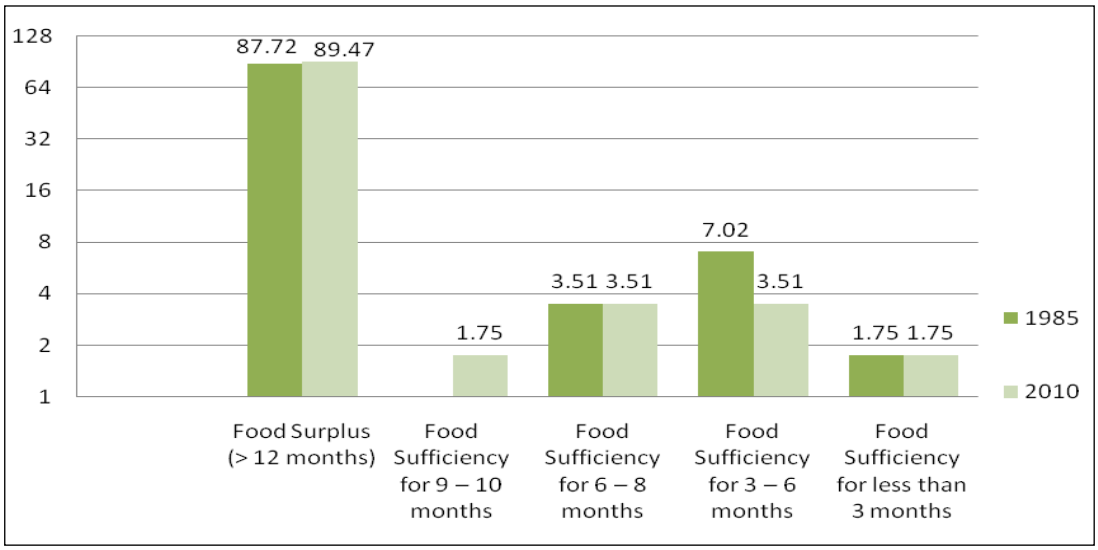


Table 4.8 and figure 4.11 reveals that there slight increase in the status of food surplus in 2010 by 1.75 percent of sampled household as compare to that of 1985.

The farmers have adopted various strategies such as working on farm and off farm labourers, temporary migration to other places in search of jobs and doing miscellaneous activities in order to earn cash for purchasing food grains.

Table 4.9 shows the various way adopted by sampled household to meet deficit of the food. There is slight change in the mode of activities adapted to deficit the food demand. It is observed that during last 25 years most of people are inclined towards the off farm occupation like wages, trade, and services rather than on-farm work like adhiya or contract. In past, 25.0 percent of household overcome food deficiency by purchasing with the income by wage which has rose up to 33.3 percent at present. Likewise, 12.5 percent of household fulfilled food deficiency by purchasing with income by service in past, while 16.7 percent at present. Way to defeat food deficiency by adhiya or contract has been notably decreased from 62.5 percent (in past) to 50.0 percent at present.

Table 4.9: Changes in the Way to Meet the Food Deficit over Time (1985-2010)

1985			2010		
Way	HH	Percent	Way	HH	Percent
Purchasing (Income from Wage)	2	25.0	Purchasing (Income from wage)	2	33.3
Purchasing (Income from Service)	1	12.5	Purchasing (Income from Service)	1	16.7
By adhiya or contract	5	62.5	By adhiya or contract	3	50.0
Total	8	100.0	Total	6	100.0

Source: Field Survey, 2011

4.6.5 Livestock

Livestock is another important part of agriculture which constitutes the major components of Nepalese farming system. Livestock farming is closely interrelated with crop farming. Most of waste receive from crop farming is source of food for domesticated animals where as animal waste is used for manure and for energy source of bio-gas and manure bricked. Animals (oxen and buffalo) reared thus are utilized for power to till the land and draw the carts. Moreover livestock provides milk, meat, egg etc which helps farmers to generate extra income.

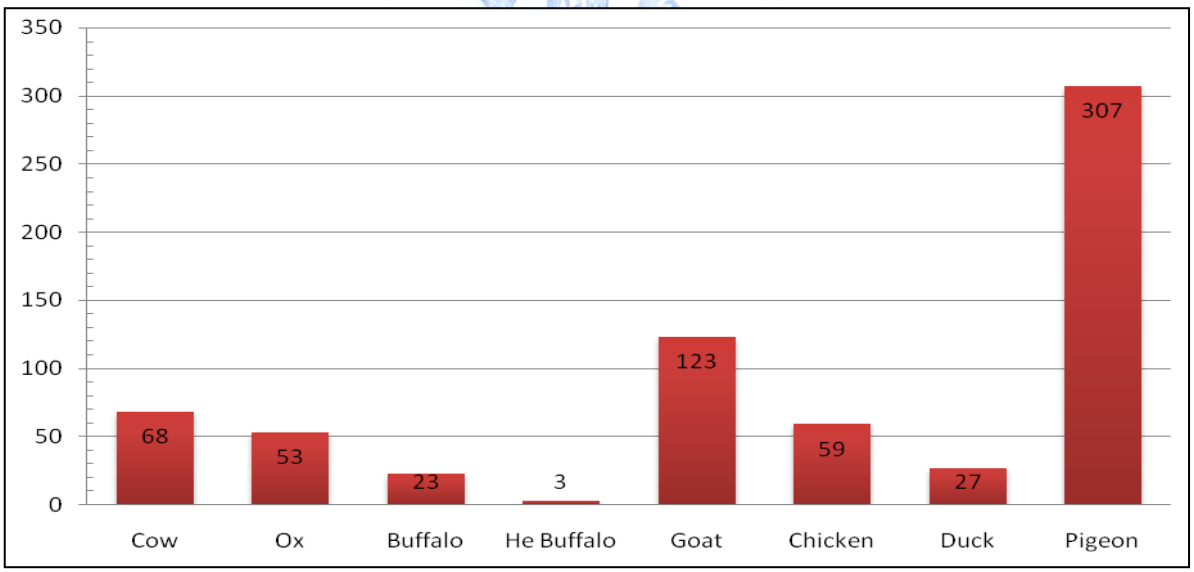
Livestock raised by farmer in the study area are cow, ox, buffalo, he buffalo, goat, chicken, duck and pigeon. Cattle are raised for milk and ploughing purposes, buffaloes are raised for milk and meat, goat for meat, chicken and duck for meat and eggs while pigeon for meat. The average size of livestock is presented in table 4.10.

Table 4.10: Number of Household Keeping Livestock and Number of livestock by Types

Livestock Type	Number	Percentage	HH Number	Percentage
Cow	68	10.3	34	59.6
Ox	53	8.0	27	47.4
Buffalo	23	3.5	13	22.8
He Buffalo	3	0.5	3	5.3
Goat	123	18.6	35	61.4
Chicken	59	8.9	7	12.3
Duck	27	4.1	11	19.3
Pigeon	307	46.3	34	59.6

Source: Field Survey, 2011

Figure 4.12: Average Number of Livestock by Types



The main livestock reared in the study area are cattle, buffalo, goat and poultry (chickens, ducks and pigeons). The table 4.11 reveals that goat is dominant livestock (45.55% of total) followed by cow (25.18% of total) in animal categories in Balaha. About 61.4% household raised goat for meat. Cows are mainly raised both for manure and milk; oxen are used for ploughing the land and to draw the carts. During the survey it is observed that 96.49% of total household have reared the cattle. This shows the importance of cattle for meat, milk,

manure and energy sources. Manure-bricket (Goraha) is used by 66.67 percent of total household as main source of energy for cooking in study area and takes up to 80 percent share of total energy use. Low economic status of farmer and lack of awareness about the importance of manure for agri-field are the main reasons to use manur-bricket as a main source of energy for cooking. Negligible numbers of Buffalo (8.52% of total cattle) are raised for milk in Balaha.

Table 4.11: Number of Livestock by Household

Livestock Type	Local			Improved			Grand Total	No. of HH	Livestock Percent
	Young	Adult	Total	Young	Adult	Total			
Animal									
Cow	33	26	59	5	4	9	68	34	25.18
Ox	7	44	51		2	2	53	27	19.63
Buffalo	8	9	17	3	3	6	23	13	8.52
He	2	1	3			0	3	3	1.11
Goat	32	88	120	3		3	123	35	45.55
Total	82	168	250	11	9	20	270		100
Poultry									
Chicken	33	26	59			0	59	7	15.01
Duck	5	22	27			0	27	11	6.87
Pigeon			307				307	34	78.12
Total	38	48	393				393		100

Source: Field Survey, 2011

Small numbers of poultry are raised in the study area for meat and eggs for home use only. Pigeon, the leading livestock in poultry categories (78.12 percent of total poultry) is reared by 59.65 percent of household mainly for meat. Similarly, Chicken (15.01 percent of total poultry) is raised by 12.28 percent of household whereas small number of Duck (6.87 percent of total poultry) is reared by 19.29 percent of household.

4.6.6 Livestock Production

Most of the farmers said that, while milk and ghee are mostly consumed in own house, other livestock (goats and poultries) are sold to generate income. Table 4.12 shows the annual income generated through livestock and its product.

Table 4.12 reveals that maximum 61.9 percent of average total returns from livestock is attained mainly from milk. Likewise, livestock reared for meat generate about 34.7 percent of average total income while a minimum 3.4 percent earnings is obtained from ghee.

Table 4.12: Annual Average Income from Livestock and its Products

Livestock & Products	Unit	Average Value (Rs)	Average Value (Percent)
Livestock for Meat	516	8,725	34.7
Milk (Ltr.)	22,225	15,596	61.9
Ghee (Kg)	97	851	3.4
Total	-	25,173	100.0

Source: Field Survey, 2011

4.6.7 Livestock Feeds and Feeding System

The farmers feed green fodder to their animals when available in summer season and during the scarcity period (in winter season) dried fodders such as paddy straw, maize-stover and ear-husk etc are fed. The feed is supplemented mainly by the rice barn and maize grains to their animals. The chicken and duck are feed with kitchen waste and concentrated livestock feed. At present, due to lack of grazing land, livestock are stall-fed but in the past (22 years ago) cattle were grazed in open field near Garun Khola.

Available fodder plants in study area are listed in table 4.13. Bamboo is commonly used for fodder and for multiple purposes. Out of 57 household surveyed, 39 household have bamboo in their own field. Similarly, most prominent fodder tree in the study area is Bakaino.

Table 4.13: Different Trees Available In the Study Area by Household

Local name	Botanical Name	HH Number	No. of Trees	Trees per HH
Bamboo	Fartuitis dermatumotus	39	69	1.21
Bakaino	Melia azedarach	37	235	4.12
Ipil-Ipil	Leucaena leucocephala	11	43	0.75
Badahar	Artocarpus lLokoocha	2	3	0.05
Khamari	Gmelina arborea	1	25	0.44
Kadam	Neolamarckia	23	76	1.33
Sisau	Dalbergia sissoo	13	85	1.49
Litter	Eucalyptus diversicolor	4	30	0.53
other	-	22	40	0.70

Source: Field Survey, 2010/11, Sunsari

4.6.8 Sources of Energy and Uses

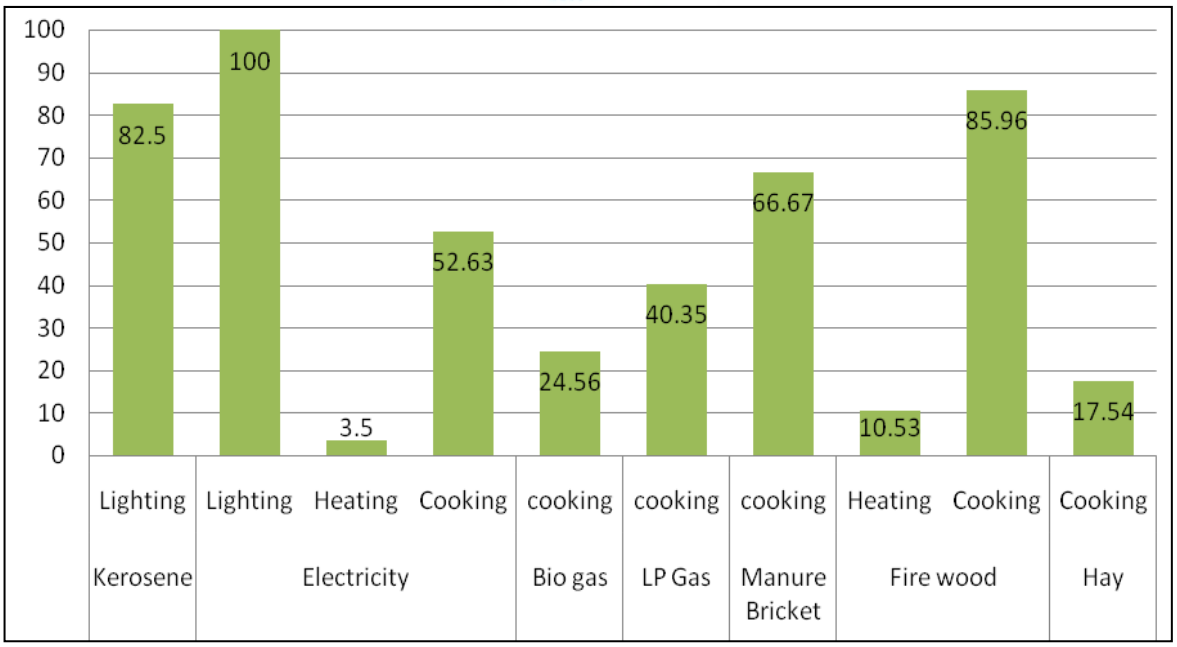
Table 4.14 illustrate that, there are altogether seven types of energy used for different purpose in the study area viz. kerosene, electricity, bio-gas, LP gas, manure bricket, firewood and hay. Obviously, electricity is used by 100 percent of household for lighting purpose but due to the current energy crisis about 82.50 percent use kerosene for lighting during load-shedding. Likewise, 52.63 percent use electricity for cooking rice while only 3.50 percent household use electricity for heating purpose.

Table 4.14: Number of households with Different Sources of Energy Use

Energy Type	Purpose	HH Number	Percent
Kerosene	Lighting	47	82.50
Electricity	Lighting	57	100.00
	Heating	2	3.50
	Cooking	30	52.63
Bio gas	cooking	14	24.56
LP Gas	cooking	23	40.35
Manure Bricket	cooking	38	66.67
Fire wood	Heating	6	10.53
	Cooking	49	85.96
Hay	Cooking	10	17.54

Source: Field Survey, 2011

Figure 4.13: Use Percent of Different Energy Source by Household



For cooking 66.67 percent of household use manure-bricket (Goraha), 40.35 percent of household use LP Gas, 24.56 percent household use Bio-gas, 17.54 percent of household use

hay (paddy straw). Similarly, firewood is used by 85.96 percent of household mainly for cooking the cattle feed and only 10.53 percent of household use firewood as heating purpose.

Table 4.15 shows the actual distribution of different energy use by percent for cooking. Manure-bricket (Goraha), main source of energy for cooking in study area, takes up to 80 percent share of total energy use. Firewood is mostly used for cooking cattle feed and it serve 10 to 50 percent of energy requirement. Most of the household obtained about 60 percent of annual firewood requirement by their own field and remaining 40 percent is purchased in local market.

Table 4.15: Distribution of Different Energy Use by Percent for Cooking

Use Percent	Number of HH using different energy sources					
	Electricity	Bio-gas	LPG	Manure Bricket	Firewood	Hay
10	25			1	17	
11 - 20	5		3	5	12	1
21 - 30			6	3	7	3
31 - 40			2	3	7	4
41 - 50		4		12	6	1
51 - 60		6	1	5		1
61 - 70		3	4	8		
71 - 80		1	5	1		
81 - 90			2			
Total Household	30	14	23	38	49	10
Total percent	52.63	24.56	40.35	66.67	85.96	17.54

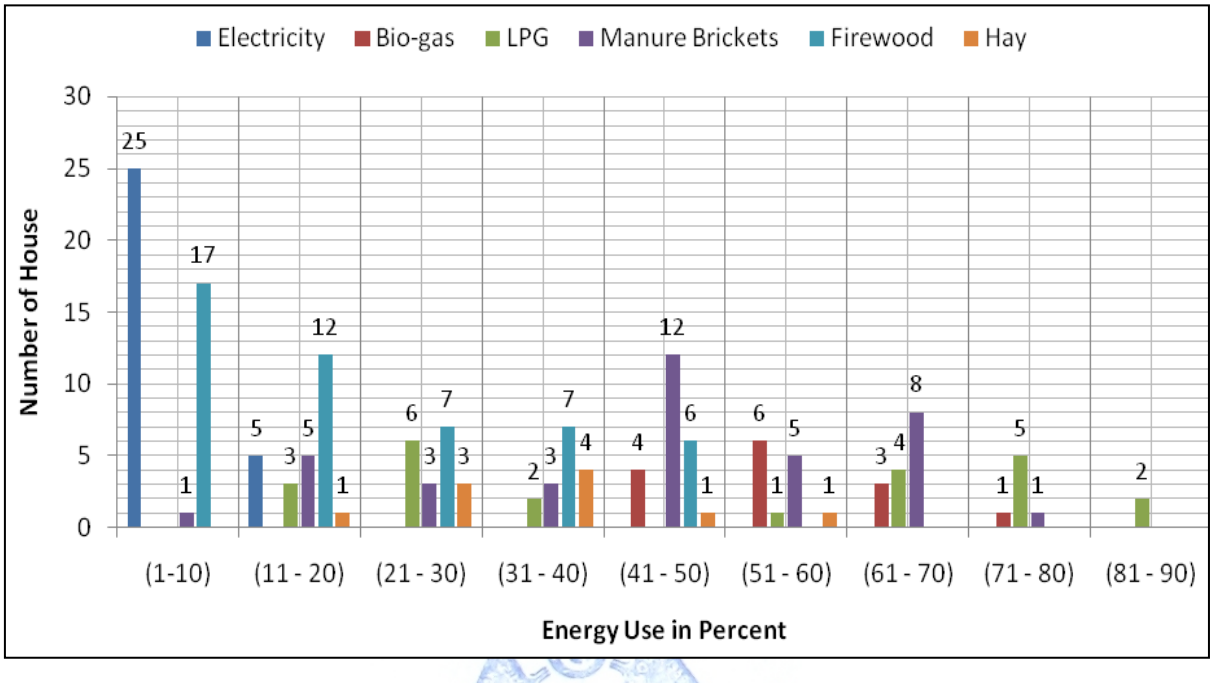
Source: Field Survey, 2011

Bio gas serves up to 40 to 80 percent of energy requirement. Use percent of LP Gas varies from 11 percent to maximum 90 percent but distribution is inconsistent in nature. About 52.63 percent of household use electricity for cooking and maximum use percent of electricity for cooking is 10 to 20 percent. Surprisingly, about 17.54 percent of household (mainly in Tharu community) use Hay as an energy source for cooking which contribute 11 to 60 percent of energy requirement.

This study shows that large numbers of people are still using manur-bricket as a main source of energy for cooking. The main reason behind this is lack of awareness about the

importance of manure for agri-field and low economic status of farmer. Low economic status compel them (especially in Tharu community) to use hay as an energy for cooking which could be used to feed cattle.

Figure 4.14: Number of Household by Energy Use Percent for Cooking



4.6.9 Settlement and House Type

In Balaha there are two distinct types of settlements, those of indigenous Tharu people and those of in-migrants Brahmin, Newar and other. Ethnic indigenous Tharu group's settlement once used to be compact over single large area in a joint family, in the past but at present they are living together at same area in new houses and in little spacious way. In-migrant's settlement is found to be more scattered.

Similarly the house type is also different between indigenous Tharu people and in-migrants. Tharus' houses are traditional type made by mud and wood, mostly two story and corrugated tin roof. Some of them have modern type of concrete house in Tharu settlement. The house type of in-migrant people is mostly of wood wall and corrugated tin roof type some of them having concrete type houses. Table 4.16 illustrate the total number and type of house according to ethnicity.

Table 4.16: Number and Type of House by Ethnicity

Ethinicity	Wall type	Roof type	Storey	No. of House	Percent
Bramin	M W Bm	C T	2	4	6.2
	M W Bm	C T	1	3	4.6
	M W Br	C T	2	7	10.8
	M W Br	C T	1	2	3.1
	Br C	C T	2	4	6.2
	Br C	C T	1	3	4.6
	Br C	CRBC/ RCC	2	3	4.6
	Br C	CRBC/ RCC	1	7	10.8
			Total	33	50.8
Tharu	M W Bm	C T	2	8	12.3
	M W Bm	C T	1	9	13.8
	M W Br	C T	2	1	1.5
	M W Bm	M T	1	1	1.5
	M W Bm	H Kh	1	4	6.2
	Br C	CRBC/ RCC	1	2	3.1
			Total	25	38.5
Newar	M W Bm	C T	2	1	1.5
	M W Bm	C T	1	1	1.5
	M W Bm	M T	1	1	1.5
			Total	3	4.6
Roy	M W Bm	C T	1	1	1.5
Kusbaha	M W Bm	C T	1	1	1.5
Other	M W Bm	C T	1	1	1.5
	M W Br	C T	1	1	1.5
			Total	4	6.2
			Grand Total	65	100.0

Source: Field Survey, 2011

Remarks:

M W Bm: Mud Wood Bamboo, C T: Corrugated Tin, M W Br: Mud Wood Brick,

Br C: Brick and Cement, CRBC/RCC: Concrete RBC/RCC, M T: Mud and Tile, H Kh: Hay and Khar

Note: Total no. of House is 65 (i.e. more than sampled household) because some of household owned more than one house.

4.6.10 Agricultural Loan

The sources of agricultural loan, its purpose and amount in rupees taken by surveyed households are listed in table 4.17. The farmers have taken loan from different sources for different purposes. Main purpose includes – agriculture improvement, livestock, education, over-sea employment and house construction. Table 4.17 reveals that all together ten

households (17.5% of sampled household) have taken the agricultural loan. Majority of household admit that they had taken loan from Agriculture Development Bank, others from Ratriya Banijya Bank and Local Finance Company.

Table 4.17: Sources and Purposes of Agricultural Loan

Loan Purpose	HH	Percent	Source	Amount (Rs) per HH
Over-sea Employment	1	1.7	Ratriya Banijya Bank	12000
Livestock	1	1.7	Agriculture Development	30000
Agriculture Improvement/Livestock	1	1.7	Agriculture Development	36000
Over-sea employment/ Agriculture Improvement/ Livestock /House construction/Education	3	5.3	Agriculture Development Bank / Finance Company	60000
Agriculture Improvement	1	1.7	Agriculture Development	72000
Agriculture Improvement/Livestock/Education	2	3.5	Agriculture Development Bank / Finance Company	96000
Education	1	1.7	Ratriya Banijya Bank	150000

Source: Field Survey, 2011

4.6.11 Transportation, Communication and Market

The study area is facilitated by fairly developed transportation facilities. Balaha and Chadbela respectively lie at 1.8 km and 2.8 km east from the main Inaruwa bazaar (correspond to ward no. 1). Both wards have been interlinked to Inaruwa Bazaar by Dhuhabi Road (Dhuhabi – Inaruwa 14 km). The East-West Highway passes about 3 km west from Balaha. Many feeder roads have also been developed by the people.

A telecommunication facility is found to be fairly good in the study area. More than 60% youth have their own mobile phone and some of them are internet users. Other people are also advantaged by land line telephone.

Major function of the nearest market with their priority, mode of transport and distance are shown on table 4.18. For marketing purpose, most people of Balaha go to shop at Balaha for daily necessary goods. After Balaha, Inaruwa, Duhabi, Jogbani, Biratnagar, Dharan are the main destination of people.

Table 4.18: Major Function of Market, Mode of Transport and Distance

Name of market	Mode of Transport	Distance km	Purpose
Balaha	Walk, Bicycle	0.05 – 0.70	Daily necessary goods
Inaruwa	Walk, Bicycle, Riskha, Tempo	1.50 – 2.80	Administrative work, Banking, Livestock, Fertilizer, Seeds, Electronics goods etc
Duhabi	Bicycle, Tempo, Bus	11.20 – 12.50	Clothes, Shoes, Electric goods
Jogbani	Bus	29.20 – 30.50	Clothes, oil, Curry powder, Sugar
Biratnagar	Bus, Tempo	23.20 – 24.50	Medicine, Education, Clothes, Ornaments, Fertilizer, Seeds
Dharan	Bus	35.70 – 37.00	Medicine, Ornaments

Source: Field Survey, 2011

Inaruwa market is visited for buying and selling livestock, fertilizer, seeds, electronics goods, banking and other administrative work. Some people prefer Duhabi bazaar for buying clothes, shoes, electronics goods. Likewise, majority of people from study area goes to Jogbani (Indian-boarder market) for buying cotton clothes, bed sheets, oil, curry powder, sugar etc. Biratnagar is taken as a center for education and medical facilities and for clothes, ornament, fertilizer, seeds etc. Similarly, people visit Dharan for buying, ornaments and for medical service. Kathmandu is also destination for medicinal, some administrative and other purpose.

Periodic market (haat bazaar) is another characteristic of the study area. Periodic markets serve in easy deliver of daily necessary goods (especially foods) and livestock in reasonable price. People sell surplus food grains and buys food, vegetable from the haat. In Inaruwa municipality haat held twice a week - Monday (Sombare Bazaar) and Thursday (Bihibare Bazaar).

Within these bio-physical and socio-economic context, Structure and Change in Agriculture is discussed in the next chapter.

Chapter V

FARM, CROP AND CROPPING PATTERN

5.1 Introduction

Farm, crop and cropping pattern of the study area is discussed in this chapter. It describes about the different categories of cultivated land according to different land type and their distribution, land holding size, status of land ownership, plot's spatial location. Likewise, a description about cropping pattern, crop calendar and cropping intensity of the study area has been made.

5.2 Agriculture Land at Household Level

An attempt has been made here to discuss how the agriculture land is distributed and how the plots are spatially structured, based on the information collected from 57 households in Balaha village, Sunsari district.

5.2.1 Type of Agriculture Land

For the purpose of Cadastral Survey the government of Nepal has divided the agriculture land into different groups based on the production potential of the land. Firstly, agricultural land is divided into two types – Khet and Bari (Pakho). Both Khet and Bari as defined by Cadastral Survey are divided into four subtypes – Abbal, Doyama, Sima, Chahara based on the topography, soil, altitude, availability of water and growing season. Abbal is the first grade land with high production potential. The production potential decreases in sequence from Abbal to Chahara.

Type of the agriculture land owned by surveyed household in the study area is shown in Table 5.1. In zone A 75.93 percent of total sampled area is Doyama Khet, followed by Abbal Bari 21.58 percent. Similarly, Doyama Bari shares 1.41 percent while Abbal Khet shares only 1.08 percent area of zone A. About 61.82 percent of total sampled area in zone B is Abbal Khet, followed by Doyama Khet 31.34 percent. Likewise negligible share of Abbal Bari and Doyama Khet (5.64 percent and 1.19 percent of total sampled area respectively) exist in

zone B. Zone C has 64.43 percent of Doyama Khet and 34.87 percent of Abbal Bari. Zone D prominently has 96.58 percent of Abbal Khet followed by 3.42 percent of Doyama Khet.

Table 5.1: Zone-wise Division of Existing Cultivation Land by Different Land Type

Zones	Land Type	No. of Parcel	Area (ha)	Percentage
A	Abbal Bari	16	3.9208	21.58
	Doyama Bari	8	0.2562	1.41
	Abbal Khet	2	0.1969	1.08
	Doyama Khet	32	13.7989	75.93
	Total	58	18.1728	100.00
B	Abbal Bari	1	0.1099	1.19
	Doyama Bari	1	0.5200	5.64
	Abbal Khet	27	5.6965	61.82
	Doyama Khet	15	2.8883	31.34
	Total	44	9.2147	100.00
C	Abbal Bari	19	5.986	34.87
	Doyama Bari	1	0.1213	0.71
	Abbal Khet	0	0	0.00
	Doyama Khet	37	11.0606	64.43
	Total	57	17.1679	100.00
D	Abbal Bari	0	0	0.00
	Doyama Bari	0	0	0.00
	Abbal Khet	51	11.7598	96.58
	Doyama Khet	4	0.416	3.42
	Total	55	12.1758	100.00

Source: Field Survey, 2011

Note: Zone is defined in methodology.

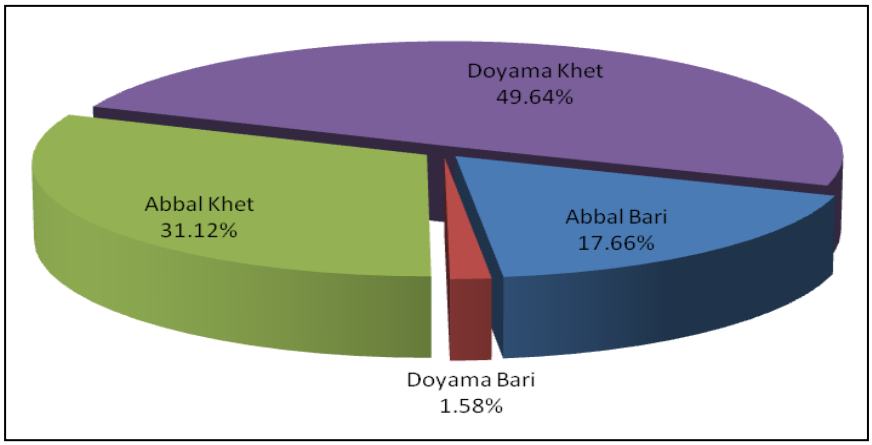
Table 5.2 and figure 5.1 shows that Doyama khet shares 49.64 percent of total sampled area, followed by Abbal khet 31.12 percent. Similarly 17.66 percent of total sampled cultivated area is under Abbal Bari categories while Doyama Bari holds a negligible share of 1.58 percent of total sampled area.

Table 5.2: Distribution of Cultivation Land by Different Land Type

Land Type	No. of Parcel	Area (ha)	Percent
Abbal Bari	36	10.0167	17.66
Doyama Bari	10	0.8975	1.58
Abbal Khet	80	17.6532	31.12
Doyama Khet	88	28.1638	49.64
Total	214	56.7312	100.00

Source: Field Survey, 2011

Figure 5.1: Distribution of Cultivation Land by Different Land Type



5.2.2 Size of Holding

Land is considered as the main asset of household for sustaining livelihood in rural areas. Land is the signal of social status, prestige and political power (Rai D.B. 2011). Land sizes determine the economic status of household. Land holding size is most useful parameter for the measurement of economic condition of the people. Who have large land holding size are considered as economically strong. Land holding size can analyze by two types.

5.2.2.1 Land Holding Size by Area

Field survey shows that total 56.7312 hectare of cultivated land is owned by 57 household of the study area, with an average holding of 0.9953 hectare. The size of land holding ranges from a minimum of 0.1151 to maximum 3.1928 hectare.

Table 5.3 shows the land holding size by area. Total households of the study area have been categorized into six different groups by their size of holding. Under the categories of size of land holding less than 1 ha there are 63.15 percent of household who owned only 34.55 percent of total cultivated land. This implies that most farmer have small land holding. Similarly 36.85 percent of household owned remaining 65.45 percent of total cultivated land.

Maximum 27.59 percent of land is owned by 6 household (10.53 percent of total household), followed by 25.30 percent of land by 19 household (33.33 percent of total household). Likewise 20.10 percent of land is hold by 9 household (15.79 percent of total

household) and 17.76 percent of land by 6 household. Minimum 2.32 percent of cultivated land is owned by 7 household (12.28 percent of total household).

Table 5.3: Land Holding Size by Area

Size of Holding (ha)	HH Number	Percentage	Total Parcel	Area (ha)	Area Percentage
under 0.25	7	12.28	13	1.3139	2.32
0.25 - 0.5	10	17.54	27	3.9312	6.93
0.5 - 1	19	33.33	69	14.355	25.30
1 - 1.5	9	15.79	34	11.4019	20.10
1.5 - 2	6	10.53	40	10.0752	17.76
2 and over	6	10.53	31	15.654	27.59
Total	57	100.00	214	56.7312	100.00

Source: Field Survey, 2011

Table 5.3 shows that 12.28 percent of total household have less than 0.25 hectare land, 17.54 percent of total household have 0.25 to 0.5 hectare land, 33.33 percent of total household have 0.5 to 1 hectare land. Similarly, 15.79 percent of total household have 1 to 1.5 ha land who are medium size farmer. About 10.53 percent of total household have at least 1.5 to 2 ha or more than 2 ha land holding.

Figure 5.2: Land Holding Size by Area

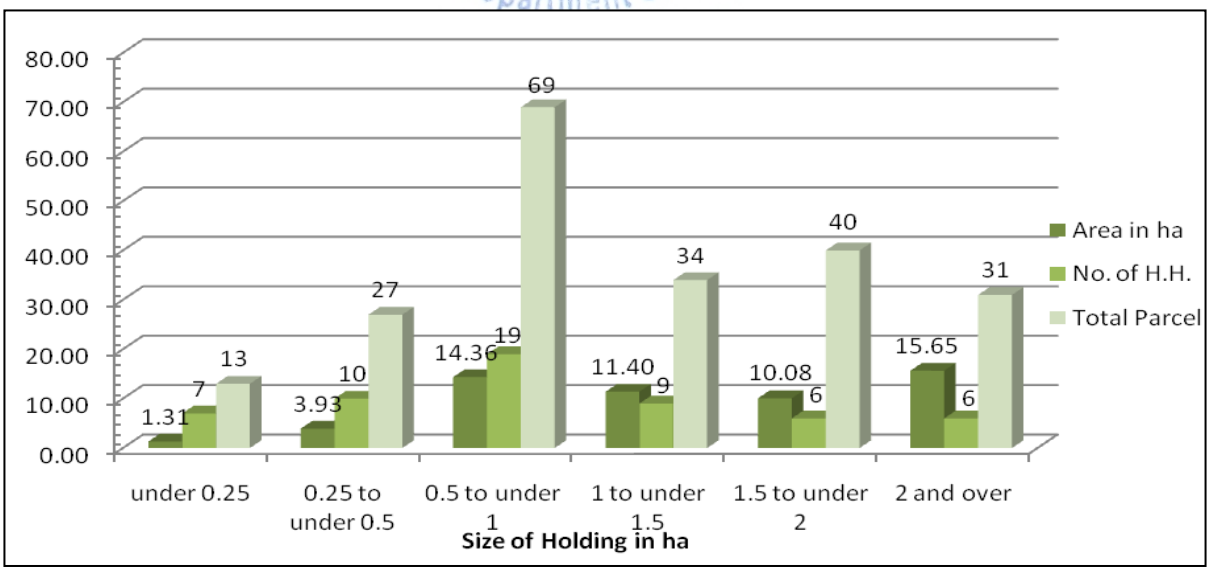
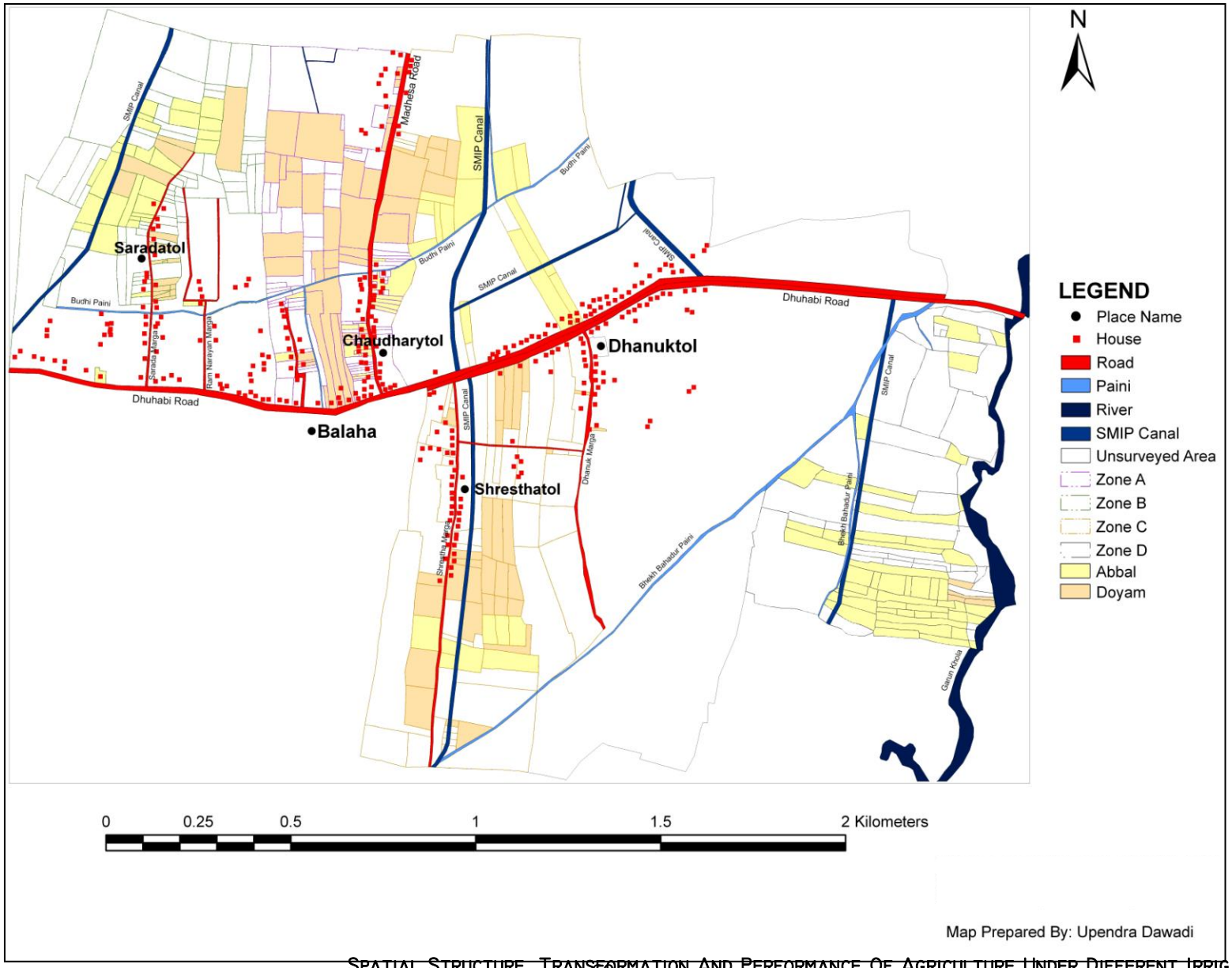


Figure 5.3: **LAND TYPE MAP OF BALAHA**



Average land holding size at national level is 0.789 hectare. It is 0.944 hectare in terai and 0.915 hectare in eastern terai (CBS 2008). The data shows that land holding size of the study area is slightly larger than national average holding.

5.2.2.2 Size of Land Parcel

Number of parcel also shows the land fragmentation situation of the area which is one of major agriculture problem of Nepal. The data shows that the study area Balaha is also suffering from the land fragmentation problem.

Altogether 214 parcels owned by 57 households were studied in the study area. The number of parcel owned by household ranges from 1 to 10 and household average is 3.75 parcels. Most of household has 2 to 3 parcels and about 52.63 percent household has maximum 3 parcels which shares the 31.60 percent of total sampled cultivated land. Out of 57 household, three household have only 1 parcel, same as two household have 9 to 10 parcels.

Table 5.4 reveals that total 156 parcels is owned by 49 household with maximum 5 number of parcel holding which amount to 75.84 percent of total sampled cultivated land. This delineate that large number of fragmented small parcel exist in study area. The total production of crops by a single farmer is directly influences by the spatial location of different parcel he own. Generally production decreases if the farmer has got many parcels scatter in different area.

Table 5.4: Land Holding Size by Number of Parcel

No. of Parcel	HH Number	Percentage	Area (ha)	Area (Percentage)	Total no. of Parcel
1	3	5.26	0.7375	1.30	3
2 to 3	27	47.37	17.1884	30.30	66
4 to 5	19	33.33	25.0992	44.24	87
6 to 8	6	10.53	10.4111	18.35	39
9 to 10	2	3.51	3.295	5.81	19
Total	57	100.00	56.7312	100.00	214

Source: Field Survey, 2011

5.2.3 Land Ownership

Majority of households are land owner (63.16 percentage of total household) and practice the cultivation by own (table 5.5). About 61.38 percent of the total cultivated land is cultivated by the owner itself. Similarly, cultivation either under contract basis or in Batuwa/Adhiya is practiced by about 36.84 percent of total sampled household. About 30.64 percent of cultivated land is under Batuwa or Adhiya and 7.99 percent of the total cultivated area has been given or taken as in fix contract basis.

Table 5.5: Number of Household, Parcel and Area by Types of Ownership

Ownership of Land	HH Number	Percentage	No. of Parcel	Parcel (Percentage)	Area (ha)	Area (Percentage)
Contract	5	8.77	17	7.94	4.5301	7.99
Batuwa / Adhiya	16	28.07	45	21.03	17.3799	30.64
Own	36	63.16	152	71.03	34.8212	61.38
Total	57	100.00	214	100.00	56.7312	100.00

Source: Field Survey, 2011

Figure 5.4: Percentage of Parcel by Ownership Type

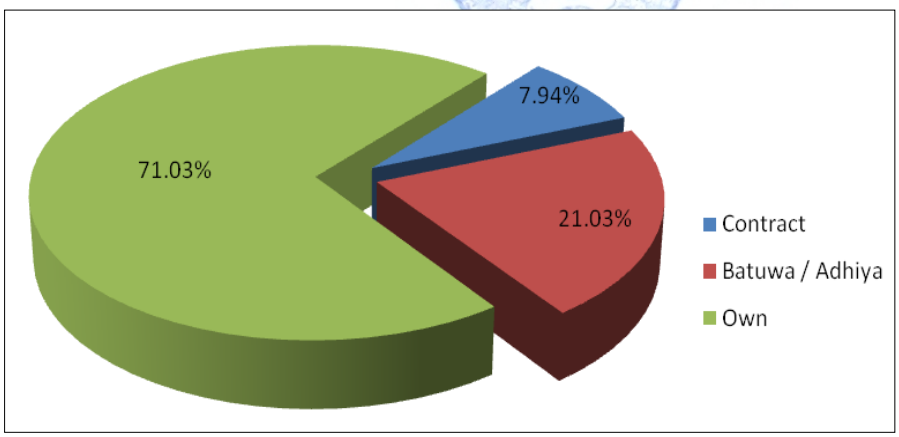


Figure 5.4 reveals that cultivation on 71.03 percent of total parcel is done by landowner himself, 21.03 percent of total parcel is given or taken as Batuwa / Adhiya and 7.94 percent of total parcel is under contract.

5.2.4 Spatial Dimension of Agricultural Land

Agricultural lands of farmers in Balaha are scattered. Farms are in different distance from farmers' house ranging from 5 minute walking distance to more than 25 minutes. Table 5.6 illustrates the time to reach farm from house by walking.

Table 5.6: House to Farm Walking Distance

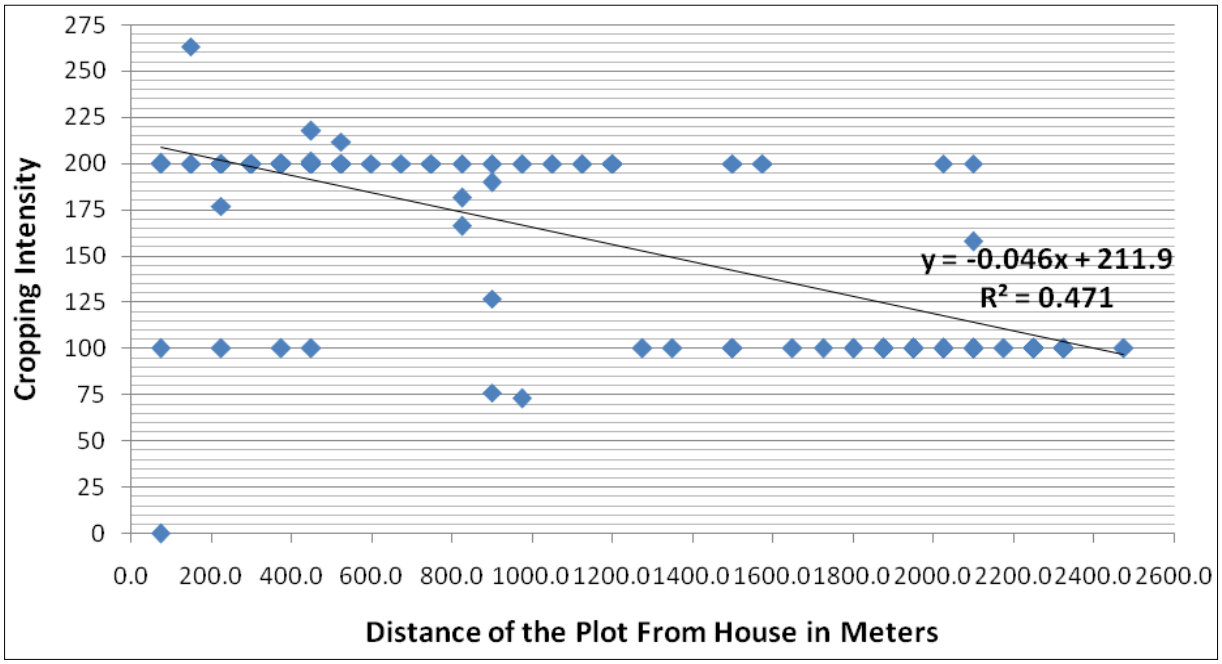
Distance in minutes	No. of Parcel	Percentage	Area (ha)	Percentage
Below 5	109	50.93	23.4137	41.27
More than 5 to 15	51	23.83	20.316	35.81
More than 15 to 25	23	10.75	6.7139	11.83
More than 25	31	14.49	6.2876	11.08
Total	214	100.00	56.7312	100.00

Source: Field Survey, 2011

Table 5.6 shows that 50.93 percent of total parcel (i.e. 41.27 percent of total sampled cultivated land) is situated within 5 minutes walking distance from farmers' house. Similarly, 23.83 percentages of total parcels (i.e. 35.81 percent of total sampled cultivated land) is located between 5 to 15 minutes walking distance. Remaining 25.24 percent of total parcel (i.e. 22.91 percent of total sampled cultivated land) is sited farther than 15 minutes walking distance from the residence.

Cropping intensity, pattern and productivity of plot of land is directly influenced by the distance between the place of residence of the farmers and the field they owned. General concept is that nearer the field from the place of residence, higher the cropping intensity and vice versa. A regression model test about the relation between distance and cropping intensity of study area is shown in figure 5.5.

Figure 5.5: Cropping Intensity According to Distance



Weak positive relationship is found between the distance and the cropping intensity. The R^2 value is 0.471 which shows a positive correlation though weak between distance and cropping intensity. So, the generally accepted concept of the control of distance does exist as important factors in study area. Similarly, irrigation status, soil type and other factor seems to play vital role in determining cropping intensity.

5.3 Crop Cultivation

Table 5.7 reveals that cereal crops production especially paddy cultivation dominate the study area. Paddy is the first choice of the farmers and about 98.2 percent of household cultivate paddy.

Table 5.7: Present Status of Crop Cultivation by Household in Study Area

Crop	HH Number	Percent	No. of Plots	Plots Percentage
Paddy	56	98.2	156	72.9
Wheat	39	68.4	96	44.9
Maize	21	36.8	23	10.7
Pulses	10	17.5	12	5.6
Mustard	18	31.6	23	10.7
Sunflower	5	8.8	5	2.3
Potato	21	36.8	28	13.1
Vegetable	38	66.7	44	20.6
Jute	2	3.5	2	0.9
Sugarcane	1	1.8	5	2.3
Total	57	100	214	100

Source: Field Survey, 2011

Wheat is second major crops production of Balaha (about 68.4 percent of household cultivate wheat) whereas maize and potato cultivation practiced in small area and in small quantity. Besides, some of the farmer having lager land holding is now inclined to start commercial sugarcane farming while few farmers still practice jute cultivation especially for household purpose in scanty area. About 66.7 percent of household found to cultivate vegetable mainly for home consumption. Oilseeds and jute are other cash crops practiced by farmers in Balaha In very small scale.

5.4 Horticulture and Vegetable farming

Horticulture is another part of agriculture practiced in Balaha. Mainly tropical fruits are grown in Balaha. The main fruits grown in the study area are mango, betel nut (supari), papaya, coconut, banana, jackfruits, litchi, guava, citrus, pineapple, gooseberries (amala), black berry (jamun) etc.

From the point of view of production and cash value mango, coconut, papaya, litchi, guava, citrus, jackfruits, betel nut (supari) and banana are the important fruits of the study area.

Similarly, potato, broadleaf mustard, radish, tomato, cabbage, onion, cauliflower and other seasonal green vegetable are major vegetables produced in the study area. The fruits and vegetables are produced mainly for home consumption only a small portion is marketed. Only one of the farmer produced vegetables commercially. Major fruit tree are listed in table 5.8.

Table 5.8: Major Fruit Tree, Annual Production

Fruits	Number of Plants	Production (Kg)
Mango	177	5955
Betel nut	100	142
Papaya	87	2470
Coconut	69	3335
Banana	43	90
Jackfruits	37	574
Litchi	34	1499
Guava	26	771
Citrus	26	660
Pineapple	25	25
Gooseberries	9	150
Black berry	8	632
Sarifa	6	5
Bell	4	25
Bayar	2	120
Palm (Toddy) Tree	1	-
Total	654	16453

Source: Field Survey, 2011, Sunsari

5.5 Cropping Pattern

There are three distinct cropping seasons in the study area: summer or monsoon (June to October), winter (November to February) and spring (March to May). In past, Jute was the most dominant crop in this area but presently, paddy is the dominant crop during monsoon in both irrigated and rainfed land.

Presently Zone A, B and C shows more or less same cropping pattern with Paddy and Wheat dominance respectively in monsoon and winter. Other crops grown in Zone A, B and C are maize, mustard, sunflower, pulses, potato and jute. Likewise, in Zone D (irrigated) cultivation of Paddy is followed by fallow winter. In Zone A (rainfed) only local varieties of maize and mustard are cultivated while in Zone B farmer are more attracted towards improve varieties of mustard and sunflower and in Zone C improved varieties of both maize and mustard are prominent.

Field survey shows that different cropping pattern is followed by farmer on different agricultural land at study area. The present study noted different combination of crops exhibiting different cropping pattern in different seasons. During monsoon paddy crop dominant in total agricultural land (95.51 percent of total cultivated land), 3.85 percent of land covered by sugarcane cultivation and only 0.64 percent of land contribute to jute cultivation. Maize and vegetables are other monsoon crops which are practiced to cultivate in Balaha. Similarly wheat, pulses, potato, oilseeds farming practiced in winter and spring season.

Table 5.9 shows that the major cropping pattern practicing in the study area is Paddy-Wheat-Fallow covering 36.27 percent of total number of plots and 53.36 percent of total sampled agricultural land. Similarly second major cropping pattern of the study area is Paddy–Fallow–Fallow (lies on Zone D) occupied 20.95 percent of total number of plots and 9.63 percent of total sampled agricultural area. Similarly, Paddy–Wheat+ Pulses+Mustard–Fallow is practice in 1.9 percent of total plot and 6.63 percent of total sampled area. Vegetable–Fallow–Vegetable is practice in 11.9 percent of plot which cover 0.41 percent of total cultivated land. Other main cropping patterns are Paddy–Wheat–Maize, Paddy–

Mustard–Fallow, Paddy–Potato–Fallow, Potato–Vegetable–Fallow, Maize–Mustard+Patato-Vegetable, Jute–Mustard–Fallow etc.

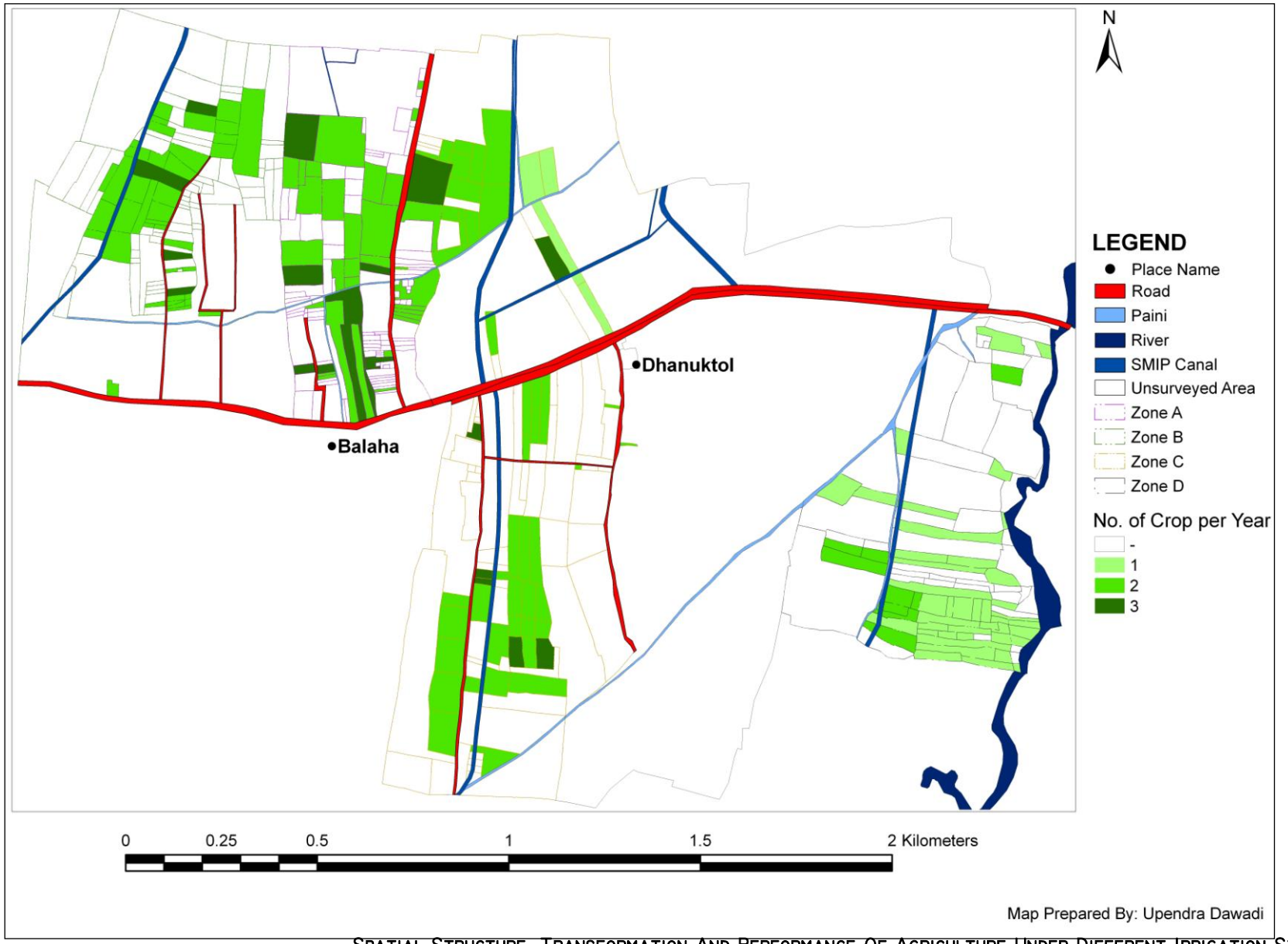
Even though the land fertile enough to practice three to four crop combination per year, most of the farmer at Balaha are compel to follow two crops combination because of labour problem and insufficient irrigation facility.

Table 5.9: Cropping Pattern of Study Area

S.N.	Cropping Pattern	No. of Crops	Plots		Area	
			No.	Percent	Ha	Percent
1	Paddy-Wheat-Fallow	2	77	36.67	52.43	53.36
2	Paddy-Fallow-Fallow	1	44	20.95	9.465	9.63
3	Paddy-Wheat+Pulses+Mustard-Fallow	2	4	1.90	6.514	6.63
4	Paddy-Wheat-Maize	3	3	1.43	5.925	6.03
5	Paddy-Mustard-Fallow	2	5	2.38	3.392	3.45
6	Paddy-Wheat+Mustard-Fallow	2	2	0.95	3.473	3.53
7	Paddy-Wheat+Sunflower-Fallow	2	6	2.86	3.015	3.07
8	Paddy-Wheat+Pulses-Fallow	2	3	1.43	2.401	2.44
9	Paddy-Pulses-Mustard+Patato-Fallow	3	2	0.95	1.281	1.30
10	Paddy-Wheat+Patato-Maize	3	1	0.48	1.268	1.29
11	Paddy-Mustard+Potato-Maize	3	1	0.48	1.405	1.43
12	Paddy- Pulses+Mustard-Fallow	2	1	0.48	0.682	0.69
13	Paddy-Patato-Fallow	2	3	1.43	0.484	0.49
14	Paddy-Pulses-Fallow	2	1	0.48	0.373	0.38
15	Paddy-Mustard+Potato- Fallow	2	1	0.48	0.322	0.33
16	Paddy-Mustard-Maize	3	1	0.48	0.406	0.41
17	Paddy-Pulses+Mustard-	3	1	0.48	0.255	0.26
18	Vegetable-Fallow-Vegetable	2	25	11.90	0.405	0.41
19	Potato-Vegetable-Fallow	2	9	4.29	0.452	0.46
20	Sugarcane	1	5	2.38	1.713	1.74
21	Maize-Potato-Vegetable	3	4	1.90	0.452	0.46
22	Maize-Potato-Fallow	2	3	1.43	0.186	0.19
23	Maize-Mustard+Patato-Vegetable	3	2	0.95	0.185	0.19
24	Maize-Mustard-Vegetable	3	2	0.95	0.524	0.53
25	Maize-Patato-Vegetable	3	1	0.48	0.470	0.48
26	Maize-Vegetable-Vegetable	3	1	0.48	0.093	0.09
27	Jute-Mustard-Fallow	2	2	0.95	0.688	0.70
28	Other	-	-	-	-	-
	Total		210	100.00	98.27	100.00

Source: Field Survey, 2011

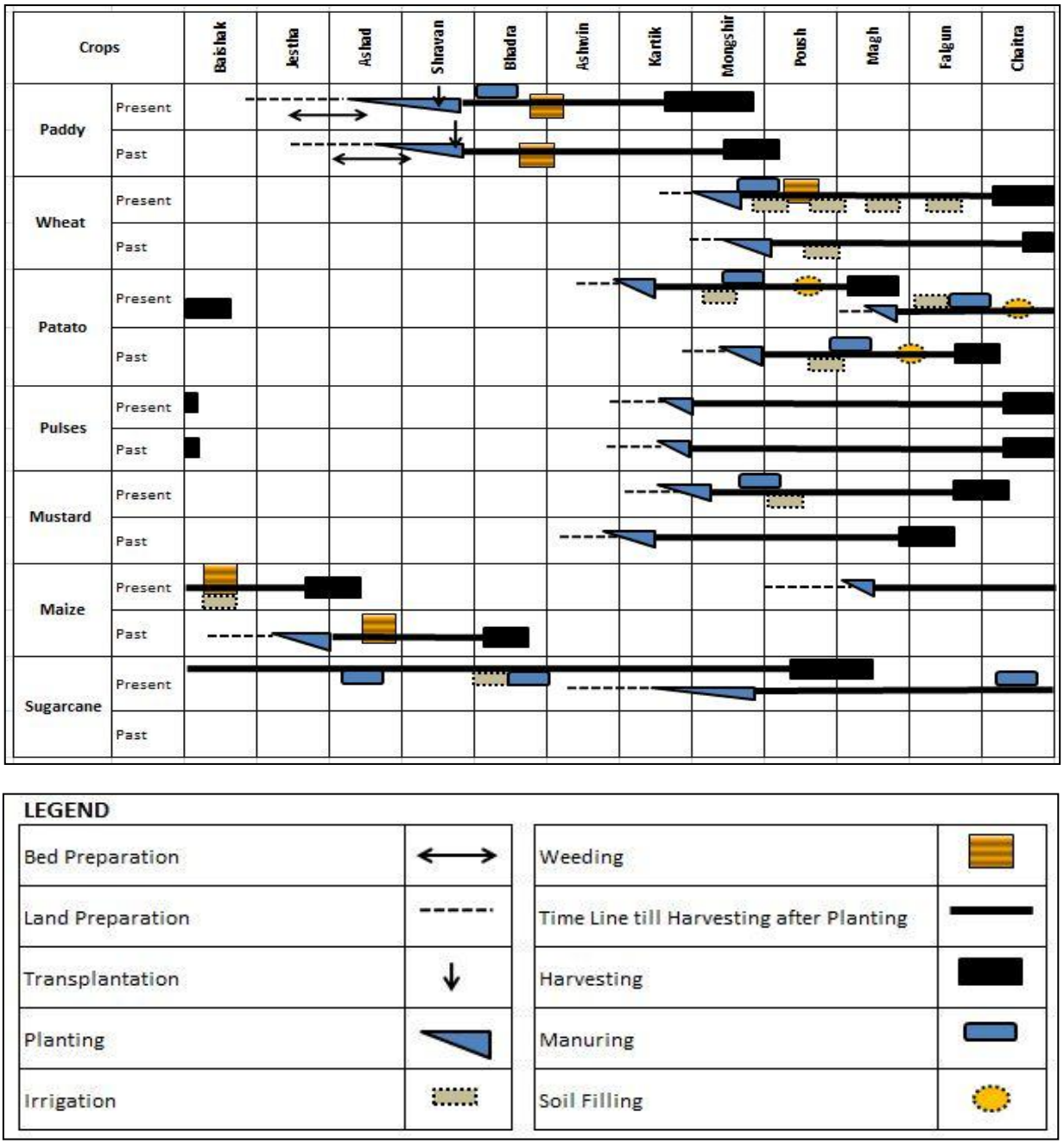
Figure 5.6: **CROPPING PATTERN MAP OF BALAHA**



5.6 Cropping Calendar

The study area Balaha was selected and developed into the command area of SMIP on Project Plan Stage 1 (mid July 1978 to mid June 1986) by extending the Shankarpur canal from Shukhasena canal and constructing minors and water courses. Since then the use of improved seeds and irrigation facility has introduced some change in cropping calendar. For example, local Paddy harvesting after 6 months of weeding time but improved species of paddy harvesting in 3 to 4 months. Similarly, climate change (increased in daily temperature, uncertainty in monsoon) has also effects on cropping calendar of the study area. The changed (around 30 days) has been experienced prominently after 1990.

Figure 5.7: Cropping Calendar of Balaha



5.7 Cropping Intensity

Intensity of cropping signifies the farming practices for extracting maximum output from a particular parcel of land by growing crops more than once a year. The interrelationship between total cropped area of various crops and cultivated area is called cropping intensity. It is measured by the ratio of the area of all temporary crops sown on arable land to the total area of all arable land. The different cropping intensity of different crops has been shown in the table 5.10.

Table 5.10: Cropping Intensity of Balaha

Crops	Gross Cultivated Land for different crops (ha)	Net Cultivated Land (ha)	Cropping Intensity percentage
Paddy (Improved)	51.0308	54.4286	180.28
Wheat (Improved)	32.0586		
Maize (Local)	2.4439		
Mustard (Improved)	2.3501		
Mustard (Local)	2.2416		
Sugarcane	2.0565		
Pulses	2.0417		
Potato (Local)	1.5550		
Vegetable (L/Im)	0.9973		
Sunflower	0.7232		
Maize (Improved)	0.4365		
Jute (Improved)	0.3440		
Grand Total	98.2792		

Source: Field Survey, 2011

Formula, Ci = (Pac/Par)*100 Where, Ci =Cropping intensity

Pac =Gross Cultivated land in a year

Par =Area of net Cultivated land

Cropping intensity of Balaha = (98.1251/54.4286)*100

= 180.28 percent

Cropping intensity of Balaha is 180.28 percent, which slightly higher than that of national context i.e. 180 percent (NSCA 2001).

Cropping intensity is an outcome of farmers' decisions which is directly or indirectly influenced by geo-physical, socio-economic, infrastructure conditions of the area. This is

clearly reflected in table 5.11 which shows the zone-wise cropping intensity of the study area.

Zone A (rainfed) seems to have maximum cropping intensity of 207.58 percent, followed by Zone B (202.30 percent). Likewise Zone C has cropping intensity of 189.80 percent whereas Zone D has minimum cropping intensity of 119.59 percent.

Table 5.11: Zone-wise Cropping Intensity of Balaha

Zones	Crops	Gross Cultivated Area in ha	Net Cultivated Area in ha	Cropping Intensity percentage
A	Paddy	10.8900	11.3754	207.58
	Wheat	7.4071		
	Maize	2.0255		
	Pulses	0.3844		
	Potato	0.5669		
	Oilseeds	1.8535		
	Jute	0.0491		
	Vegetable	0.4364		
	Total	23.4588		
B	Paddy	10.363	10.5923	202.30
	Wheat	7.4010		
	Maize	0.4981		
	Pulses	1.1232		
	Potato	0.1520		
	Oilseeds	1.6617		
	Jute	0.0000		
	Vegetable	0.2293		
	Total	21.4283		
C	Paddy	17.853	20.536	189.80
	Wheat	14.914		
	Maize	0.3568		
	Pulses	0.5340		
	Potato	0.8361		
	Oilseeds	1.7996		
	Jute	0.2949		
	Sugarcane	2.0565		
	vegetable	0.3316		
	Total	38.9765		
D	Paddy	11.9249	11.9249	119.59
	Wheat	2.3364		
	Maize	0		
	Pulses	0		
	Potato	0		
	Oilseeds	0		
	Jute	0		
	Total	14.2613		

Source: Field Survey, 2011

Study reveals that the cropping intensity is influenced by availability of water and spatial location of plot from house (fig 5.5). Cropping intensity in Zone A (rainfed) is high due to cultivation of vegetable and potato in kitchen garden and few parcel nearby house get some waste water from household use. Jute, an important cash crop, is now cultivated in very small scale because of labour shortage, lack of processing water and market crisis. The initial cost for sugarcane cultivation is very high so there is no sugarcane cultivation in Zone A, B and D. Despite of irrigation facilities, Zone D, has low cropping intensity because it lies at more than 25 minutes walking distance from house and crop are susceptible to graze by large number of cattle from adjoining village across the river (especially in winter season). Thus it is clear that the agriculture land of Balaha is not efficiently utilized.

A regression model has been tested to see the relationship between cropping intensity and plot size while the significant difference in cropping intensity according to land ownership types and irrigation status has been examined by applying Chi-square (χ^2) test.

Cropping intensity vs plot size is shown in figure 5.8. In a figure plots are scattered and the slope of a regression line is increased from origin, which shows a weak positive relationship between the cropping intensity and plot size. The R^2 value is 0.061 which shows weak positive correlation. In other words, the cropping intensity increases with increase in plot size.

Figure 5.8: Cropping Intensity According to Plot Size

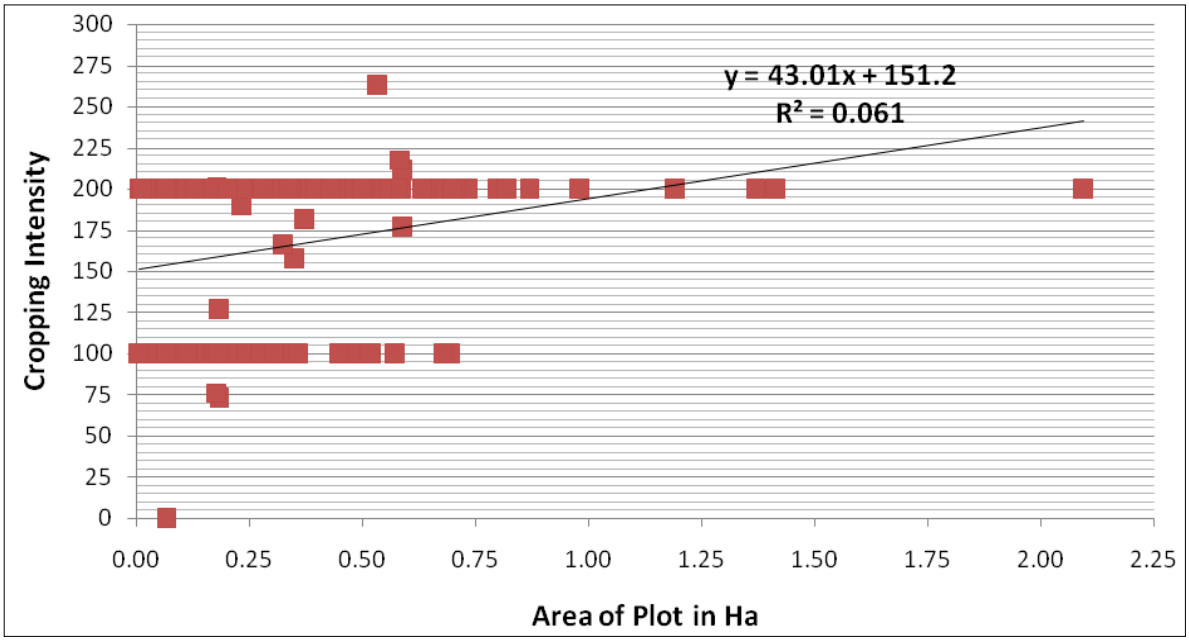


Figure 5.9: **CROPPING INTENSITY MAP OF BALAHA**

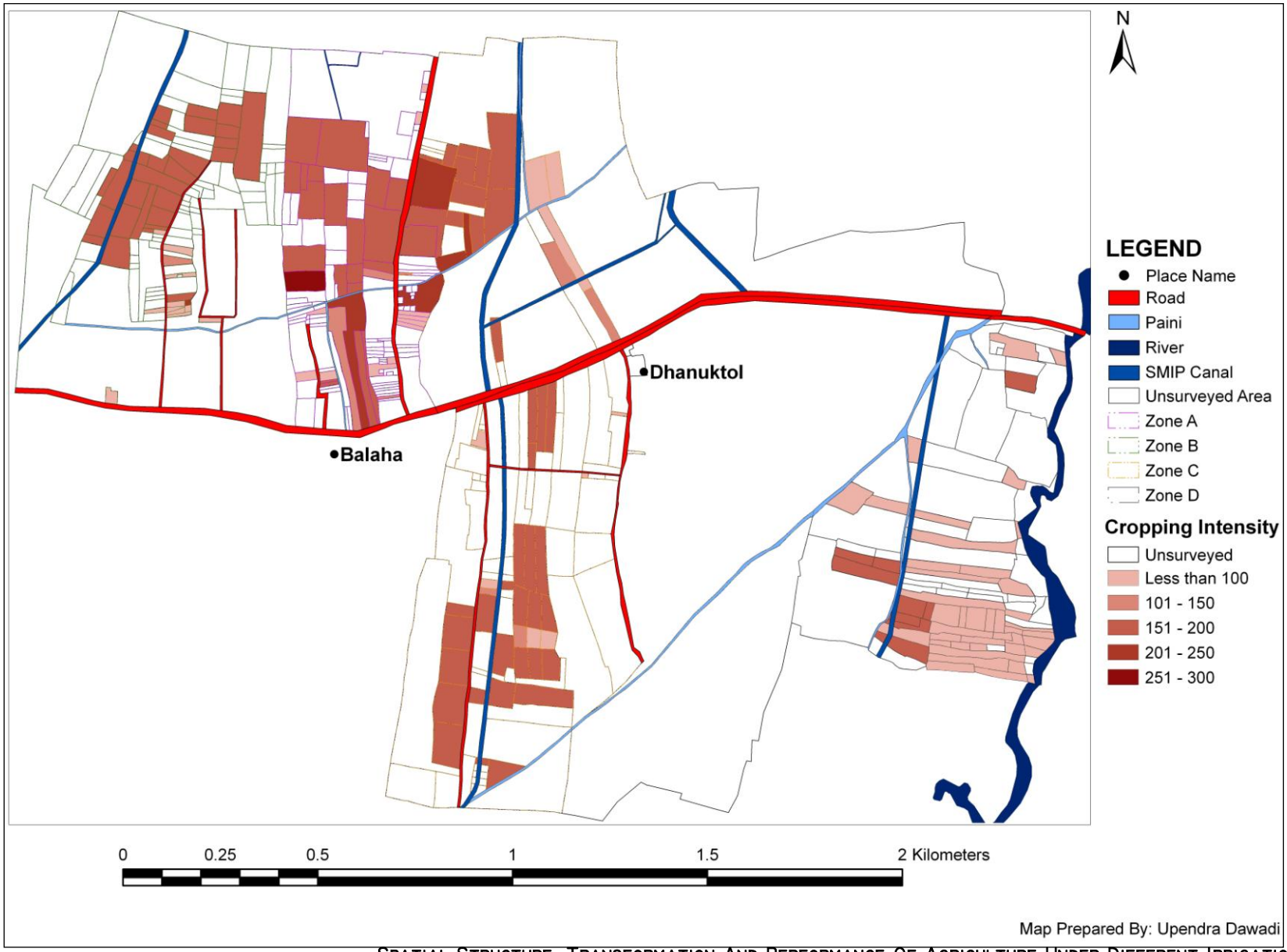


Table 5.12 shows the cropping intensity on different land ownership type. To analyse if there is a significant variation among the cropping intensity of according to land ownership types, Chi-square (χ^2) test has been applied (refer Annex-B for calculation).

Table 5.12: Cropping Intensity According to Land Ownership Type

Land Ownership Type	Cropping Intensity					
	less than 75	76-125	126-175	176-225	Above 225	Total
Own	38	45	10	57	2	152
Batuwa or Adhiya	0	10	3	32	0	45
Contract	0	0	0	17	0	17
	38	55	13	106	2	214

Source: Field Survey, 2011

The calculated value of Chi-square (χ^2) at 0.05 level of significance for 8 degree of freedom is given as 15.5. Since the calculated value (40.34) is greater than tabulated value, the null hypothesis (i.e. there is no significant variation in cropping intensity according to land ownership types) is rejected. It implies there is a significance difference in the cropping intensity according to land ownership type.

Table 5.13 shows the cropping intensity on different irrigation zone. Chi-square (χ^2) test has been applied to analyse if there is a significant variation among the cropping intensity according to irrigation zone (refer Annex-B for calculation).

Table 5.13: Cropping Intensity According to Different Irrigation Zone

Zone	Cropping Intensity					
	less than 75	76-125	126-175	176-225	Above 225	Total
A	21	4	9	22	2	58
B	11	2	1	30		44
C	6	6	5	40		57
D	0	43	2	10		55
	38	55	17	102	2	214

Source: Field Survey, 2011

The calculated value of Chi-square (χ^2) at 0.05 level of significance for 12 degree of freedom is given as 21.03. Since the calculated value (137.36) is greater than tabulated value, the null hypothesis (i.e. there is no significant variation in cropping intensity according to irrigation Zone) is rejected. It implies there is a significance difference in the cropping intensity according to irrigation zone.

Chapter VI

FARM INPUTS, PRODUCTIVITY AND RETURNS

6.1 Introduction

The different crops grown in the study area, inputs used by plots, productivity and returns are discussed in this chapter. Ranking of most efficient crop is done according to the existing different cropping pattern, cropping intensity, inputs and the productivity of different crops and its determinants has been analyzed.

6.2 Agricultural Inputs

Agricultural production and productivity solely depend upon the land capability and the appropriate use of farm inputs. The agricultural production can be increased by intensive cultivation of the existing arable land by applying increased agricultural inputs. Modern inputs and technology applied in agricultural activities plays important role for the improvement of crop production and the agricultural development. The modern inputs and technology includes chemical and organic fertilizer, high yielding improved seed, agro medicine (pesticides, insecticides, and germicides), labour, modern tools and implements, irrigation facility etc.

6.2.1 Fertilizer

Fertilizer is one of the important factors which influenced the productivity of land. Fertilizers used for maintaining soil structure and nutrients of soil of the farm land. Both chemical and organic manures are use by the farmers in study area.

In the study area, farmers have been using various chemical fertilizers. Urea, complex, DAP (Diammonium Phosphate), potash has been regularly used by farmer since 1985. At present, national average of chemical fertilizer use is 26.48 kg per hectare (MOAC, 2011) in Nepal. This is far less in comparison with South Asian Countries. The farmers are using uneven quantity of chemical fertilizer in different crops in the study area. Average annual use rate of chemical fertilizer for all the crop is 159.39 kg per hectare.

Farmers generally perceived that higher the amount of the use of chemical fertilizer higher the production. But they are not aware of the fact that long term effect of heavy use of chemical fertilizer. Some of them have experienced slight negative consequence of the higher use of chemical fertilizer. It makes soil hard and difficult to plough, need more labour to plough and break clods and reduced the moisture retaining capability of the soil. Table 6.1 shows total use of fertilizer in four irrigation zone of study area.

Table 6.1: Use Rate of Fertilizer by Different Irrigation Zone

Zone	Urea (Kg/ha)	DAP (Kg/ha)	Potash (Kg/ha)	Zinc (Kg/ha)	Manure (Kg/ha)
A	63.54	41.98	17.22	3.32	3000
B	78.92	60.51	21.41	5.67	1250
C	88.17	62.77	18.81	4.76	9810
D	87.44	58.62	19.90	4.54	-
Mean	79.52	55.97	19.3	4.57	

Source: Field Survey, 2011

6.2.1.1 Organic Manure

Organic manure is made from plant and animal sources, or from rock powders which need to be broken down by soil microbes in order for their nutrients to be released, and that takes time. Thus, manure works slowly and provides long-term steady nutrition, rather than excessive growth. It makes soil spongy to soak up water, which in turns, retards water percolation from the plot.

Organic manure differs from chemical fertilizer, in that; they feed the plants while building the soil's structure. Soils with lots of organic material, remain loose and airy, are better able to hold moisture and nutrients, foster growth of soil organisms, including earthworms, and promote healthier root development.

In Balaha farmers produced organic manure from their livestock waste, grass and dung. People are using animal dung for cooking purpose as energy that effects on the total quantity of manure used. Large number of livestock in Balaha is reared mainly by Tharu people. As the use of dung and manure-bricket as energy is high among Tharu community, the use quantity of organic manure for cultivation in Balaha is found to be very little. During

field survey farmer unanimously agreed that the use of organic manure has decreased remarkably in past 10 -15 years. In past agriculture was totally based on organic fertilizer, local seed and monsoon rain. At present, organic manure from livestock waste, grass and dung is used in negligible quantity. Shockingly, most farmer questioned why to use organic manure when there available a cheap chemical fertilizer.

6.2.1.2 Chemical fertilizer

Chemical fertilizer effect fast on increasing production and productivity of land thus it is very important and necessary for farmers. The wide use of chemical fertilizer is observed in the study area. Farmers has been regularly using various chemical fertilizers such as Urea, Complex, DAP (Diammonium Phosphate), Potash since 1985. Now they are also using zinc in small amount. Using rate of chemical fertilizer has been increasing year by year.

The four main macronutrients that have been identified as absolutely necessary for plants which are used by farmers of Balaha are nitrogen (N), phosphorus (P), potassium (K) and Zinc (Zn).

At present, almost all the sampled households at Balaha admit to use chemical fertilizer. They unanimously said that the use of chemical fertilizer is at highest peak nowadays. Table 6.2 shows the use rate of chemical fertilizers by the type of crop in 2010. The using rate of chemical fertilizer in Balaha has been remarkably changed within two and half decades. Till 1985 farmer seldom used negligible quantity of chemical fertilizer in paddy and wheat but today they use chemical fertilizer in almost all crops (jute being exception).

Figure 6.1: Use of Chemical Fertilizer for Different Crop

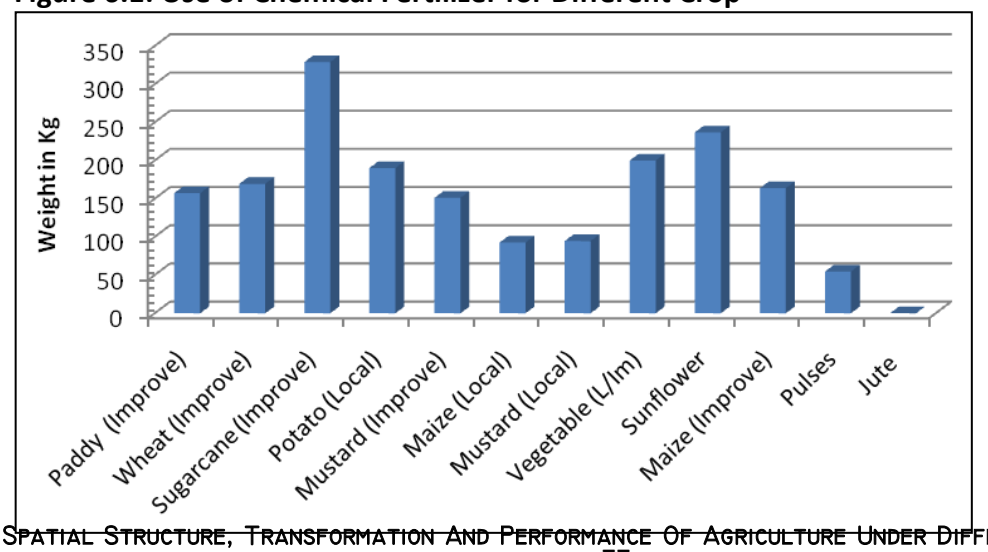


Table 6.2: Zone-wise Use of Chemical Fertilizer for Different Crop

Zone	Crop Grown	Urea Kg/ha	DAP Kg/ha	Potash Kg/ha	Zinc Kg/ha	Total	Average Cost
A	Maize (Local)	40.48	27.89	17.77	0.99	87.14	2643.00
	Mustard (Local)	41.00	30.48	15.38	0.27	87.13	2729.53
	Paddy (improved)	73.00	37.97	17.24	4.25	132.47	3906.06
	Patato (Local)	94.81	63.41	40.57	0.00	198.79	6008.31
	Pulses	2.60	2.60	2.60	0.00	7.80	237.60
	Vegetable (L/Im)	83.65	63.59	40.33	0.00	187.58	5790.67
	Wheat (improved)	61.56	54.00	15.22	4.00	134.79	4489.43
B	Maize (improved)	95.02	54.30	30.54	3.39	183.25	5434.03
	Maize (Local)	58.45	39.91	24.23	2.00	124.59	3785.74
	Mustard (improved)	0.00	64.47	46.73	20.11	131.30	4802.28
	Mustard (Local)	0.00	53.69	42.95	10.74	107.38	3915.93
	Paddy (improved)	84.43	53.02	14.95	4.52	156.93	4903.13
	Patato (Local)	83.89	60.86	36.19	0.00	180.94	5575.04
	Pulses	17.81	17.81	17.81	0.00	53.42	1626.24
	Sunflower	88.84	88.84	29.59	29.59	236.86	7816.98
	Vegetable (L/Im)	91.16	71.75	45.36	0.00	208.27	6466.43
	Wheat (improved)	89.68	75.09	25.67	4.61	195.05	6380.31
C	Jute (improved)	0.00	0.00	0.00	0.00	0.00	0.00
	Maize (improved)	88.20	46.69	19.02	0.00	153.91	4596.53
	Maize (Local)	59.06	29.53	0.00	0.00	88.59	2756.20
	Mustard (improved)	88.39	59.15	14.79	0.00	162.32	5188.35
	Mustard (Local)	67.82	47.47	22.04	0.00	137.33	4284.88
	Paddy (improved)	85.66	56.09	16.35	4.57	162.66	5117.55
	Patato (Local)	89.11	61.60	35.28	0.00	185.99	5702.35
	Pulses	29.96	33.71	27.15	0.00	90.82	2885.56
	Sugarcane	152.69	95.07	63.22	17.99	328.96	9729.69
	Vegetable (L/Im)	95.74	71.77	43.27	0.00	210.78	6521.24
	Wheat (improved)	86.41	69.58	14.66	4.49	175.14	5819.96
D	Paddy (improved)	89.15	57.48	20.97	4.56	172.16	5344.46
	Wheat (improved)	78.71	64.48	14.40	4.40	161.99	5386.66
Average		**79.52**	**55.97**	**19.33**	**4.57**	**159.39**	**5042.24**

Source: Field Survey, 2011

6.2.3 Seed

Among the various agricultural inputs improved varieties of seed play a vital role increasing agricultural production and productivity. Application of other inputs like chemical fertilizer, pesticides and irrigation depend on the seed. Farmers use both local and improve seed types in the study area. Previously they used to take improved seeds from Inaruwa and Biratnagar. Nowadays they produce the seed by themselves. Most of the farmer use the

improved seeds instead of local seeds and lots of changes in the type of seeds used is take place in the area in last two decades.

6.2.3.1 Improved Seed

Improved high yielding variety (HYV) seed plays a vital role to enhance the crops production. Farmer are planting different varieties of improve seeds for different crop. In the study area all most all farmers are aware about HYV seeds and are positive towards it. They have an experience of high production of crop after using HYV seed for instance: the production of paddy was on average 2.037 metric tons per ha before using HYV seed which has increased to 4.841 metric tons per ha after using HYV seed.

Farmer used two types of improved seeds; one is treated HYV seeds and non treated improved seeds collected from local area. Improved seeds bought from Inaruwa, Duhabi and Itahari. Radha-12, one of improved seeds of Paddy is the first choice of farmers which was introduced in 2001. Sona Mansuli and Ranjit is the alternative choice of Radha-12. Similarly N.L.-257, B.L.-1473 and Gautam are the variety of improved wheat seeds widely used in Balaha. Similarly improved seeds of maize, potato, oilseeds and vegetables seeds are widely used. Improved seeds was introduced in Balaha in early 80's but become more popular in last decades. Use of seed quantity for different crops and cost of the seed per ha is illustrated in table 6.3.

Table 6.3: Use of Seed Quantity and Cost of Seed per hectare in Study Area 2010

Crop Grown	Area (ha)	Seed (kg)	Seed (kg/ha)	Cost of seed/Kg (Rs)	Cost of Seed kg/ha (Rs)
Sugarcane	2.0565	8870	4313.25	1.3	5607.10
Paddy (Improved)	51.0308	3349.6	65.64	40	2625.55
Wheat (Improved)	32.0586	3314.1	103.38	40	4135.06
Patato (Local)	1.5550	2105	1353.69	25	33842.18
Maize (Local)	2.4440	75.25	30.79	12	369.48
Mustard (Local)	2.2416	29.7	13.25	40	529.98
Pulses	2.0417	22.8	11.17	60	670.04
Mustard (Improved)	2.3501	21.15	9.00	60	539.97
Maize (Improved)	0.4365	10.3	23.60	80	1887.86
Vegetable (L/Im)	0.9973	7.3	7.32	-	-
Sunflower	0.7232	3.31	4.58	1000	4580
Jute (Improved)	0.3440	2.65	7.70	-	-

Source: Field Survey, 2011

The quantity of seed used in different irrigation zone for different crops is shown in table 6.4. Table reveals that quantity of seed rate per ha varied according to the irrigation status. Generally seed rate for Rainfed system are higher than that in irrigated system.

Table 6.4: Zone-wise Seed Rate in Study Area 2010

Zone	Crop Grown	Area ha	Seed kg	Seed kg/ha
A	Paddy (Improved)	10.8899	864.5	79.39
	Wheat (Improved)	7.4071	794.00	107.19
	Patato (Local)	0.5669	764.00	1347.59
	Maize (Local)	2.0255	59.75	29.50
	Mustard (Local)	1.8536	25.70	13.87
	Pulses	0.3844	5.40	14.05
	Jute (Improved)	0.0491	0.40	8.14
	Vegetable (L/Im)	0.4364	3.20	7.33
A Total		23.6129	2516.95	106.59
B	Wheat (Improved)	7.4010	752.50	101.68
	Paddy (Improved)	10.3630	640.80	61.84
	Patato (Local)	0.1520	235.00	1546.18
	Maize (Local)	0.3508	13.00	37.06
	Pulses	1.1232	11.50	10.24
	Mustard (Improved)	0.8454	7.50	8.87
	Sunflower	0.7232	3.31	4.58
	Maize (Improved)	0.1473	3.30	22.40
	Mustard (Local)	0.0931	1.00	10.74
	Vegetable (L/Im)	0.2293	1.65	7.20
B Total		21.4283	1669.56	77.91
C	Sugarcane (Improved)	2.0565	8870.00	4313.25
	Wheat (Improved)	14.9140	1528.50	102.49
	Patato (Local)	0.8361	1106.00	1322.83
	Paddy (Improved)	17.8530	1097.60	61.48
	Mustard (Improved)	1.5047	13.65	9.07
	Maize (Improved)	0.2891	7.00	24.21
	Pulses	0.5340	5.90	11.05
	Mustard (Local)	0.2949	3.00	10.17
	Maize (Local)	0.0677	2.50	36.91
	Jute (Improved)	0.2949	2.25	7.63
	Vegetable (L/Im)	0.3316	2.45	7.39
C Total		38.9767	12638.85	324.27
D	Paddy (Improved)	11.9249	746.70	62.62
	Wheat (Improved)	2.3364	239.10	102.33
D Total		14.2613	985.80	69.12
Grand Total		98.2792	17803.86	181.16

Source: Field Survey, 2011

Paddy has highest seed rate of 79.39 kg/ha in Zone A (Rainfed) which ranges from 61.48 kg/ha in Zone C, 61.84 Zone B to maximum 62.62 to in Zone D in irrigated condition. Similarly, a highest seed rate of 107.19 kg/ha is observed in Zone A (Rainfed) for Wheat while in irrigated system it varies from minimum 101.68 kg/ha in Zone B, 102.33 kg/ha in Zone D to maximum 102.49 kg/ha in Zone C.

Likewise, seed rate of 1347.59 kg/ha is observed in Zone A for Potato, which is 1546 kg/ha in Zone B and 1322.83 kg/ha in Zone C. Also the seed rate of Local Maize is found minimum 29.50 kg/ha in Zone A, 36.91 kg/ha in Zone C while maximum 37.06 kg/ha in Zone B. Alike, the seed rate of Local Mustard is 13.87 kg/ha in Zone A, 10.74 kg/ha in Zone B and 10.17 kg/ha in Zone C. Seed rate of Pulses ranges from 14.05 kg/ha in Zone A, 10.24 kg/ha in Zone B, and 11.05 kg/ha in Zone C. Same as seed rate of Jute are 8.14 ha/kg in Zone A and 7.63 in Zone C.

6.2.3.2 Local Seed

For some crops they are still using local seed. Main reason to use local seed is: small scale farming for home use, unavailability of irrigation and for taste. Crop cultivated using with local seed are – Potato, maize, mustard and vegetables.

6.2.4 Agro-medicine

Pesticides are used for plant protection which is one of the supporting factors in increasing agricultural production in the study area. Two types of pesticides, viz dust and liquid are commonly used in the study area. According to the local farmer, although use of pesticide has been started since 1985, the use percent and frequencies have been increasing in last decade. They use pesticides, in accordance with the different condition. For the application of pesticides on the crops, farmers, usually count the following criteria: presence of pests or their damage symptoms or both. Some farmers also use pesticides even without noticing above criteria.

During field data collection most of the farmer admitted that one of the major cause for increment of crop production is due to easy availability and use of pesticides. Some of them perceived that with new high yielding seed and use of chemical fertilizer nowadays they are

compel to use pesticide more frequently than in the past. They also admitted various effects of pesticides such as headache, nasal bleeding, vomiting, cough, neck pain, dizziness, eye pain, respiratory problem, skin problems, burning, fever, body ache, neck and tongue problems etc.

Plant protection is very important in order to reduce crop losses and improve crop yield. Crops as they are grown in the fields are prone to damage through pests and diseases. In order to check such pests and diseases, different types of pesticides, insecticides are used in Balaha such as Metacid, M-45, Indocel, Forete, Renova, Chlorophylum, Vitamin-240, Agricultural lime etc.

Costs of different agro-medicine for different crops are listed in the table 6.5. Survey data reveals that farmer expense maximum in agro-medicine for vegetable followed by Potato, Sugarcane and Paddy respectively. Likewise use of agro-medicine are almost nil for Mustard, Pulses and Jute.

Table 6.5: Cost of Different Agro-medicine for Different Crop

Crop Grown	Area (ha)	Agro Medicine (Rs/ha)	Total Cost (Agro-medicine)
Sugarcane (Improved)	2.0565	1815	3732.55
Paddy (Improved)	51.0308	1455	74249.84
Wheat (Improved)	32.0586	643	20613.66
Patato (Local)	1.5550	1635	2542.44
Maize (Local)	2.4440	455	1112.00
Mustard (Local)	2.2416	-	0
Pulses	2.0417	-	0
Mustard (Improved)	2.3501	-	0
Maize (Improved)	0.4365	597	260.57
Vegetable (L/Im)	0.9973	3850	3839.42
Sunflower	0.7232	610	441.15
Jute (Improved)	0.3440		0

Source: Field Survey, 2011

6.2.5 Labour

Labour is another main input for agricultural production. Human labour is very important from seeding to harvesting period in all crops. Nowadays, farmers also use the animals (Oxen) and machinery (tractor, thresher) labour in agricultural works.

Among the total economically active population (44.91 percent of total) 33.1percent are engaged as student, other work in office or gone for foreign employment in Balaha. Obviously, this composition of population structure has primarily affected the availability of agricultural labour. There are three categories of agricultural labour in the study area. These are family labour, hired labour and labour exchange.

Table 6.6 shows that sugarcane cultivation requires maximum 183.81 labour per ha which is followed by paddy 145.85 labour per ha and Jute 127.89 labour per ha respectively. Pulses demands the minimum 44.57 labour per ha.

6.2.5.1 Own labour

Own labour is the labour done by family member of a household who possesses the land. The input of the labour depends on the type of the crops. Some crops need more labour while other needs less. The use of own labour in the study area is shown in table 6.6. The table reveals that maximum number of own labour is used in Paddy cultivation, followed by Wheat cultivation whereas minimum number of own labour is engaged in Sugarcane cultivation.

Table 6.6: Number of Labour by Different Crops and Labour Cost per ha

Crop	Area	Labour Own	Labour Hired	Total	Labour (per ha)	Labour Cost (Rs/ha)
Paddy (Improved)	51.0308	1527	5916	7443	145.85	51048.56
Wheat (Improved)	32.0586	463.5	1093	1556.5	48.55	16993.11
Patato (Local)	1.5550	138	15	153	98.39	34437.03
Mustard (Improved)	2.3501	82	70	152	64.68	22637.23
Mustard (Local)	2.2416	81	56	137	61.12	21391.04
Maize (Local)	2.4440	64	69	133	54.42	19046.96
Pulses	2.0417	57	34	91	44.57	15599.91
Sunflower	0.7232	41	4	45	62.22	21778.12
Jute (Improved)	0.3440	24	20	44	127.89	44762.63
Maize (Improved)	0.4365	19	14	33	75.61	26462.06
Sugarcane (Improved)	2.0565	10	368	378	183.81	64334.04

Source: Field Survey, 2011

6.2.5.2 Hired Labour

The households which do not have sufficient own labour to cultivate their land, use hire labour. The use of hired labour depends on the crop types. The use of hired labour in different crop is shown in table 6.6. Maximum number of hired labour is used in paddy cultivation, followed by wheat cultivation and the minimum number of hired labour is employed for sunflower cultivation among total sampled cultivated land.

6.2.5.3 Animal Labour

Animal labour force plays vital role in Nepalese agriculture. Oxen are used for ploughing the plot and preparing land for seedling. Table 6.7 reveals that at least 40.35 percent of total sampled household use animal labour. The animal labour used for different crops is shown in Table 6.8. Maximum number of animal labour is used in small size parcel which cultivates Potato and vegetable. Table 6.8 reveals 50 percent of total parcel is plough using animal labour.

6.2.6 Agro-equipment

Agricultural equipments used for farming practice are another important factor which affect on production. Agricultural equipment refers to machinery and equipment used on the holding, wholly or partly for agricultural production. Both types of agro-equipments traditional (e:g Iron Plough, wheel-cart etc) and modern (Power tillers, Thresher, rower pumps, sprayers) used by farmers of Balaha. The use of modern agricultural equipments tractors, thresher, and sprayers has been increasing slowly. Thresher occupies a very important place among equipment used in farming operation. The iron plough was the most popular traditional agro-equipment available on the holding. Despite the introduction of some modern agro-equipment, farm mechanization in Nepal on the whole is still at incipient stage.

Table 6.7: Mode of Ploughing by Household

Ploughing By	HH Number	Percentage
Both Bullock and Tractor	24	42.11
Bullock	23	40.35
Tractor	10	17.54
Total	57	100.00

Source: Field Survey, 2011

Tractor is used for ploughing and preparing land for cultivation. It is new technology in the context of Nepalese agriculture. It is equally important as compare to man and animal labour in the field. Tractor is also used for transporting the fertilizers and crops in harvesting period. Table 6.7 shows that 17.54 percent of total household use tractor for ploughing while next 42.11 percent of total household both Tractor and Bullock.

Table 6.8 shows the mode of ploughing by crops. Generally small parcel are plough by bullock, so, parcel that cultivates Patato and Vegetables are plough by Bullock only. About 38.46 percent parcel that cultivates Paddy is plough by Bullock while 33.33 percent parcel that cultivates Wheat is plough by Bullock. For every crop the parcel-wise use percent of both Bullock and Tractor for tillage is higher than that of Tractor only (except for Sugarcane).

Table 6.8: Mode of Ploughing by Crops

Crop	Total No. of parcels	Bullock Using Parcel	Bullock Use Percent	Tractor Using Parcel	Tractor Use Percent	Both Bullock and Tractor Using Parcel	Both Bullock and Tractor Percent
Paddy	156	60	38.46	30	19.23	66	42.3
Wheat	96	32	33.33	22	22.92	42	43.8
Maize	23	14	60.87	2	8.70	7	30.4
Pulses	12	7	58.33	1	8.33	4	33.3
Mustard	23	11	47.83	1	4.35	11	47.8
Sunflower	5	0	0.00	2	40.00	3	60.0
Potato	28	28	100.00		0.00		0.0
Vegetable	44	44	100.00		0.00		0.0
Jute	2	1	50.00	1	50.00		0.0
Sugarcane	5	0	0	5	100.00		0.0
Total	394	197	50.00	64	16.24	133	33.76

Source: Field Survey, 2011

6.3 Agriculture Area, Production and Productivity

Agricultural production is meant by per unit area production of crops. It shows the relationship among land labour and capital, in addition to this social and cultural factors are also related to it.

6.3.1 Area

The existing and previous condition of major crops, area, production and productivity of land is shown in table 6.9 and 6.10 respectively.

The table 6.9 explains the area under cultivation, production and productivity of different crops. Paddy and wheat are the major crops of Balaha. Survey data reveals that cereal crops production especially paddy cultivation dominate the study area at present. Paddy is cultivated in 51.0308 ha (95.51 percent of total cultivated land) and contribute shares of 68.68 percent of total crop production with yield 4.84 mt per ha. All farmers grown paddy crop and paddy is the first choice of the farmers.

Wheat, second major crops production of Balaha, is cultivated in 32.0586 ha (60.00 percent of total cultivated land) and contributes share of 18.39 percent of total crop production with yield 2.06 mt per ha. Likewise, maize, pulses, mustard, sunflower, potato, jute, vegetables, are cultivated in very small area and in small quantity for home use only. Besides, some of the farmer is now inclined to start commercial sugarcane farming. Table 6.9 reveals that oilseeds cultivation occupied 5.315 ha, maize 2.8805 ha, sugarcane 2.0565 ha, pulses 2.0417 ha, potato 1.555, vegetable 0.9973 ha and jute occupied 0.3440 ha area in 2010.

Table 6.9: Crop Area and Production 2010

Crop Grown	Area (ha)	Prod. (mt)	Yield (ton/ha
Paddy (Im)	51.0308	247.062	4.841
Wheat (Im)	32.0586	66.147	2.063
Maize (Local)	2.4440	2.285	0.935
Mustard (Im)	2.3501	4.67	1.987
Mustard (L)	2.2416	1.303	0.581
Sugarcane (Im)	2.0565	97.16	47.25
Pulses	2.0417	0.707	0.346
Patato (L)	1.5550	6.345	4.080
Vegetable (L/Im)	0.9973	7.66	7.681
Sunflower	0.7232	1.725	2.385
Maize (Im)	0.4365	1.625	3.723
Jute (Im)	0.3440	0.87	2.529
Total/Mean	98.2792	437.559	6.533

Source: Field Survey, 2011, Sunsari

Table 6.10: Crop Area and Production 1985

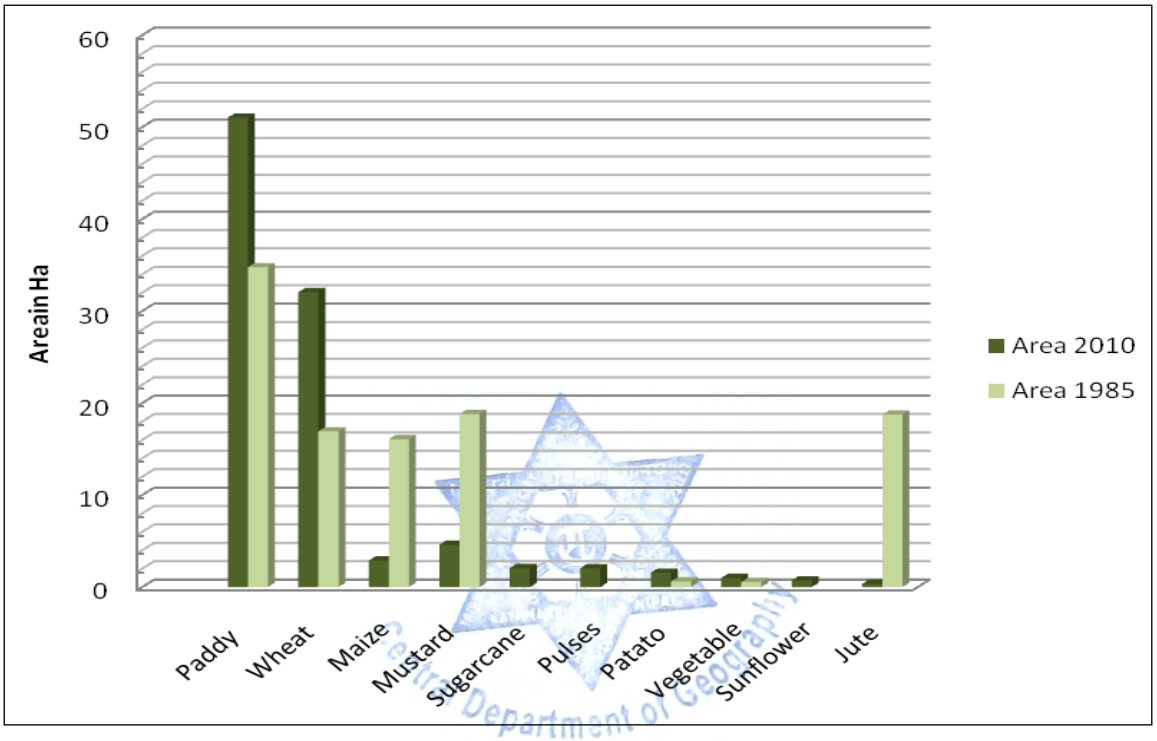
Crop Grown	Area (ha)	Prod. (mt)	Yield (ton/ha)
Paddy	34.7729	70.829	2.037
Mustard	18.8035	9.025	0.480
Jute	18.7557	35.080	1.870
Wheat	16.9311	23.228	1.372
Maize	16.0828	22.416	1.394
Patato	0.6029	2.257	3.743
Vegetable	0.5609	3.205	5.714
Pulses	0.0000	0.000	0.000
Total/Mean	106.5098	166.040	1.559

Source: Field Survey, 2011, Sunsari

There are some remarkable changes in area of crops between 25 years. In 25 years the agriculture land use pattern has been changed in Balaha (refer figure 6.2). According to table 6.9 and 6.10 paddy cultivation area has increased by 16.2579 ha within 25 years; area under paddy was 34.7729 ha in 1985. But at the same time area of jute cultivation has been decreased by 18.4117 ha which was 18.7557 ha in 1985 and 0.3440 ha in 2010. Although,

the soil and climate are most suitable for the production of jute cultivation farmers had left to cultivate jute commercially mainly because of lack of labour, drying up of ponds/swampy area and unavailability improve seeds. Now they cultivate jute for santhi (used to make manure bricked) and rope for personal household use. Cultivation area of wheat has been almost double from 16.9311 ha in 1985 to 32.0586 ha in 2010.

Figure 6.2: Change in Cultivated Area by Different Crops (1985 – 2010)



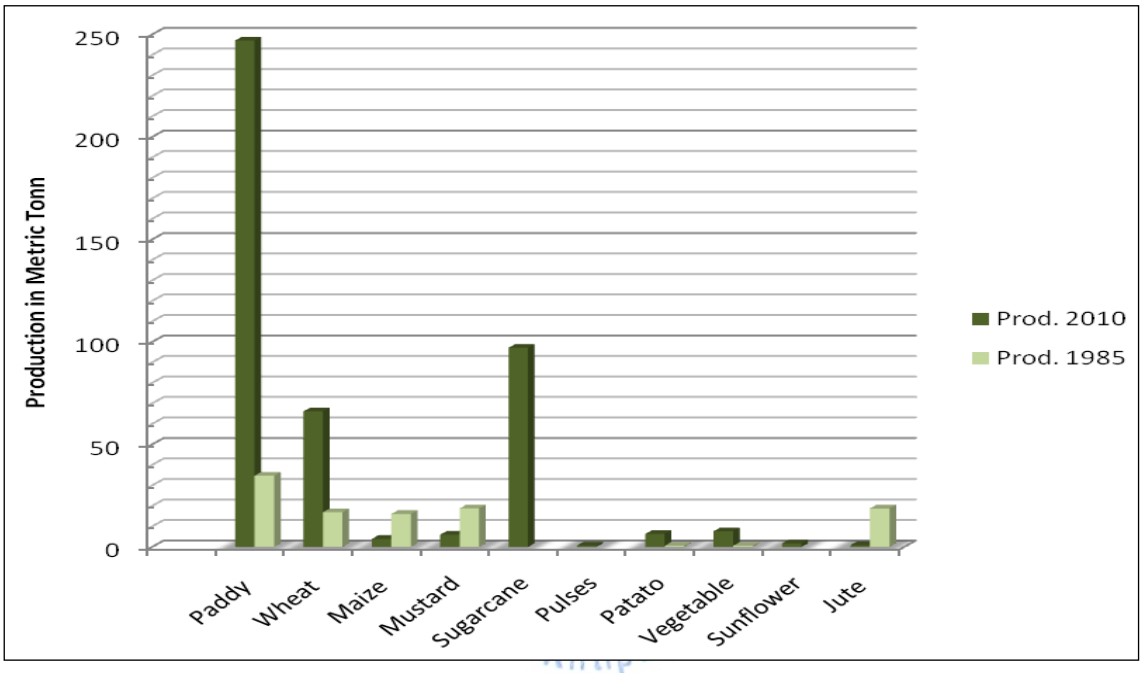
Another most remarkable change is in area of maize cultivation which was 16.0828 ha in 1985 and which is just 2.8805 ha in 2010. Interestingly, farmer from Tharu community admit a social cause, which directly influence in decrement of maize cultivation area. They said that they left maize cultivation because in past when they cultivate maize, guests used to visit their home at the time of maize harvesting period and eat and take maize in large quantity as koseli (gift) at their departure. Tharu people got dissatisfied from guest behavior and slowly left maize cultivation. At present small number of Tharu farmer practice maize cultivation. Similarly, area of mustard (or oilseeds) has been decreased but the area of potato and vegetable cultivation is increased than that in the year 1985.

6.3.2 Production

There exist a positive relation between area and production. An increase in total crop cultivation area results a boost in total production of crop, even though other climatic and

socio-economic factors also affects on the production of crops. The quantity of total production of crops has increased by 163.53 percentages to that of 1985. Total production in 1985 was 166.040 metric tons which has inflate to 437.559 metric tons. Between these 25 years paddy production has been raised largely which is followed by wheat. Increase in cultivation area, maximum use of chemical fertilizer, introduction of HYV seeds and agro-medicine, availability of irrigation and use of modern agro-equipment are the main factor for increasing production of different crops.

Figure 6.3: Change in Production of Different Crops (1985 – 2010)



At present, the total area of paddy cultivation has increased by 46.75 percent to that of 1985 and the production of paddy has increased by 248.82 percentages to that of 1985. Today, the production of paddy has rose up to 247.062 metric tons in 51.0308 ha from 70.829 metric tons in 34.7729 ha in 1985. Likewise, productions of wheat also bear 184.77 percentage of increment in compare to its production in 1985. Presently, the production of wheat, potatoes and vegetable has been increased respectively by 42.92 metric tons, 4.088 metric tons, 4.455 metric tons whereas; the production of oilseeds, maize and jute has been decreased respectively by 13.49 metric tons, 19.54 metric tons and 18.412 metric tons (refer figure 6.3).

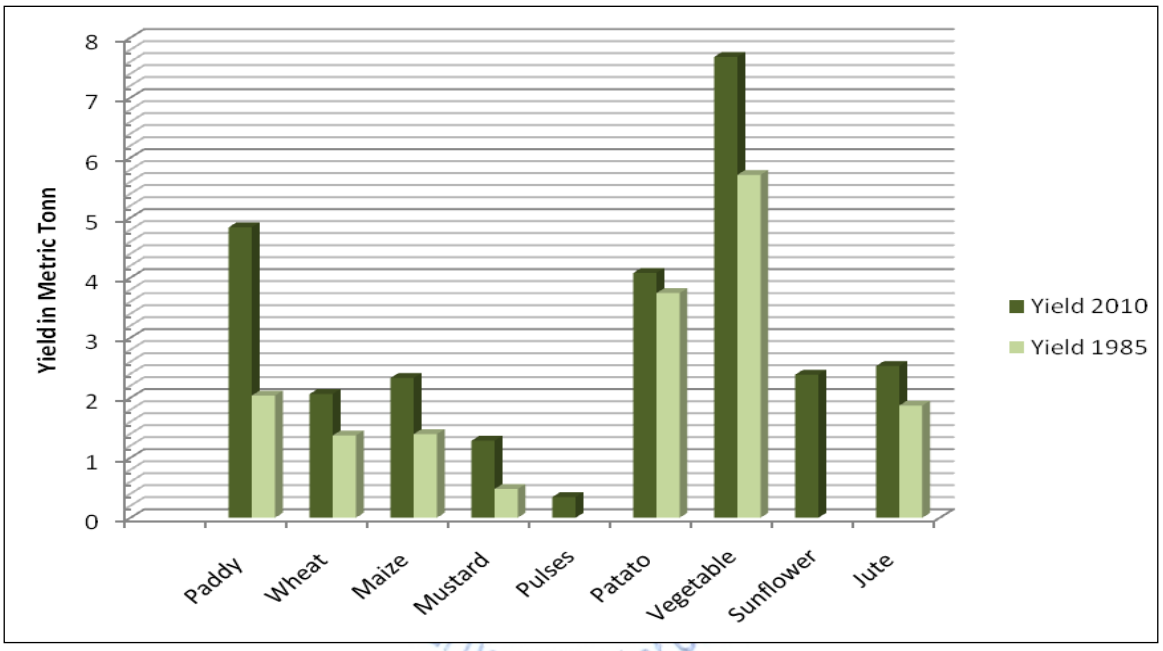
6.3.3 Yield

Agricultural productivity of an area is influenced by number of physical, socio-economic, institutional and organizational factors, agricultural productivity is thus function of interplay

of the physical and cultural variables and it manifests itself through per ha productivity and total volume of production.

There is a notable difference in productivity of different crops cultivated in study area (refer table 6.9, 6.10 and figure 6.4). There is an increase in yield per hectare for all crops as compare to 1985.

Figure 6.4 Changes in Yield of Different Crops (1985 – 2010)

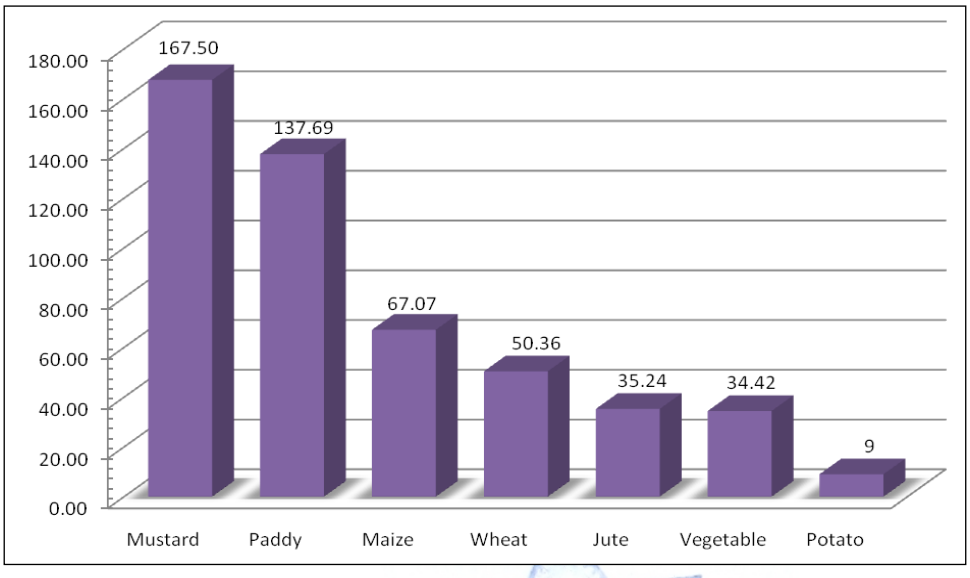


The table 6.9 reveals that sugarcane has the highest productivity of 47.25 metric tons per hectare in the year 2010. Similarly green vegetable, which is cultivated in scanty area for household use has the second highest productivity with 7.681 metric tons per hectare. Paddy has productivity of 4.841 metric tons per hectare (highest among cereal crop) whereas wheat has yield rate of 2.063 metric tons per hectare. The productivity of other cereal crop is: maize 2.329 mt per ha, oilseeds 1.651 mt per ha, pulses 0.346 mt per ha. Also, the yield rate of potato is 4.080 mt per ha while jute is 2.529 mt per ha.

The yield of different crops has increased remarkably within two and half decades (refer figure 6.5). The productivity of Mustard has augmented extremely by 167.5 percent (from 0.48 mt per ha in 1985 to 1.284 mt per ha in 2010), followed by paddy. The yield rate of Paddy has grew highly by 137.69 percentage from 2.037 mt per ha in 1985 to 4.841 mt per ha (average) in 2010. Also, the productivity of maize increased by 67.07 percent from 1.394 mt per ha in 1985 to 2.329 mt per ha in 2010. Productivity of wheat, jute, vegetable and

potato has increased respectively by 50.36 percent, 35.24 percent, 34.42 percent and 9 percent in 2010. Besides farmer of Balaha now started cultivating pulses, banana, sugarcane and sunflower too.

Figure 6.5: Increase in Yield Percent of Different Crops at Present (2010)



The increasing use of improved seeds, chemical fertilizer and agro medicine, irrigation facilities are the major factor which plays a vital role to increase the productivity of crops in Balaha.

6.4 Zone-wise Analysis of Agriculture Area, Production and Yield

Irrigation plays a vital role on crop production. Impact of irrigation in yield of different crop in different Zone (according to irrigation status) can be explained according to table 6.11 and 6.12.

In Zone A (rain fed) total mean yield of crop has increased by 95.68 percent in 2010 as compare to that of 1985. Table 6.11 and 6.12 shows that, there is positive increase in yield of every crop except local maize. The yield of paddy has inflated by 123.89 percent whereas yield of local mustard and potato has increased by 25.66 percent and 10.73 percent respectively. Likewise yield of jute has aroused by 38.81 percent.

In Zone B (irrigated) total mean yield of crop has been boosted by 174.30 percent in 2010 as compare to that of 1985. Except local maize, there is positive increment in yield of every crop. The yield of Paddy has been inflated by 213.16 percent whereas yield of Local Mustard

Table 6.11: Zone wise Crop Area and Production 2010

Zone	Crop Grown	Area (ha)	Prod. (mt)	Yield (ton/ha)
A	Paddy (Im)	10.8899	36.74	3.374
	Wheat (Im)	7.4071	13.365	1.804
	Maize (L)	2.0255	1.73	0.854
	Mustard (L)	1.8536	1.053	0.568
	Patato (L)	0.5669	2.31	4.075
	Vegetable (L/I)	0.4364	3.395	7.780
	Pulses	0.3844	0.109	0.284
	Jute (Im)	0.0491	0.12	2.443
A Total/Mean		23.6129	58.822	2.491
B	Paddy (Im)	10.3630	53.775	5.189
	Wheat (Im)	7.4010	18.6	2.513
	Pulses	1.1232	0.385	0.343
	Mustard (Im)	0.8454	1.71	2.023
	Sunflower	0.7232	1.725	2.385
	Maize (L)	0.3508	0.46	1.311
	Vegetable (L/I)	0.2293	1.875	8.178
	Patato (L)	0.1520	0.625	4.112
	Maize (Im)	0.1473	0.6	4.072
	Mustard (L)	0.0931	0.07	0.752
B Total/Mean		21.4283	79.825	3.725
C	Paddy (Im)	17.8530	89.517	5.014
	Wheat (Im)	14.9140	31.409	2.106
	Sugarcane (Im)	2.0565	97.16	47.25
	Mustard (Im)	1.5047	2.96	1.967
	Patato (L)	0.8361	3.41	4.079
	Pulses	0.5340	0.213	0.399
	Vegetable (L/I)	0.3316	2.39	7.207
	Mustard (L)	0.2949	0.18	0.610
	Jute (Im)	0.2949	0.75	2.543
	Maize (Im)	0.2891	1.025	3.545
	Maize (L)	0.0677	0.095	1.403
C Total/Mean		38.9767	229.11	6.92
D	Paddy (Im)	11.9249	67.03	5.621
	Wheat (Im)	2.3364	2.773	1.187
D Total		14.2613	69.803	3.404
Grand Total/Mean		98.2792	437.559	6.533

Source: Field Survey, 2011

Table 6.12: Zone wise Crop Area and Production 1985

Zone	Crop Grown	Area (ha)	Prod. (mt)	Yield (ton/ha)
A	Jute	7.5986	13.375	1.760
	Mustard	7.4348	3.359	0.452
	Maize	4.1005	5.380	1.312
	Paddy	3.6557	5.510	1.507
	Patato	0.2478	0.912	3.680
	Vegetable	0.1812	1.030	5.685
	Wheat	-	-	-
A Total/Mean		23.2186	29.566	1.273
B	Mustard	7.3842	3.486	0.472
	Jute	7.2403	13.865	1.915
	Maize	3.5081	5.235	1.492
	Paddy	3.2027	5.306	1.657
	Patato	0.1689	0.615	3.642
	Vegetable	0.1597	0.910	5.700
	Wheat	-	-	-
B Total/Mean		21.6638	29.417	1.358
C	Paddy	15.9896	31.662	1.980
	Wheat	15.8032	22.008	1.393
	Mustard	3.9845	2.180	0.547
	Jute	3.9168	7.840	2.002
	Maize	0.4074	0.563	1.382
	Vegetable	0.2201	1.265	5.747
	Patato	0.1862	0.730	3.920
C Total/Mean		40.5079	66.248	1.635
D	Paddy	11.9249	28.351	2.377
	Maize	8.0668	11.238	1.393
	Wheat	1.1278	1.220	1.082
	Vegetable	-	-	-
	Mustard	-	-	-
	Jute	-	-	-
	Patato	-	-	-
D Total		21.1195	40.809	1.932
Grand Total/Mean		106.5098	166.040	1.559

Source: Field Survey, 2011

and Potato has increased by 59.32 percent and 12.90 percent respectively.

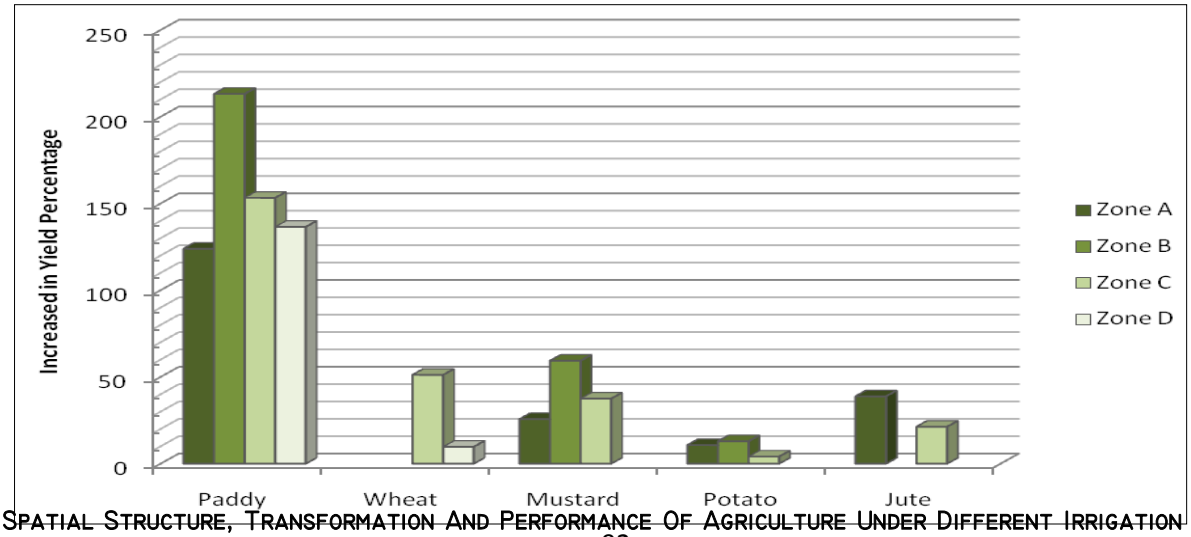
In Zone C (Irrigated) total mean yield of crop has augmented by 323.24 percent (due to sugarcane cultivation) in 2010 as compare to that of 1985. There is positive enhancement in yield of every crop. The yield of paddy and wheat has magnified by 153.23 and 51.18 percent respectively, whereas the yield of local mustard and potato has increased by 37.47 and 4.06 percent respectively. Likewise yield of jute has aroused by 21.27 percent.

In Zone D (Irrigated) total mean yield of crop has stirred up by 76.19 percent in 2010 as compare to that of 1985. Table 6.11/6.12 shows that there is positive increase in yield every crop. The yield of paddy and wheat has risen by 136.47 and 9.7 percent respectively.

To sum up, this study reveals that irrigation through SMIP canal has play positive role in increasing production of crop. In Zone A (Previously rainfed area and still rainfed) the yield of Paddy, Local Mustard and Patato has risen respectively by 123.89, 25.66, and 10.73 percent (as compare to 1985). Here the main factor for augmented yield is the increasing use of improved seeds, chemical fertilizer and agro-medicine only.

But with the introduction of irrigation through SMIP, the yield rate of paddy, local mustard and potato has increased respectively by 213.16, 59.32 and 12.9 percent in Zone B. The exceptional increase in yield percent (especial for Paddy) in Zone B is due to conversion of rainfed system (in 1985) into irrigated system (now irrigated by SMIP). There exist a notable increased in yield of different crops in Zone C and Zone D too.

Figure 6.6: Increase in Yield Percentage by Different Irrigation Zone at Present (2010)



Average yield of different crops and zone wise percent difference in yield is illustrated in table 6.13. Almost all crops except vegetable in zone A score negative figure in percent difference in yield showing a low mean yield as compared to that in zone B. This implies that mean yield of each crop in irrigated condition is higher than that in rainfed.

Table 6.13: Average Yield and Percent Difference in Yield in Different Irrigation Zone

Average Yield (Ton/ha)			Percent Difference in Yield			
Food Grains	A+B+C+D	Mean	A	B	C	D
Paddy (Im)	19.198	4.799	-29.701	8.11	4.47	17.12
Wheat (Im)	7.61	1.902	-5.18	32.09	10.69	-37.61
Maize (Im)	7.617	3.808	0	6.92	-6.92	0
Maize (L)	3.568	1.189	-28.19	10.23	17.96	0
Cash Crops						
Mustard (Im)	3.99	1.995	0	1.40	-1.40	0
Mustard (L)	1.93	0.643	-11.71	16.89	-5.18	0
Sunflower	2.385	2.385	0	0	0	0
Jute(Im)	4.986	2.493	-2.01	0	2.01	0
Other Crops						
Pulses	1.026	0.342	-16.96	0.29	16.67	0
Vegetable (L/I)	23.165	7.721	0.75	5.91	-6.66	0
Patato (L)	12.266	4.089	-0.33	0.57	-0.24	0
Sugarcane (Im)	47.25	47.25	0	0	0	0

Source: Field Survey, 2011

Figure 6.7: Difference in Average Yield of Food Grains According to Irrigation Zone

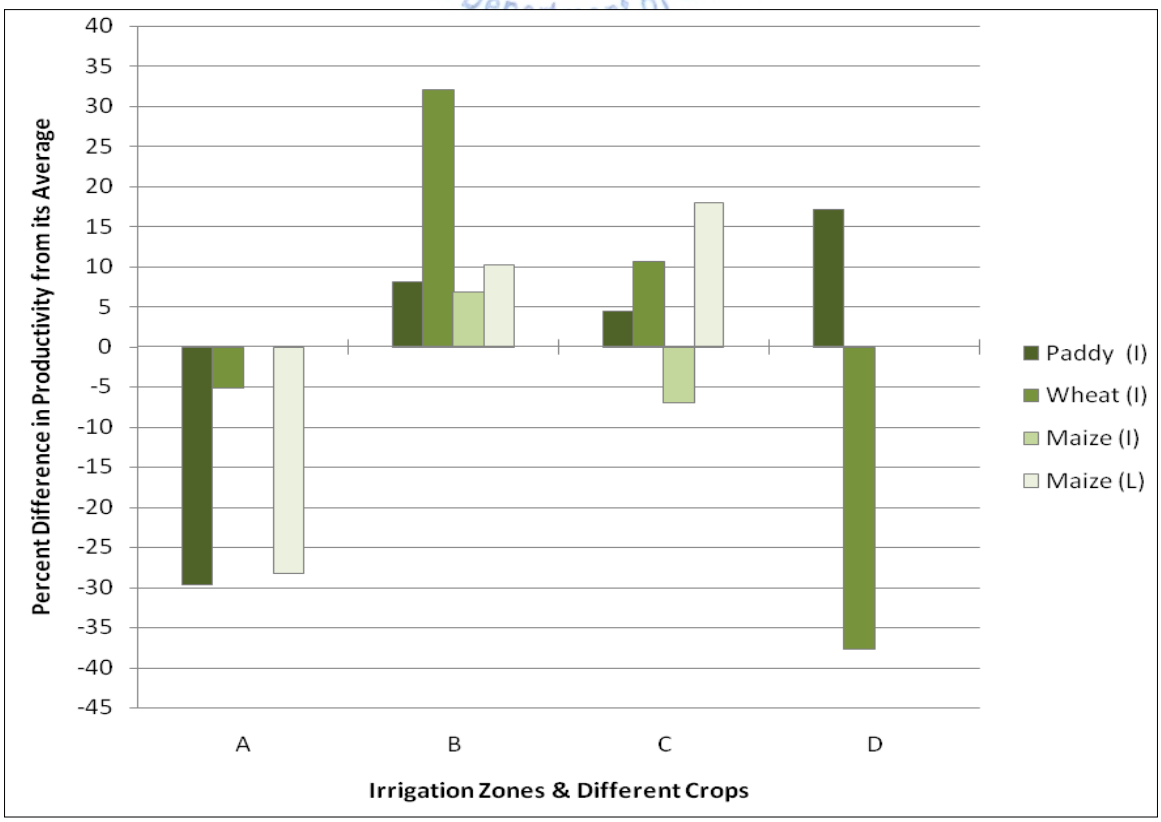


Figure 6.8: Difference in Average Yield of Cash Crop According to Irrigation Zone

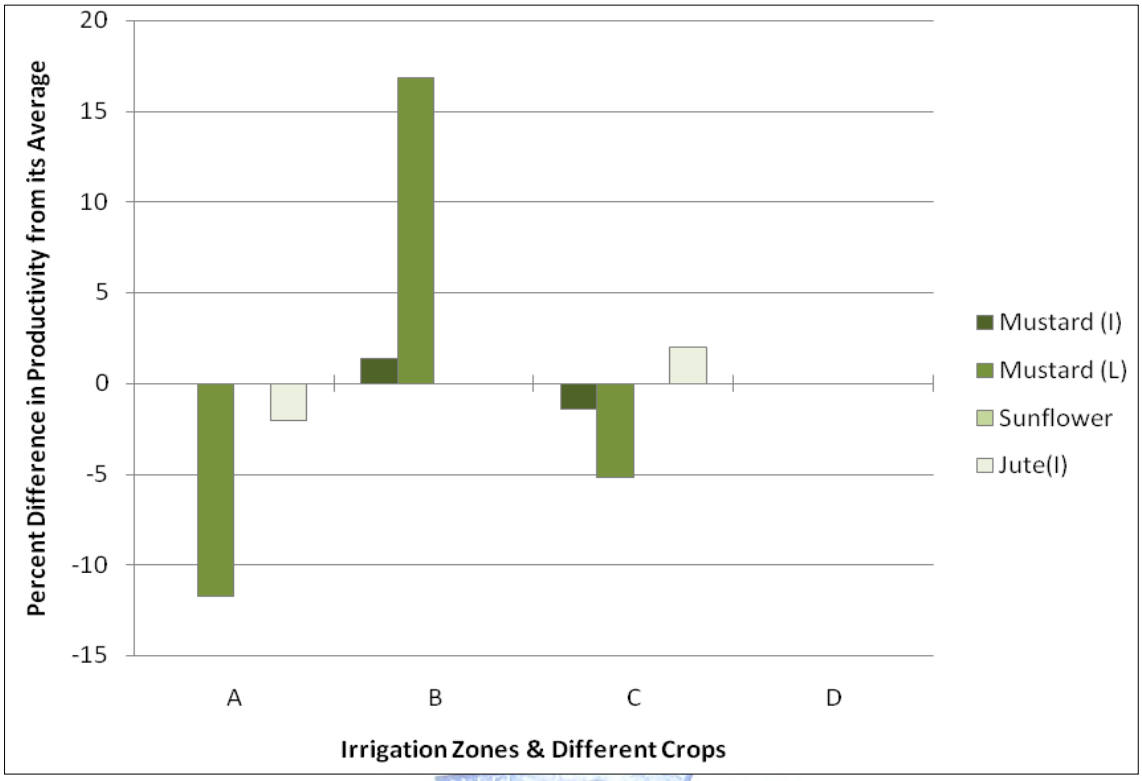
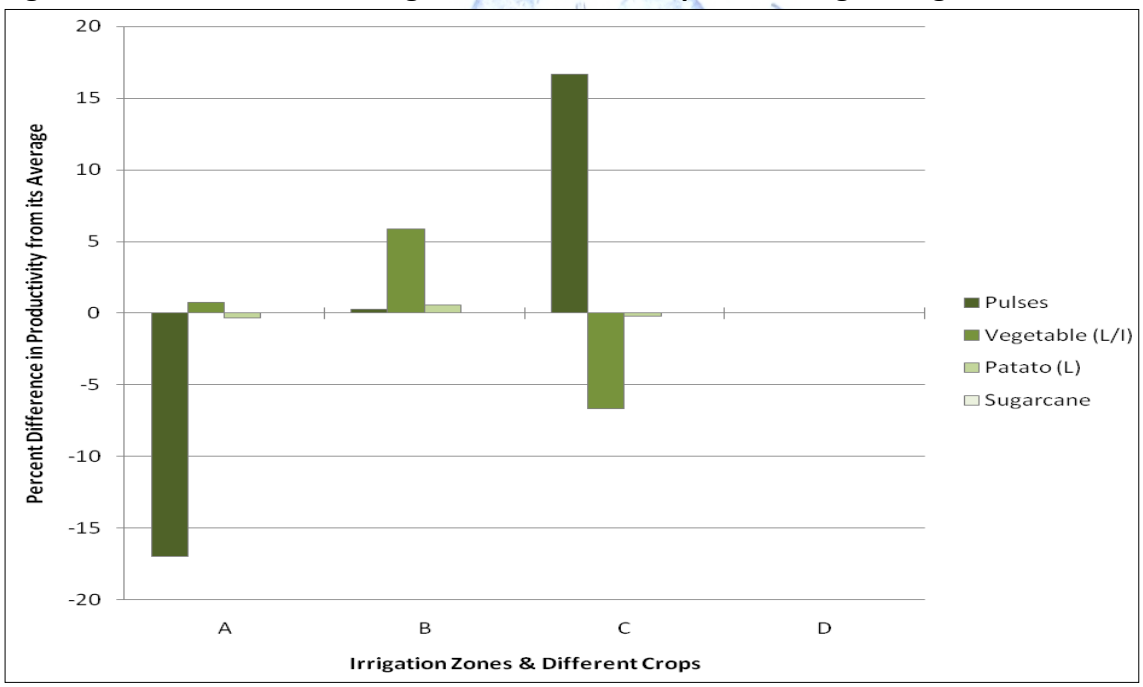


Figure 6.9: Difference in Average Yield of Other Crops According to Irrigation Zone



6.5 Cost and Benefit of Agricultural Crops

The net profit from agricultural crop has been calculated in Nepalese rupees on the basis of present (2010/11) value regarding the cost of agricultural inputs (including labour, seed, manure, and pesticide in accordance with different crops and land types) and returns.

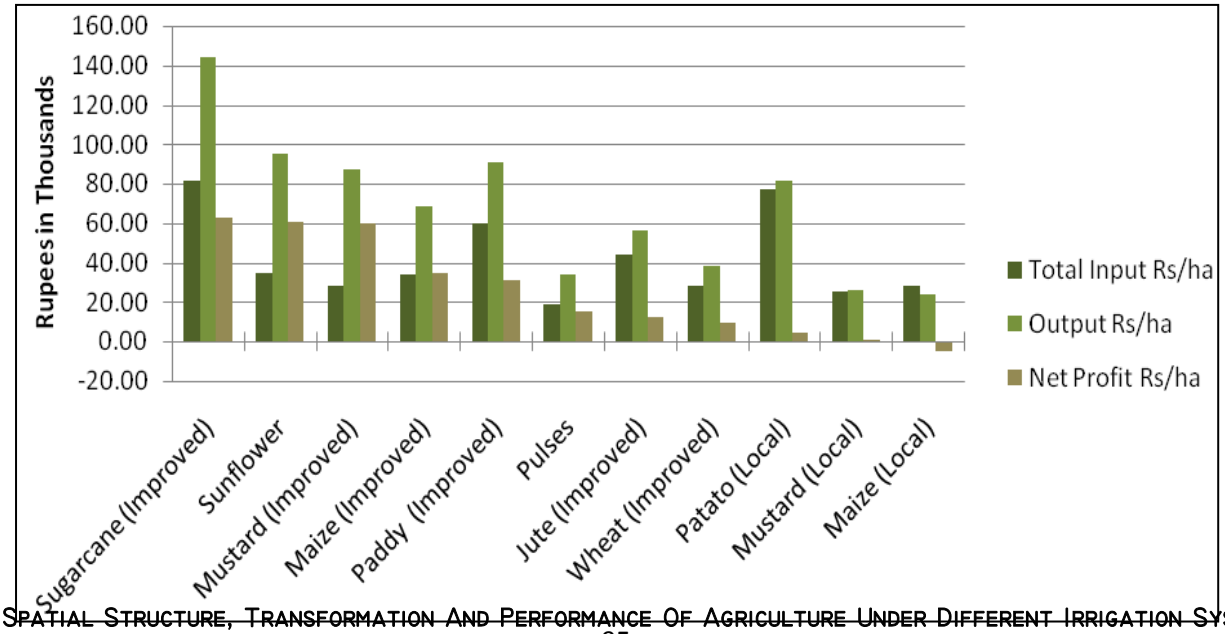
Table 6.14: Average Input Cost, Return and Net Profit of Major Agricultural Crops

S.N.	Crop Grown	Total Input Rs/ha	Output Rs/ha	Net Profit Rs/ha
1	Sugarcane (Improved)	81485.96	144112.50	62626.54
2	Sunflower	34781.96	95408.90	60626.93
3	Mustard (Improved)	27928.07	87528.57	59600.50
4	Maize (Improved)	33857.09	68555.13	34698.04
5	Paddy (Improved)	59850.31	91190.60	31340.30
6	Pulses	18969.03	34172.22	15203.19
7	Jute (Improved)	43923.50	56091.61	12168.10
8	Wheat (Improved)	28400.11	38051.86	9651.75
9	Patato (Local)	77148.00	81768.26	4620.26
10	Mustard (Local)	25332.63	26056.79	724.16
11	Maize (Local)	28456.87	23788.58	-4668.29

Source: Field Survey, 2011

Table 6.14 shows that sugarcane cultivation has highest net profit with high input cost while sunflower cultivation has highest net profit with low input cost. Regarding production economics improved mustard is found to be the most important crop practiced in Balaha. It has low input cost with high net profit per ha. Likewise, pulses is found to be the crop with lowest input but having more returns than the wheat. Still farmer prefer wheat cultivation over pulses. Major causes to neglect the cultivation of pulses are – high rainfall, frost, inception of pest. On the basis of net profit per ha Paddy falls in fifth rank while wheat descend in eighth rank. Rice and wheat flour constitute a daily diet, so farmer's first priority is paddy and wheat although these crop ranked in fifth and eighth place respectively.

Figure 6.10: Input Cost, Return and Net Profit of Major Agricultural Crops



Yield of Local mustard is itself low and as it is often cultivated as mix cultivation with wheat so, there is low profit from it. Farmer cultivates local maize in small area just for household purpose and for fodder but there is a loss in local maize cultivation. Farmers are attracted to wheat cultivation rather than improved mustard due to labour problem. Likewise, due to high input cost, irrigation problem and labour problem people are not interested to hybrid maize cultivation even though hybrid maize is high profitable crops.

Table 6.15 shows the zone-wise breakdown of total input cost, return and net profit of major agricultural crops. Obviously, the net profit from each crop in zone A (rainfed) is lower than that from zone B, C & D which has irrigation facilities.

Table 6.15: Zone-wise Input Cost, Return and Net Profit of Major Agricultural Crops

Zone	Crop Grown	Total Input Rs/ha	Output Rs/ha	Net Profit Rs/ ha
A	Jute (Improved)	42748.96	54962.95	12213.99
	Pulses	22022.43	28356.17	6333.75
	Wheat (Improved)	29880.27	36086.94	6206.67
	Patato (Local)	77139.57	81490.54	4350.97
	Paddy (Improved)	60442.27	64101.48	3659.21
	Mustard (Local)	24432.68	23007.94	-1424.74
	Maize (Local)	21077.46	17082.39	-3995.07
B	Mustard (Improved)	26863.80	88750.34	61886.53
	Sunflower	34781.96	95408.90	60626.93
	Paddy (Improved)	57533.56	98593.36	41059.81
	Maize (Improved)	33952.28	73298.36	39346.08
	Wheat (Improved)	27925.90	50263.52	22337.62
	Pulses	16262.44	34275.75	18013.32
	Mustard (Local)	23137.61	30443.28	7305.67
	Patato (Local)	80407.09	82243.88	1836.79
	Maize (Local)	29631.68	26229.13	-3402.55
C	Sugarcane (Improved)	81485.96	144112.50	62626.54
	Mustard (Improved)	28992.34	86306.81	57314.47
	Paddy (Improved)	60611.33	95268.23	34656.90
	Maize (Improved)	33761.90	63811.91	30050.01
	Pulses	18622.24	39884.73	21262.49
	Wheat (Improved)	29043.39	42120.09	13076.70
	Jute (Improved)	45098.05	57220.26	12122.22
	Patato (Local)	73897.33	81570.36	7673.03
	Mustard (Local)	28427.59	24719.15	-3708.44
	Maize (Local)	34661.46	28054.22	-6607.24
D	Paddy (Improved)	60814.06	106799.33	45985.27
	Wheat (Improved)	26750.88	23736.91	-3013.97

Source: Field Survey, 2011

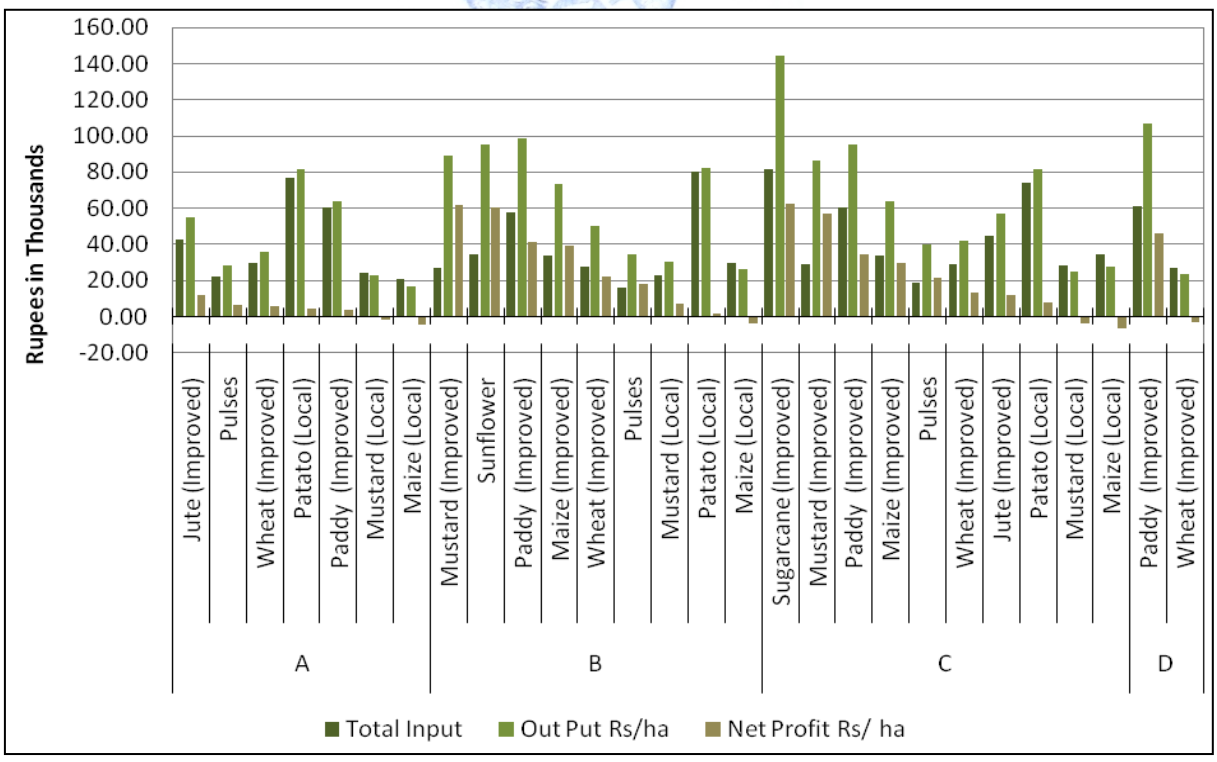
In zone A (rainfed) jute cultivation lies in first rank while pulses takes second place on the basis of net profit per ha. Likewise, wheat and paddy respectively falls in third and fifth rank. But there is loss in local mustard and local maize cultivation.

In zone B mustard (Improved) ranks first followed by sunflower on the basis of net profit per ha. Similarly, paddy and wheat respectively falls in third and fifth rank. But there is loss in local maize cultivation.

In zone C sugarcane positions in first rank followed by mustard (Improved) on the basis of net profit per ha. Likewise, paddy and wheat respectively falls in fourth and sixth rank. But there is loss in local maize and local mustard cultivation.

In zone D paddy attains first rank on the basis of net profit per ha. But there is loss in wheat cultivation.

Figure 6.11: Zone-wise Input Cost, Return and Net Profit of Major Agricultural Crops



6.6 Agriculture-related Problems and Their Prioritization

Study of socio-economic status and agricultural activities of Balaha reveals many agriculture related problems influencing the production of agricultural crop. Table 6.15 listed the problems mentioned by people and their corresponding priorities in Balaha. Lack of

required labour is the major problems of agriculture. People engaged on other different sector like service, foreign employment, study etc. so at the time of agriculture activities there is dearth of labour force. Secondly farmers raise the problem of insufficiency of water. Although most of the fields are irrigated by SMIP quantity of water it delivers is not enough.

Likewise another major issue raised by farmer from Balaha is the shortage and corresponding high prices of fertilizers during peak agricultural seasons. Last year, farmer experienced shortages in potassium fertilizers but took advantage of the easy availability of different local brands of Indian fertilizers in the market. They believed that the available Chinese chemical fertilizer is of high quality than locally available chemical fertilizer imported from nearby Indian border. Many farmers complained about the price increase after deregulation and some argued against the current fertilizer policy of the Nepalese Government.

Table 6.16: Major Agriculture Related Problems and Their Priorities

Problems	Priorities
Lack of required labour	I
Insufficiency of irrigation	II
Lack of high quality chemical fertilizer	III
Lack of improved seeds on peak time	IV
Crop damage caused by heat waves and unknown diseases	V
Lack of crop and livestock insurance facilities	VI
Lack of modern agricultural inputs	VII
Lack of grazing land and forest for livestock	VIII
Lack of skills and technical knowledge	IX
Absence of Government's or other related organization	X

Source: Field survey 2011

Similarly some of the farmer raised problem of lack of improved seed in peak seasons. Some of the Balaha farmers reported travelling to India in order to collect Hybrid quality seeds of sunflower. Farmers signaled towards the increasing vulnerability of climate and demanded the policies to cover crop and livestock insurance facilities. Many farmers criticize the failure of Nepalese agricultural research to produce hybrids seeds, particularly maize and pulses seeds. Other problems related with agricultural activities are lack of modern agricultural inputs, lack of technical knowledge, lack of grazing land and absence of government and other related organization to support the problem of poor farmer.

The issues raised by the farmer mostly deal with difficulties encountered in commercializing agriculture such as insufficient irrigation and lack of chemical fertilizers, improved seeds and credit, high fertilizer prices. They believe Nepal Government's technical extension workers are not competent enough to teach them properly and do not exert enough effort to help provide seeds and fertilizers in a timely manner. To enhance community resilience, APROSC should direct their efforts to make agriculture credits, seeds and fertilizer more widely available.

6.7 Determinants of Farmer's Decision Making

The major determinants to influence the farmer's decisions to change agriculture pattern of particular area are follows:

6.7.1 Bio-physical Factors

Bio-physical factor are most common and known determinant of farmers decisions making. Climate, geology, soil types/texture, temperature and rainfall are major conditions which help to make decisions to farmers of particular place. Also, the presence of irrigation water plays vital role in the determination of crop, seed varieties, seed rate and use of fertilizer.

Farmers are more or less aware of the bio-physical conditions of their habitat and accordingly makeup their mind about agricultural activities. Biophysical conditions and in particular soil conditions are generally seen as important determinants of land use and receive much emphasis both in land use planning and in attempts to understand actual land use patterns. People have very good knowledge about their soil types; they easily choose best suitable crops and seeds for the soil. Similarly, they are very alert about climate. Farmers use their knowledge from seeding time to harvesting time to analyze climatic conditions. The farmers at Balaha are seeding more seeds than normal requirements because they have many bad experience of drought, over rainfall etc. similarly the quantity of seeds, fertilizers use are different in different irrigation zone and different soil types.

6.7.2 Economic Factors

Another major determinant of farmer's decisions is economic factors. The economic condition of farmer play important role to decide the crop selection to crop harvesting.

Farmer at Balaha told that if they would have enough money they buy improve seeds, use modern implements, fertilizer and agro-medicines etc. Most of the farmer cultivates Paddy and wheat as these cereal crops constitute their daily diet. There are economically high profile cash crops like sugarcane, improve mustard, hybrid sunflower and hybrid maize but they give less priority to these crop due to high seed cost, uncertain returns (unreliability of HYV seed) and labour.

6.7.3 Infrastructural Development

Road, irrigation canal, cold-store, market etc are also major influencing factors for farmer's decisions on agricultural activities. If required infrastructures are available farmer are will involve in cash crops such as vegetable farming, livestock farming for milk products, fish farming, sugarcane etc. In the case of Balaha farmer left jute cultivation, one of the cause was lack of ponds for jute production. Due to availability of water from SMIP canal now it is possible to cultivate paddy two to three week earlier and production of crops is also increasing.

6.7.4 Social Factors

Social background also holds a major role on most of the human decisions. Farmers decision on agriculture land use may sometimes guided by different social aspects like culture, religion etc. People of the study area mostly select Radha-12 (variety of paddy) because of neighbour VDCs people cultivates the same species of paddy. Interestingly, farmer from Tharu community admit a social cause (an arrival of undesirable guest at the time of maize harvesting period who eat and take maize in large quantity as koseli (gift) at their departure), which directly influence in decrement of maize cultivation area. At present small number of Tharu farmer practice maize cultivation in very small scale.

6.7.5 Crop Selection

Farmer always prefers that crop which is highly used by their family for their own consumption. Paddy is main food crops of people so paddy is first choice of farmers in Balaha. After paddy people prefer wheat for self use and surplus quantity of these crops are easily sold in the local market. Oilseeds, maize, pulses, jute and vegetable are cultivated by farmers only for their own use.

The interaction with farmer during study reveals that while men dominated women with regard to decisions on important issues relating to land use, spending of cash income and family planning, joint decisions were made on matters related to farming such as the selection of seeds, planting date, harvest time and use of chemical fertilizers and seeds.

6.7.6 Crop Productivity, Net Benefit and Risk

Crop productivity and net benefit are the moulding factor in farmer's decision making. Farmer always prefer highly productive crop at low input cost. This will ensure farmer risk of less amount of capital in case of loss of crop. But the demand of input cost and net profit varies crop to crop. So, farmer use his own best knowledge and necessity to choose right crop on suitable environment. Similarly, farmer store more crops than they need for managing possible damage by climatic or other hazard.

In current study, sugarcane emerges out in first rank in terms of crop yield per ha while green vegetable and paddy respectively takes second and third rank. Based on crop yield per ha potato and wheat lies in 4th and 7th rank respectively. Likewise, on the basis of net profit per ha Paddy falls in fifth rank while wheat descends in eighth rank. Still farmer in Balaha gives first priority to Paddy and wheat. Rice and wheat flour constitute a daily diet, and there is less risk of crop damage so farmer's first priority is paddy and wheat. Pulses is found to be the crop with lowest input but having more returns as compare to wheat but due to the uncertainty of yield they practice combination of pulses and wheat cultivation.

Although vegetable farming, sugarcane cultivation, sunflower farming and poultry are more profitable farmer are not attracted in these agricultural practice as they demand high input cost and also there exist uncertainty in production.

6.7.7 Resource Requirements and Farm's Spatial Location

Land, labour, draft power and operating capital are the resources which are necessary for agricultural activities. An irrigation facility plays a vital role to increase the production of crops. Factors such as farm size, farm's spatial location, market and input related concerns are more decisive for farmers' actual choice of crop type. Labour requirements also vary among the different crops

Study reveals that cropping pattern and total production of the crops has gone notable change in Balaha due to the irrigation facility of SMIP. Because of labour shortage the cropping pattern has totally changed from Jute-Mustard-Fallow in past to Paddy-wheat-Fallow. Jute, an important cash crop now is cultivated in small scale as it demands maximum number of labour. Similarly input cost of potato cultivation is higher than others crops and it also has storage problem so people are not so motivated to cultivate it.

Farm's spatial location also seems to play a significant role in use of inputs, cropping intensity, cropping pattern and the protection of field crop in Zone D of study area. As there is an irrigation facility in Zone D, it is possible to cultivate wheat or pulses / beans. But the Zone D which lies near Garun Khola (river), is at more than 25 minutes walking distance from house and crop are susceptible to graze by large number of cattle from adjoining village across the river (especially in winter season).

Chapter VII

SUMMARY CONCLUSION AND RECOMENDATION

7.1 Summary

Balaha a small village in eastern Terai has both rainfed and irrigated agricultural system. Traditional indigenous system has been practiced in agriculture management. The plain terrain with fertile soil and the sub-tropical monsoon climatic condition has facilitated the crop production in this region so that average production of crops is higher than national average.

Agriculture is the major occupation of about 63.28 percent of total economically active population (15 to 59 years age group) in the study area. Although the land is fertile, and irrigation facility is developed partially, the concept of commercial farming is not emerged yet. Thus, annual average income generated by agriculture sector per sampled household of Balaha is only 46.20 percent (agriculture = 39.00% & Livestock = 7.20%) of their total income.

More than 90 percent of total area in Balaha is under agricultural use, of which at least 20 percent is rainfed. Mostly agricultural land utilized for cereal crops production. Horticulture and livestock farming is also practiced in small scale and only for self use.

As regard quality of land, Doyama khet shares 49.64 percent of total sampled area, followed by Abbal khet 31.12 percent. Similarly 17.66 percent of total sampled cultivated area is under Abbal Bari categories while Doyama Bari holds a negligible share of 1.58 percent of total sampled area. It means the area is suitable for agriculture. At present, agriculture of Balaha is partially affected by insufficient irrigation facilities and lack of labour force.

Majority of households are land owner (63.16 percentage of total household) and practice the cultivation by own. About 61.38 percent of the total cultivated land is cultivated by the owner itself. Similarly, cultivation either under contract basis or in Batuwa/Adhiya is practiced by about 36.84 percent of total sampled household. About 30.64 percent of

cultivated land is under Batuwa or Adhiya and 7.99 percent of the total cultivated area has been given or taken as in fix contract basis. The size of land holding ranges from minimum 0.1151 to maximum 3.1928 hectare with an average holding of 0.9953 hectare which is higher than national level.

Change is observed in way to deficit food demand. Way to deficit annual food requirement by adhiya or contract has been notably decreased from 71.43 percent (in past) to 50 percent at present. This clearly delineates the increasing trend in involvement in different non-farm activities for income generation such as: wage, employment, foreign employment, trade etc. Agricultural management has slowly changed by traditional and indigenous to modern system. Still most of the farmers are practicing subsistence types of agriculture. The area is dominated by food grains cultivation specially paddy cultivation. At present, Paddy, wheat, mustard, maize, pulses, sunflower, potato and jute are the major crops. Some of the farmers are recently interested in sugarcane farming and large scale banana cultivation. Although most of the farmers grow vegetables in kitchen garden near house only few are involved in off-house vegetables farming while none in this area interested in large scale vegetable farming as cash crops.

Common type of cropping pattern is practicing in Balaha. Multiple cropping is also in practiced in Balaha. The major cropping pattern practicing in the study area is Paddy-Wheat-Fallow (Zone A, B, C) and Paddy-Fallow-Fallow (Zone D). Even though the land fertile enough to practice three to four crop combination per year, most of the farmer at Balaha are compel to follow two crops combination because of labour problem and insufficient irrigation facility. Mostly maize cultivation is practiced only for home use and fodder purpose. Tharu people completely left to cultivate maize because of some social problem.

Cropping intensity of Balaha is 180.28 percent, which slightly higher than that of national context i.e. 180 percent (NSCA 2001). In fact, cropping intensity is an outcome of farmers' decisions which is directly or indirectly influenced by Geo-physical, socio-economic, infrastructure conditions of the area. This is clearly observed in different irrigation zone of study area. Zone A (rainfed) has maximum cropping intensity of 207.58 percent, followed by Zone B (202.30 percent). Likewise Zone C has cropping intensity of 189.80 percent whereas

Zone D has minimum cropping intensity of 119.59 percent. This indicates that the agriculture land of Balaha is not efficiently utilized. The distance from house to farm has affects the use of inputs, cropping intensity, cropping pattern and the protection of crop in Zone D which lies more than 25 minutes walking distance from house.

A regression model test about the relation between distance and cropping intensity of study area shows weak positive relationship between the distance and the cropping intensity. Regression of cropping intensity vs plot size reveals a weak positive relationship between the cropping intensity and plot size. Chi-square (χ^2) test on cropping intensity according to land ownership type shows there is a significant difference in cropping intensity according to land ownership type. Similarly, the Chi-square (χ^2) test on cropping intensity according to the irrigation zone validates that there is significance difference in the cropping intensity according to irrigation zone.

Livestock farming is also practiced but only for self consumption. At present, due to lack of grazing land, livestock are stall-fed but in the past (22 years ago) cattle used to graze in open field near Garun Khola. Based on the purpose, there exist two different types of livestock farming pattern between different ethnicity. Tharu people keep livestock for energy, cooking and agricultural purpose (tilling farm and to draw the carts) while Brahmin and Chhettri people keep livestock for milk and organic manure for their farm.

An evaluation of farm inputs in the study area in terms of use of technological innovation in which farmers take advantage of improved varieties of seeds, chemical fertilizers, agro-medicines and farm machineries shows almost all farmer used chemical fertilizer which were used in low quantity before two decades. Quantity of chemical fertilizer is mainly depends upon irrigation condition of the farm. Similarly, use of pesticide is also uneven in the study area. People's perception about chemical fertilizers and pesticides is that the more use of these inputs give more production of crops. They want more production instantly at any cost. Farmer from Tharu community uses less quantity of organic manure on their farm as compare to others.

Irrigation is playing an important role in enhancing food security, income and livelihoods of the local people in the area. Most farmers do not apply organic manure; still production of the crops has been increased substantially due to use of chemical fertilizer, improved HYV seeds and irrigation facilities. For water allocation under existing modern irrigation system (SMIP canal), farmers has been grouped according to the secondary or tertiary canal they are using. Farmers do not receive a constant supply of water, but the supply of water is rotated between different areas within the irrigation scheme. Farmer expresses their dissatisfaction over insufficient delivery of water through SMIP canal. The potential implication of the existing irrigation systems is that if available water is managed properly it will lead to sustainable increases in small farmer's productivity and income.

This study reveals that irrigation through SMIP canal has played positive role in increasing production of crop. In Zone A, the yield of Paddy, Local Mustard and Patato has risen respectively by 123.89, 25.66, and 10.73 percent (as compare to 1985). Here the main factor for augmented yield is the increasing use of improved seeds, chemical fertilizer and agro-medicine only. But with the introduction of irrigation through SMIP, the yield rate of Paddy, Local Mustard and Potato has increased respectively by 213.16, 59.32 and 12.9 percent in Zone B. The exceptional increase in yield percent in Zone B is due to conversion of rainfed system (in 1985) into irrigated system (SMIP). There exist a notable increased in yield of different crops in Zone C and Zone D too.

Study of average yield of different crops and zone wise percent difference in yield illustrates mean yield of each crop in irrigated condition is higher than that in rainfed. Likewise, the zone-wise breakdown of total input cost, return and net profit of major agricultural crops reveal the net profit from each crop in zone A (rainfed) is lower than that from zone B, C & D which has irrigation facilities.

According to input cost, the ranges of investment cost vary by crops. Sugarcane cultivation has highest net profit with high input cost while sunflower cultivation has highest net profit with low input cost. Regarding production economics improved mustard is found to be the most important crop practiced in Balaha. It has low input cost with high net profit per ha. Likewise, pulses is found to be the crop with lowest input but having more returns than the

wheat. Still farmer prefer wheat cultivation over pulses. Major causes to neglect the cultivation of pulses are uncertainty in yield due to high rainfall and inception of pest. On the basis of net profit per ha paddy falls in fifth rank while wheat descend in eighth rank. Rice and wheat flour constitute a daily diet, so farmer first priority is paddy and wheat although these crop ranked in fifth and eighth place respectively.

Farmer admits that the climatic condition of Balaha has been changing steadily. The study area in general has experience increased temperature, erratic and intense rainfall with no decrease in total amount of annual rainfall. Incidence of pest has also increased, occurrence of fog has been more prominent (since 2004/05) and prolonged drought is prevailing in winter. Similarly the cold intensity has increased while the total days of winter have decreased. Disappearances of some animals (jackal, vulture, bat, dove etc) and continual decreases of others (snakes, crow, parrot), existence of mosquitoes in winter season, shorting of flowering time and early ripening of fruits and shrinkage of ground water level in summer are alarming signals of climate change in Balaha.

The syndrome of climate change has also been seen on agricultural sector. People have bad experience of drought in the year 2005/06 when paddy production decreased by 50 percent and 25-30 percent of total agricultural land left fallow. People also worried about heat wave which effects on the production of pulse and wheat. Incident of new alien grass and insect in the farmland are being more prominent and the crops are infected by diseases more often.

7.2 Conclusion

Agricultural land use change is a continual phenomenon. Farmers' family concerns and priorities plays guiding role in existing land use management and conservation. The farmer would choose a new cropping pattern (i.e. change the existing land use) if he is benefited from this decision or the risk that is associated with the change is minimum. His decisions in changing current land use are influenced by availability of labour, improved seed, input price of irrigation and fertilizer. Similarly, cropping pattern and crop yield in future might be affected due to policy change and climate change.

Field observation and study of earlier topographical maps/aerial photographs (1978 and 1992) of Balaha reveal the last two decades as a pathway of agricultural expansion. In the recent year technological progress and better market access has facilitated a shift to more market-oriented production in a pathway of agricultural intensification. Current change in agriculture land use, a consequence of decisions made by farmers and policy makers in the past, is a key driver of change in the Balaha economy. The investments in irrigation and infrastructure, improvements and extension of the road network in Balaha have contributed significantly to facilitate market integration, improvements in agricultural inputs and productivity and welfare. The construction of SMIP irrigation channels has enabled farmer to intensify agricultural production and facilitated agricultural development. Major technological innovation of HYV seeds is a vital source of increase in productivity.

The yield of every crop has been increased in four different zone of study area due to the increasing use of improved seeds, chemical fertilizer and agro-medicine. There is an exceptional increase in yield percent of every crop in Zone B as it is now irrigated through SMIP canal which was rainfed previously (1985). Presently, yield of paddy and wheat is respectively 1.54 and 1.39 times higher in irrigated condition (SMIP) than that in rainfed. Crop yield is more or less analogous in zone B and zone C which suggest validity of irrigation by old canal as compare to SMIP canal. The distance from house to farm has affects the use of inputs, cropping intensity, cropping pattern and the protection of crop in Zone D. Study of average yield of different crops and zone wise percent difference in yield illustrates mean yield of each crop in irrigated condition is higher than that in rainfed. Likewise, the zone-wise breakdown of total input cost, return and net profit of major agricultural crops reveal the net profit from each crop in zone A (rainfed) is lower than that from zone B, C & D which has irrigation facilities.

The cropping intensity of Balaha succumbs slight more than that of national average. Despite a high possibility of both intensification and diversification of crop, two crop patterns seem prominent in study area. It clearly indicates that agriculture land of Balaha has not been efficiently utilized.

During the last two and half decades, Balaha has seen major changes in the way agriculture is organized. These changes suggest a level of dynamism which is influenced by and is responding to new opportunities offered by expanding and changing markets. One of the important changes is the introduction of sunflower and sugarcane as a cash crop. The improving access to new markets and availability of irrigation facilities has allowed farmers to experiment and take advantage of new crops and technologies. The increase use of thresher, tillage by tractor, use of power tailor and other agro-tools is also worth noticing.

Change is seen in way to deficit food demand. There is increasing trend of farmers' involvement in different non-farm activities such as: wage, employment, foreign employment, trade etc for income generation. Likewise, the number of livestock reared has been decreased and now are stall-fed, due to lack of grazing land.

In contrast to past, today school enrolment and food security has been increased, and access to markets is improved. Yet, the socio-economic data demonstrates the diverse characteristics of village dweller. There exists a significant difference in living standard of Pahade Community (Bramin, Chhetri) and other Ethnic Groups. Better roads and irrigation has reduced poverty and food insecurity. Also, the decreasing house-to-land distance has further open an opportunity to transform traditional subsistence-based agriculture into market-driven production.

A sign of climate change is prevailing in study area and is affecting agricultural production. Identifying climatic behavior and its consequence upon agriculture and strategic option to help agrarian communities to adapt to changing situation is a growing challenge in agriculture sector development.

To sum up, this study reveals that irrigation plays a crucial role in intensification of agricultural production and facilitates agricultural development. There exist a significance difference in the cropping intensity according to land ownership type and available irrigation facilities. The distance from house to farm also affects the use of inputs, cropping intensity, cropping pattern and the protection of field crop. Similarly, cropping intensity, to some extent is also influenced by the farm size. Factors such as farm size, farm's spatial location,

market and input related concerns are more decisive for farmers' actual choice of crop type. Thus, useful finding of the study is that social value and bio-physical processes determine crop productivity in response to environment and management interactions. Present challenge is translating these complex processes into practical decision-support tools of use, to farmers and policy-makers.

7.3 Recommendation

Based on the findings of the study, the following recommendations are suggested to deploy environmentally sustainable and economically profitable agricultural land-use/land management practices thereby improving the agricultural productivity in the coming days:

Farmers are concentrated on subsistence based cereal crops cultivation which is economically less profitable so it is important to encourage the farmer to concentrate on commercial agriculture. The policy measures have to focus on a reduction in subsistence cultivation and facilitated agricultural intensification. Similarly, attention should be given to initiate commercial horticulture farming and livestock rearing.

Lack of labour force effect the agricultural activities. It is therefore very crucial to introduce labour saving and effective improved agricultural tools. Government should focus on intensive use of technology (small low cost effective agro-tools to hi-tech machine) through agricultural research, extension and human resource development. Concept of large scale intensive commercial farming should be initiated in Terai region. A serious step should be taken to generate employment opportunities through agricultural commercialization and diversification, to control the migration for foreign employment in gulf country.

More than 25 ha agriculture land in Balaha is totally rainfed and other lands which are irrigated through SMIP canal also do not get sufficient water in winter season. Attention must be taken to improve the irrigation facility by mutual coordination between farmers and concern authority. Appropriate plans and program should be implemented to extend irrigation facility in study area. Alternative method of irrigation such as sallow tube well, pump set etc should be provided to the farmers at minimum cost.

Shortage of chemical fertilizers during the peak agricultural season, untimely and irregular supplies of agro-medicine have been affecting the production negatively. Responsible Government's authorities should give grave attention to solve these problems as soon as possible.

As the soil of this area has increasing acidity, use of limestone must be encouraged for soil amendment. Programmes are urgently needed to promote the use of a combination of organic and inorganic fertilizers to capture the synergistic relationship that exists between them. Likewise adaptation of legume based crop rotations and promotion of conversion of plough till to conservation till system should be initiated.

The agricultural production is affected by changing conditions of climate such as temperature, precipitation, drought, hot waves etc. Conservation of local crop varieties through seed banks and field gene banks, identification and promotion of climate stress (particularly drought, flood and pest) tolerant underutilized crops, fruits, livestock and their local breeds are some of the crucial adaptive strategies to be taken to tackle the aspect of climate vulnerability.

Land reform is seen by many as a vital pre-requisite for improving productivity. Government should promote consolidation of small parcels. Problem of widespread deleterious practices of land fragmentation and absentee landlordism should be addressed by strong land use and land management policy. Type of agriculture land should be categorized more scientifically according to its capability and economic productivity. There should be a strict law to cease possible transformation of agriculture land into residential use or commercial use in future.

To shift traditional subsistence farming to market-oriented production, agriculture related government and non-government organizations existing nearby Balaha could play a vital role. These organizations should be serious in delivering required intensified investments in advisory services to concern farmer. External support could facilitate the adaptation process to the needs of commercialized, environmentally sustainable agricultural production and marketing, including the provision of market information.

Today's need is to attain maximum sustainable production level to satisfy the diverse needs of society while at the same time conserve fragile ecosystems and our genetic heritage. This could be achieved by managing land types and land uses in the most rational way possible. Monitoring of agriculture land use changes is needed to understand and predict the dynamic process of agriculture land use patterns at different times. For this, national level parcel based agriculture information system should be developed. So, that current situation of any area could be easily analyzed by comparing old series of map data with current data, acquired by direct field survey or by the study of Remote Sensing Imageries. Likewise, future prediction can be carried out by taking at least 20 years land use map of different time series.

Cropping pattern is a dynamic concept as it changes over space and time. The cumulative effect of farmer's decision regarding the choice of crops, the method of tillage and his appreciation of the land resources is reflected in the spatial as well as temporal variation in agriculture land use. So, a micro level model base study on farmer's perception and decision in agriculture practices should be carried out on this subject. Besides, for each crop types, an individual parcel based study of agricultural land use change should be done in different region of Nepal, on the basis of soil type, total moisture available, seeds, fertilizer and agro-chemical used.

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ANNEX – A

METEOROLOGICAL DATA

Annual Average Temperature at Tarahara Sunsari (1990-2010)

Year	Max. Temp.	Min. Temp.
1990	29.61	18.25
1991	30.00	17.70
1992	29.73	18.11
1993	29.71	18.31
1994	30.52	18.72
1995	31.33	19.67
1996	30.59	18.43
1997	29.68	17.58
1998	30.29	18.63
1999	30.83	18.61
2000	30.78	18.12
2001	29.90	18.22
2002	29.63	18.90
2003	28.99	19.13
2004	29.21	18.67
2005	29.64	18.75
2006	29.90	18.53
2007	29.44	18.65
2008	29.49	18.30
2009	30.13	18.40
2010	29.93	18.69
Mean	29.97	18.49

Source: Hydrology and meteorology department

Annual Average Rainfall at Tarahara Sunsari (1980-2010)

Year	Rainfall (mm)	Year	Rainfall (mm)
1980	1295.5	1996	2103.7
1981	1849.9	1997	1523.9
1982	1699.3	1998	2241.9
1983	2249.4	1999	1937.8
1984	2480.4	2000	2248.4
1985	1582.2	2001	2125.0
1986	1601.8	2002	1822.7
1987	2820.2	2003	2101.2
1988	2003.3	2004	2217.0
1989	2797.5	2005	1623.1
1990	1948.9	2006	1264.1
1991	2086.2	2007	2073.9
1992	1388.6	2008	2138.6
1993	1930.8	2009	1727.8
1994	1502.3	2010	2309.1
1995	1980.2	Mean	1957.25

Source: Hydrology and meteorology department

ANNEX – B

CALCULATION OF CHI-SQUARE TEST

Table 5.12 shows the cropping intensity on different land ownership type. To analyse if there is a significant variation among the cropping intensity of according to land ownership types, Chi-square (χ^2) test has been applied.

Table 5.12: Cropping Intensity According to Land Ownership Type

Land Ownership Type	Cropping Intensity					
	less than 75	76-125	126-175	176-225	Above 225	Total
Own	38	45	10	57	2	152
Batuwa or Adhiya	0	10	3	32	0	45
Contract	0	0	0	17	0	17
	38	55	13	106	2	214

Source: Field Survey, 2011

Suppose, H_0: there is no significant variation in cropping intensity according to land ownership types

H_1: there is significant variation

Chi-square (χ^2) = $\Sigma\{(O-E)^2/E\}$ where, O = Observed Value & E = Expected value

Calculation:

Land Ownership Type	Cropping Intensity				
	less than 75	76-125	126-175	176-225	Above 225
Expected (E)					
Own	26.99	39.07	9.23	75.29	1.42
Batuwa or Adhiya	7.99	11.57	2.73	22.29	0.42
Contract	3.02	4.37	1.03	8.42	0.16
$\{(O-E)^2/E\}$					
Own	4.49	0.90	0.06	4.44	0.24
Batuwa or Adhiya	7.99	0.21	0.03	4.23	0.42
Contract	3.02	4.37	1.03	8.74	0.16
Chi-square (χ^2)	40.34				

Here, the degree of freedom = (r-1) (c-1)
= (3-1) (5-1)
= 2×4
= 8

The calculated value of Chi-square (χ^2) at 0.05 level of significance for 8 degree of freedom is given as 15.5. Since the calculated value (40.34) is greater than tabulated value the null hypothesis is rejected. It implies there is a significance difference in the cropping intensity according to land ownership type.

ANNEX – B

CALCULATION OF CHI-SQUARE TEST

Table 5.13 shows the cropping intensity on different irrigation zone. Chi-square (χ^2) test has been applied to analyse if there is a significant variation among the cropping intensity according to irrigation zone.

Table 5.13: Cropping Intensity According to Different Irrigation Zone

Zone	Cropping Intensity					
	less than 75	76-125	126-175	176-225	Above 225	Total
A	21	4	9	22	2	58
B	11	2	1	30		44
C	6	6	5	40		57
D	0	43	2	10		55
	38	55	17	102	2	214

Source: Field Survey, 2011

Suppose, H_0: there is no significant variation in cropping intensity according to irrigation Zone

H_1: there is significant variation

Chi-square (χ^2) = $\Sigma\{(O-E)^2/E\}$ where, O = Observed Value & E = Expected value

Calculation:

Zone	Cropping Intensity				
	less than 75	76-125	126-175	176-225	Above 225
Expected (E)					
A	10.30	14.91	4.61	27.64	0.54
B	7.81	11.31	3.50	20.97	0.41
C	10.12	14.65	4.53	27.17	0.53
D	9.77	14.14	4.37	26.21	0.51
$\{(O-E)^2/E\}$					
A	11.12	7.98	4.19	1.15	3.92
B	1.30	7.66	1.78	3.89	0.41
C	1.68	5.11	0.05	6.06	0.53
D	9.77	58.94	1.28	10.03	0.51
Chi-square (χ2)	137.36				

Here, the degree of freedom = (r-1)(c-1)
= (4-1)(5-1)
= 3×4
= 12

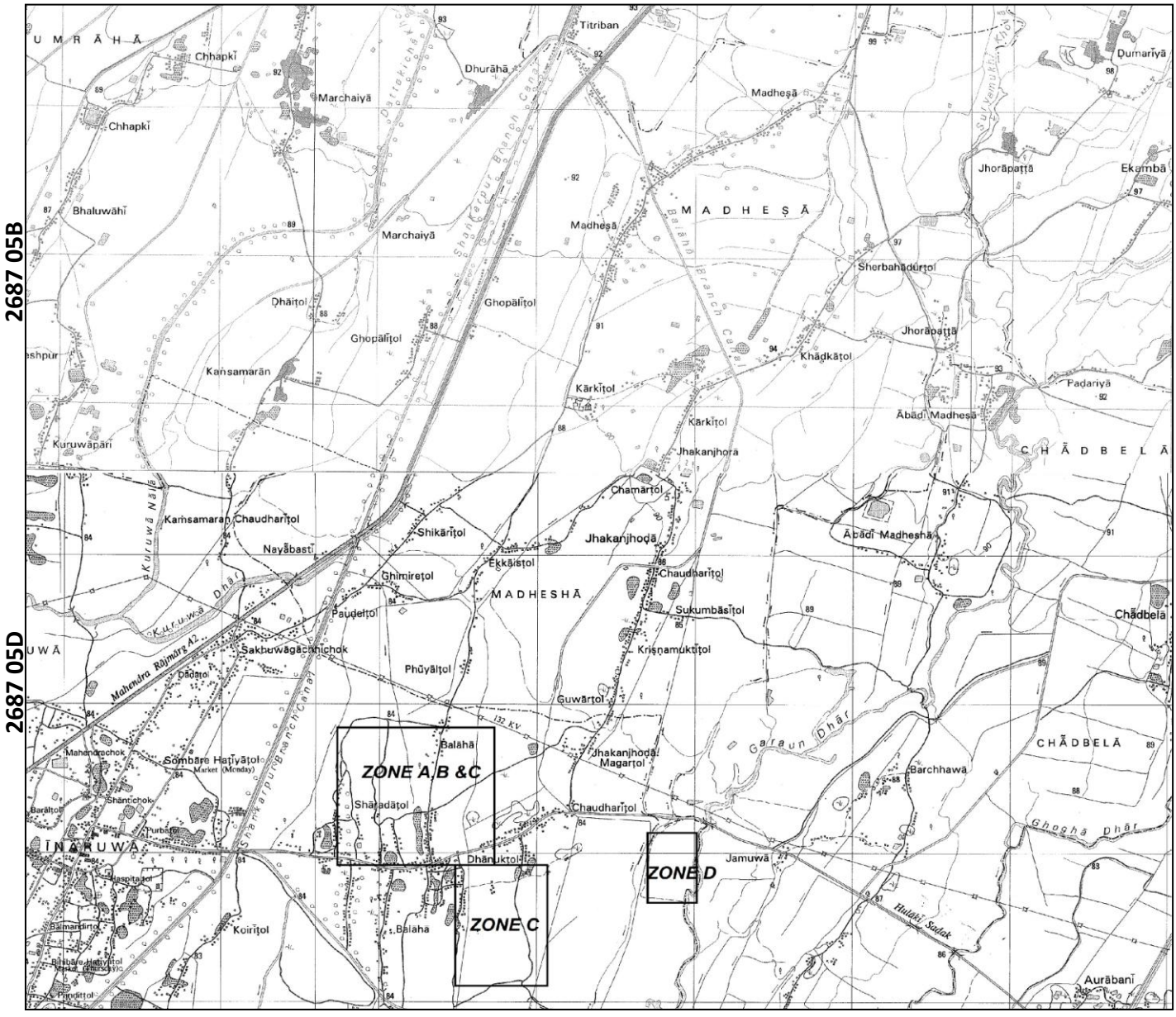
The calculated value of Chi-square (χ^2) at 0.05 level of significance for 12 degree of freedom is given as 21.03. Since the calculated value (137.36) is greater than tabulated value the null hypothesis is rejected. It implies there is a significance difference in the cropping intensity according to irrigation zone.

ANNEX - C

Cropped part of Topographical Map

(JHUMKA BAJAR and INARUWA)

Sheet No. : 2687 05B
2687 05D



SOME PHOTOGRAPS DURING FIELD STUDY

ANNEX - D

1. Women prepares a Goraha; 2. & 3. Livestock and Goraha; 4. Unstructured interview with respondent; 5. Farmer locates their parcel in Cadastral map.

SOME PHOTOGRAPS DURING FIELD STUDY

ANNEX - D

1. A typical house owned by Tharu community; 2. A typical house owned by Newar community; 3. Thresher; 4. SMIP Canal and agriculture area in Balaha; 5. Focus Group Discussion.

ANNEX - E

Study on Land Use Change

HOUSEHOLD QUESTIONNAIRE

1. Background Information

Name of the Interviewer: Date:

VDC Name: Village:

Name of the Respondent: Age:

Ethnicity: Religion:

No. of Family: Male: [ ] Female: [ ]

2. House type and ownership:

No. of House	Place	Roof type	Wall type	Story	Ownership	Remarks (Change in house type: when, what)

- **Separate building for cowshed:** Yes [ ] No [ ]

3. History of migration: Native / in-migrant Year of in-migration……..

If in-migrant, Place of Origin (Village, VDC, and District): ……

Reasons for migration: ……

4. Family Size (Eating and living together including temporal absentees):

Total number of family members …… Member present …… Member absent……

S.N.	Relation to Head	Age	Sex	Marital Status	Education	Main Occupation	Secondary Occupation	Place of work	Duration of work	Income / Remittance (per mth)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										

5. Livestock:

5.1 Livestock type and number

Type of livestock	Local		Improved		Stall-feeding present	Adopted from others	…… years ago	Stall-feeding ……. yrs ago	Remarks
	Young	Adult	Young	Adult					
Cow									
Oxen									
She Buffalo									
He Buffalo									
Horse									
Goat									
Pig									
Chicken									
Duck									
Pigeon									
Bee									
Fishing									
Other (Specify)									

5.2 Animal Grazing:

Type of Animal	No. of animal	Place of Grazing	Type of Land	Ownership of land	Duration of Grazing	Distance from the house
Cow / Oxen						
Buffaloes						
Goat						
Others						

a) Total no. of days spend in year to graze animal: ……..

b) Who graze the animal? Male (%) ……Female (%)…… Children (%) ……

c) Specific practice during inundation or Other stress :

……

……

……

6. Agricultural land:

6.1 Land use by parcel at present:

Parcel No.	Type of the land	Area	Ownership of the land*	Distance from the house (Time)	Status of Irrigation	Crop Grown	Local or Improved	Area	Production (K.G.)	Use of Input						
										Labour** days		Bullock or Tractor	Seeds (K.G.)	Manure (K.G.)	Chemical Fertilizer (K.G.)	Pesticides (K.G.)
										Own	Hire					

*Type of land tenure or type and amount of land contract

**Calculate total number of man days used for land preparation, plough, irrigation, seed preparation, transplantation, weeding and harvesting

6.2 Land use by parcel …….. years ago:

Parcel No.	Type of the land	Area	Ownership of the land*	Distance from the house (Time)	Status of Irrigation	Crop Grown	Local or Improved	Area	Production (K.G.)	Use of Input						
										Labour** days		Bullock or Tracter	Seeds (K.G.)	Manure (K.G.)	Chemical Fertilizer (K.G.)	Pesticides (K.G.)
										Own	Hire					

*Type of land tenure or type and amount of land contract

**Calculate total number of man days used for land preparation, plough, irrigation, seed preparation, transplantation, weeding and harvesting

Year of change: **History of change:** ……

6.3 Status of Agro-forestry at present:

Fruit Tree					Fodder Trees				Other Trees			
Species	No. of trees	Plot no.	Area	Production	Species	No. of trees	Plot no.	Area	Species	No. of trees	Plot no.	Area

Year of change: History of change: ……

……

6.4 Status of Agro-forestry ……. years ago:

Fruit Tree					Fodder Trees				Other Trees			
Species	No. of trees	Plot no.	Area	Production	Species	No. of trees	Plot no.	Area	Species	No. of trees	Plot no.	Area

7. Use of alternative Source of Energy in % use:

Types	Year of use	Purpose of use				Remarks
		Lighting	Heating	Cooking	Others	
1. Kerosene						
2. Electricity						
3. Fuel saving stoves						
4. Bio-gas						
5. Manure Brickets						
6. Solar panels						
7. Others if specify						

8.1 Forest resource extractions:

Type	Own farm	Private Forest	Community Forest	Government Forest	Changes during ……. years (Frequency, time & quality)
1. Fire wood					
a. Number of times / week went for collection					
b. Time taken to collect one load					
c. Quantity used (per week)					
d. Labour days spent (per week)					
Male					
Female					
Children					
2. Fodder					
a. Number of times / week went for collection					
b. Time taken to collect one load					
c. Quantity used (per week)					
d. Labour days spent (per week)					
Male					
Female					
Children					
3. Leaf Litter					
a. Number of times / week went for collection					
b. Time taken to collect one load					
c. Quantity used (per week)					
d. Labour days spent (per week)					
Male					
Female					
Children					
4. Cut Grass					
a. Number of times / week went for collection					
b. Time taken to collect one load					
c. Quantity used (per week)					
d. Labour days spent (per week)					
Male					
Female					
Children					
5. Charcoal or Others if Specify*					
a. Number of times / week went for collection					
b. Time taken to collect one load					
c. Quantity used (per week)					
d. Labour days spent (per week)					
Male					
Female					
Children ⇨					

* Others Wild Vegetables: Medicinal plants:

8.2 Sales of Forest resource extractions:

Resources	Quantity	Price
Wood		
Fodder		
Litter		
Others		

9. Consumption and expenditure:

9.1 Food Sufficiency

Food Sufficiency	At present	..... years ago	Reasons for change
No. of months of self sufficiency			
Quantity Deficit			
Way of fulfillment of deficit			
Surplus Quantity			
Surplus Quantity in values in (Rs)			

9.2 Consumption and expenditure pattern:

Items	Quantity used (Kg Per year)	Values (Rs)	Quantity Own Production (kg)	Quantity Purchased (kg)	Remarks
I) Food Grains					
1.Maize					
2. Rice					
3. Wheat					
4. Potatoes					
5. Pulses					
6. Mustard (Oil) /Ghee					
7. Milk Products					
8. Sugar					
9. Meat / eggs					
10. Beverage / Beef /					
11. Fruits/ Vegetables					
12. Drinks/ Cigarettes					
13. Others Specify					
II) Non-food					
1. Clothing					
2. Education					
3. Health					
4. Transport					
5. Taxes / Donation					
6. Wages					
7. Social ceremonies					
8. Fuel wood					
9. Electricity/ Kerosene					
10. Soaps, combs, battery, torch, utensils etc					
11. Loan Repayment					
12. Others if Specify					

Items	Quantity used (Kg Per year)	Values (Rs)	Quantity Own Production (kg)	Quantity Purchased (kg)	Remarks
III) Investment					
1. Land purchase					
2. Land Improvement					
3. Irrigation					
4. House/shed construction					
5. Agri-impliments					
6. Livestock					
7. Others if Specify					

10. Sources of family annual income (Last year):

S.N.	Sources	Annual income in Rs
1	Agriculture	
2	Horticulture and Vegetables	
3	Live stock	
4	Fishing	
5	Cottage industry	
6	Trade	
7	Wages	
8	Porterage	
9	Service	
10	Hotel and lodges	
11	Remittances	
12	Pensions	
13	Other sources	

11. Market access

S.N.	Name of markets	Name of assets	Distance(km)	Means
1				
2				
3				
4				
5				

Focus Group Discussions

Calendar of Activities

a) Agriculture (Calendar of Cropping Pattern)

	Poush	Falgun	Baishak	Aashar	Bhadra	Kartik	Poush
	Magh		Chaitra	Jestha	Shrawan	Aswin	Mongshir
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
a. Paddy												
Land Preparation												
Seedling												
Transplantation												
Weeding												
Harvesting												
b. Wheat												
Land Preparation												
Sowing												
Weeding												
Harvesting												
c. Maize												
Land Preparation												
Sowing												
Weeding												
Harvesting												
d. Millet												
Land Preparation												
Sowing												
Weeding												
Harvesting												
Weeding												
Harvesting												
e. Potatoes												
Land Preparation												
Sowing												
Weeding												
Harvesting												
f. Others (Specify)												
Land Preparation												
Sowing												
Weeding												
Harvesting												

- **Do you wait for rain for sowing?**

.....

.....

- **Do you have enough water?**

……

……

b) Resource Collection

	Poush	Falgun		Baishak		Ashar		Bhadra		Kartik		Poush
	Magh		Chaitra		Jestha		Shravan		Ashwin		Mongshir	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Fire wood												
Fodder												
Leaf Litter												
Cut grass												
Medicinal plants												
Wild vegetables												
Charcoals												
Fishing												
Others (Specify)												

c) Feast and Festivals

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1.												
2.												
3.												
4.												
5.												
6.												
7.												

1) Time line (Change)

a) Agriculture

	Year	Remarks
New seed		
Fertilizer		
Crop rotation		
Drought		
Heavy Rain		
Flood		
Productivity		

b) Natural Hazard and Land use change

Type of Natural Hazard	Year of occurrence	Damages					Implication to other Land use change
		Land type or plot	Area	Crops in value (Rs)	No. of Animals	Other assets (Rs)	
Earthquakes							
Floods							
Siltation or Erosion							
Drought							

Type of Natural Hazard	Year of occurrence	Damages					Implication to other Land use change
Hailstorms							
Strom, Wind							
Fire							
Pest & diseases							
Others							

2) Over all perception on land use change in their locality

Land use	Increasing / Decreasing / Constant	Reasons for change	Future Trend (Increase / decrease / constant)
1. Agriculture			
a. Area under Khet			
b. Area under food crops			
c. Area under fruits crops			
d. Area under vegetables			
e. Diversity of crops			
f. Intensity of crops			
g. Productivity of crops			
h. Use of improved seeds			
i. Use of chemical fertilizer			
j. Use of pesticides			
k. Other if specify			
2. Forest			
a. Forest area			
b. Number of species			
c. Crown cover			
d. Availability of fuel wood			
e. Availability of timber			
f. Availability of fodder			
g. Availability of leaf/ litter			
h. Other forest products			
i. Number of wild life			
3. Waste land			
a. Area of waste land			
b. Use of waste land			
4. Environmental Hazards			
a. Surface run off			
b. Soil erosion			
c. Floods			
d. Drought			
e. Pests and diseases			
f. Forest fire			
5 Other land use (Specify)			

Check list for Climate Change Assessment

Hazard, Vulnerability and Risk Assessment in Sunsari District in Nepal

Understanding the Climate Change: People's Experience and Perception

(Exposure within last 30 years)

Checklist for Key Informant's Survey

1. Climate change processes

Climate parameters	Trend					Impacts
	Magnitude	Frequency	Intensity	Return period	Timing (season)	
Annual mean temperature						
Summer mean temperature						
Winter mean temperature						
Annual max temperature						
Summer max temperature						
Winter max temperature						
Annual min temperature						
Summer min temperature						
Winter min temperature						
Annual precipitation						
Summer precipitation						
Winter precipitation						
Snowfall						
Cold waves						
Cloud cover						
Heat waves						
Hail storm						
Fog						
Frost						
Windstorm						
Thunderstorm						

2. Climate change calendar (different symbol for the past and changed condition)

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Tm												
Pp												
Sn												
Cw												
Cc												
Hw												
Hs												
Fo												
Fr												
Wn												
Th												

3. Proxy Indicators for climate change

Indicators for climate change	Description (processes and key species)
Flora	
New flushing date	
Flowering date	
Fruit setting date	
Fruit ripening date	
Appearance of alliance species – number of species and abundance	
Disappearance of existing species	
Upward shifting of plant species	
Fauna	
Migration time of birds	
Nesting time of birds	
Hatching time of birds	
Appearance of new bird species	
Disappearance of existing bird species	
Appearance of mosquitoes	
Outbreak of pests/diseases and magnitude	
Physical and hazards	
Landslides	
Floods	
Natural water springs	
Water bodies	
Drought	

4. Major crops grown, its calendar and change in crop and cropping calendar
   f= field preparation, s = seeding, t = transplantation,
   w = weeding, h = harvesting

Crops	J	F	M	A	M	J	J	A	S	O	N	D
Summer paddy												
Winter paddy												
Summer maize												
Winter maize												
Wheat												
Millet												
Mustard												
Sugarcane												
Potatoes												
Buckwheat												

5. Sensitivity of climate change

Agriculture	
Crop production, productivity and seasonality	
Livestock fisheries production and productivity	
Livestock fisheries health	
Forestry and biodiversity	
Forest resources availability and seasonality	
Effect on forest resources and biodiversity	
Wildfires	
Disasters	
Effects on infrastructure - damage	
Human causalities	
Livestock causalities	
Crop damage	
Land damage	
Building damage	
Others	
Water resources	
Effects on water availability and seasonality for human use	
Social economy	
Effects on employment, labour movement, labour availability for agriculture	
Effects on migration pattern	
Increased violence and social unrest	
Cross-cutting	
Effects on tourism	
Effects on women, children and aged people	