Role of gender on agricultural intensification and its implication for soil fertility management

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Role of Gender on Agricultural Intensification and its Implications for Soil Fertility Management

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CREDIT

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DECLARATION

I, Bhola Raya, declare that this thesis is a result of my research investigation and findings. Sources of information other than my own have been acknowledged and reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature……………………………………………………………

Date…………………………………………………………..

Abstract

This study deals with gender differences in agricultural activities that have a potential effect on soil fertility in the Anshikhola watershed of the mid-hill region of Nepal. Multiple methods were used to collect data, including a questionnaire survey (310 households), six focus group discussions, five key informant interviews and direct observation to generate information about the gender role in agricultural activities. Four replicates of soil sample are collected from each site to analyze soil fertility in the watershed. Results indicate that women are involved in land clearing, farmyard manure (FYM) collection, transport and application, planting and household works whereas men are involved in plouging, chemical fertilizers and pesticide application, marketing and selling of the products. But there has been equal involvement of women and men for decision regarding choice of crop, buying of chemical fertilizers and pesticides. But this has been limited to the upper two caste group which is not seen in the lower castes.

Soil sample analysis shows that there is a gradual decrease of soil carbon, nitrogen, phosphorus and potassium with depth in all types of cultivated land but the bulk density did not show such pattern. With the introduction of intensive agricultural practice in this study site, there is maximum use of chemical fertilizer as well as FYM to increase yield. Hence intensive agricultural land had a significantly higher value of soil carbon, soil nitrogen, phosphorus and potassium but the bulk density was also higher indicating the negative consequences of soil compaction. The highest values of nitrogen, phosphorous and potassium were seen in the surface layers of class A and class B types of land, which was attributed to the recent use of fertilizers in the field. Thus, this study revealed that there is an increasing use of fertilizers in the intensive agricultural practice compared to the traditional one.

Keywords

Keywords: gender; Nepal; agricultural intensification; manure; fertilizer; soil carbon; nitrogen; phosphorous; potassium.

Nomenclature

APP = Agricultural Perspective Plan

AI = Agricultural Intensification

DAP = Diammonium phosphate

FAO = Food and Agriculture organization

FGDs = Focus group discussions

FYM = Farm yard manure

Gm/cc = Gram per cubic cemtimeter

Gt = Giga tone

IPM = Integrated pest management

Km = Kilometer

M = Meter

Mm = Millimeter

Ppm = Parts per million

List of Figures

List of Tables

Table of Contents

1 Introduction

Over the past few decades, increasing population growth, rapid increase in human activities such as urbanization, industrialization, increased use of chemical fertilizers and pesticides, changes in irrigation practices and improved seed stock, have lead to the intensification. Nepal is one of the densely populated countries with a total population of 28,901,790 until 2007 and growing at the rate of 2.5% per annum (CBS, 2007). With this high population pressure and rapid increase in human activities, there is a decrease in the agricultural land and thus the process of agricultural intensification is increasing (Maskey et al., 2003). The situation is even worse in mid-hills since landholdings of farmers are small compared to Terai and the opportunities for them to have other sources of income are also limited. Therefore, a majority of the Nepalese hill farmers have chosen agricultural intensification as an alternative approach for farming where they can have high levels of production on small plots of land. While intensification has supported food demand to some extent but have negative consequences in soil fertility, land use system and other natural resources management in the long run (Alauddin and Quiggin, 2008). There are several factors like soil diversity, climatic condition, physiographic and other natural resources which favor agricultural intensification. Yet, there is widespread poverty and increasing number of hunger. The unwise use of chemical fertilizers, modern ploughing systems has contributed for soil degradation which ultimately affects the soil productivity (Lal, 2001).

Nepal's agricultural production is characterized by diversity in farming systems influenced by differences in agro-ecological topography. Altitude and climatic condition widely determine the farming system and crop production in Nepal. According to CBS 1996, the agricultural sector contributed 40.22% to the Gross Domestic Product in 1995/96. A large portion of the population mostly depends upon agriculture and other activities such as livestock-rearing and forest product collection. As the agriculture is the key sector of the economy, determining economic growth and employment, the standard of living of the majority of the population depends on its development. Although there is investment in irrigation and agricultural development projects recently in many parts of the country which is not sufficient and agriculture production is still largely determined by favorable weather conditions in Nepal (EIU, 1997).

1.1 Agricultural Intensification in Mid-hills of Nepal

Agriculture is the major economic source which provides employment for more than 80% of the total population of Nepal (Raut et al., 2011). In this context, agricultural development is most significant in the country. With the increase in population, there is a large food demand which can only be addressed with the intensification in the agricultural activities (Schroedar, 1985). Not only with the food demand, the agricultural land has been decreasing due to urbanization in Nepal. Along with this, extreme events and natural disaster also add to the reduction in net production and there is no way out than agricultural intensification. Therefore Agricultural Perspective Plan (APP) of 1995 gave greater importance for yield-increasing technology, intensive land use, and high value crops for the extension and promotion of agricultural activities. Thus there is a trend towards commercial farming and intensified agriculture in the areas close to city (Brown, 2000). With the changes in the government plan and policies, there has been considerable changes in the mid-hills of Nepal like access to road and market, income opportunities, agricultural inputs and support from external organization which also favors the intensification process in these areas (Dahal, 2010).

Subsistence farming has gradually intensified to meet increased demand for the population growing at 2.25 percent per annum (CBS., 2003 in Raut et al., 2011). Agricultural intensification and income diversification were given priority in the Eight five-year plan of the National Planning Commission of Nepal, with the aim of increasing per capita food production.. In order to meet household expenses and avoid food insecurity, some mid-hill farmers have shifted from a subsistence-based farming system to intensified agriculture (Paudel and Thapa, 2004; Tiwari et al., 2008). In mid-hill of Nepal, the subsistence farming has been gradually changing toward vegetable farming. This has helped the rural, disadvantageous group especially women to generate their livelihood. It has proved to be very good source of income, employment opportunity and has helped to upgrade the social status. Thus vegetable-based cropping pattern is economically and socially profitable and acceptable for the sustainable farming in the mid-hills (Twari et al., 2011). However, this has been achieved through the intensified cultivation such as use of agrochemical and hybrid seed; there is a long run effect on soil quality.

Due to the limited productive land areas in Nepal, Agricultural intensification is unavoidable due to the food requirements for the growing population, market availability and access to Agro-product. With the introduction of agricultural intensification, there is a great shift from cultivating cereal crops towards vegetables and other cash crops in the hilly region of Nepal (Dahal, 2010). With increased market access and road links to urban centers, settled agriculture in Nepal is becoming transformed into intensified cropping, especially in areas close to the city. This study reviews the development of intensification, gender role on it and its effects on soil in the Anshi Khola watershed of Kavre district in Nepal. The above study revealed that intensive agricultural practices diversified the crop production system, shifting it from need-based cereal crops to market-demanded vegetable and cash crops in relation to gender role on it.

1.2 Gender role in agricultural intensification in Nepal

Both men and women are equally involved in both field and post-harvest work in crop production. Ploughing is considered a man's job, whereas all other work, though shared by men, is mostly undertaken by women. Collecting and carrying compost to the field is normally performed by women. Women's involvement is more in producing major crops such as rice, maize, wheat, etc. (Regmi and Weber, 1997). In both rain fed and irrigated agriculture time spent by women is higher relative to that of men. In rain fed area women devote 12.36 hours per person per day, whereas men do only 9.03 hours. Similarly, in irrigated zones women put in 11.61 hours per person per day whereas men do only 7.85 hours (Hasnip, Mandal, Morrison, Pradhan, & Smith, 2001).

In addition to routine domestic work, women play a significant role in agriculture production. One participatory research project found that women do more work in agriculture than men in the high mountain areas, equal to or more than men in the middle hills and slightly less than men in the Terai (Kumar, 1998). Women are taking part in both as participants and decision making and share the responsibility of planting, transplanting, weeding, harvesting, carrying grain to the mill for grinding, collecting wood, water and fodder (Tiwari, 2007). Women's involvement is very significant in the care and management of livestock and poultry, and kitchen gardening is the other major task for them. However, they participate differently in the hills and Terai (Southern plain). In the complex social systems of the hills, women's participation in agriculture further varies tremendously across the social groups (Tiwari, 2007). Despite women's important role in agriculture, traditional social norms and customary laws which generally are biased in favor of men, are a barrier to women's equitable access to productive resources (Kumar, 1998). With the introduction of an intensified agricultural system in the mid-hill of Nepal, the man's interest in this sector is also increasing (Dahal et al., 2009a).

There are 450 million women and men worldwide who work as the agricultural labor but do not have their own land. They represent about 40% of the labor force below the poverty line (Ajani, 2008). According to United Nation in 2006, women are responsible for half of the world food production. In developing countries, rural women are producing 60-80 percent of food and are more responsible in producing staple foods like rice, wheat, maize (Ajani, 2008). From the early days, women in the rural communities are active in producing legumes and vegetables in small plots, raising poultry and small animals, harvesting, storing and processing of grains. According to FAO (Food and Agriculture organization), women produce 80% of household consumption foodstuff.

In the developing country like Nepal, there is an unequal gender relationship in terms of education, division of labor force, agricultural education, policies making (Raut et al., 2011). In this scenario, agricultural intensification might have negative consequences on the soil fertility, aquatic life downstream and environment as well. Since all agricultural activities are directly or indirectly, affected by how the “soil is handled”, its health becomes the prime concern before one can address human and livestock health issues. Managing soil is a formidable challenge to ensure productivity, profitability and national food security. Soil quality can be assessed by a number of physical, chemical and biological attributes. Relevance of one or more unfavorable soil conditions for long periods leads to un-sustainability of agricultural systems (Roy and Chakrabarty, 2010). Lack of education of the chemical fertilizers among the women (main responsible for the agricultural activities in the rural communities), its dose and effect will lead to decrease the soil fertility (Aktar et al., 2009).

The division of labor between men and women is slowly changing (Dahal et al., 2009)**.** With the change in the agricultural practices, there has been a clear division of labor between different members in a family. The agricultural tasks performed by men and women in Nepal vary according to social group, age, class etc. They are not determined only by physical differences between the sexes, but by the proper social definitions and relations between men and women. The concept of gender in this study serves to distinguish the men and women's role in agriculture and their relationship, particularly regarding to agricultural labor and decision making. By internalizing gender and farming as a system, this study aims to collect data on a set of variables that shape differential participation of men and women of various social groups in agriculture and its implication for various soil and crop management.

Agricultural development which can be said as agricultural intensification are increasingly getting popularity to deliver income, nutrition, food security and employment as well yet relatively little is known about how they affect or are affected by differential access to and control over by the role of men and women (Meinzen et al., 1997)**.** Women carry compost manure from their home to land and use them whereas men use the tractor for tilling and nitrogenous fertilizer in their land. The degree of involvement of men and women on various farm activities will have an important implication for various soil and crop management practices that regulates the pools and fluxes of soil carbon in soil. Soil management and gender role are poorly studied in mid-hills of Nepal (Dahal et al., 2009b). Therefore, there is a need to assess the involvement of men and women in the agricultural intensification process, how their activities are linked to soil management and how such soil management could contribute to soil carbon sequestration. This study will focus on the gender role and give much emphasis on the gender role on intensification in Anshi Khola watershed and its impact on soil fertility management**.**

1.3 Implications of Agricultural Intensification on Soil Fertility

In the mid hil**l**s of Nepal, agricultural intensification is mainly characterized by triple annual crop rotations which includes shorter-growing season varieties and more nutrient demanding cash crops specially potato and tomato with no fallow periods. According to Panth and Gautam, the national average number of crops per year has increased from 1.6 in 1987 to 2.7 for irrigated agriculture and 2.5 crops per year for rain-fed agriculture in the mid 1990s (Westarp, 2004). The shift from double cropping to triple annual cropping have raised concerns that soil inputs of compost and chemical fertilizers are inadequate to meet increased crop uptake and will result in a further decline in soil fertility (Schreier, 1999). Therefore, shifting to double and triple annual rotations which incorporate more nutrient demanding crops are responsible for the large annual deficit in the soil N and P budgets (Brown, 2000). With the development of animal husbandry and agricultural intensification, there is limited returns of organic residue and insufficient organic letters which result in low levels of N to fields. Low levels of available P is a result of low P content in the soil parent materials and the formation of insoluble phosphate due to the strongly acidic nature of the soils (Westarp, 2004). The changes in the agricultural process seen between 1989 and 2009 are mainly in terms of fertilizer use (urea, DAP, potassium fertilizer and farmyard manure) (Raut, 2012a).

The main factors threatening the sustainability of Nepalese agricultural are soil erosion, decrease of the vital organic matter and losses of other crop essential soil nutrients such as nitrogen, SOC**,** potassium, phosphorus (Thapa, 1996). Due to the topographical difficulty of steep slope and high rainfall, soil erosion from agricultural land is a serious problem in the middle mountains in Nepal. On top of this, agricultural intensification could contribute to even higher soil and nutrient losses in various ways. For example, crop intensification has an implication**s** for the crop management factors (C factor) and support practice factor (P factor) defined in the Universal Soil Loss Equation (Wischmeier, 1978). Depending upon choice of crop, cropping intensity, and other crop intensification related factors, soil and nutrient loss rate could be higher in the intensified system (Dahal, 2010). Very few studies explore soil and nutrient losses in the context of crop intensification despite several studies available in investigating physical soil loss measurement from Nepal (Tiwari, 2009). We were able to investigate this through a systematic field experiment and soil sample experiment from the field.

1.4 Soil Carbon Sequestration

Increasing global population and rising incomes of the people living in urban areas are drastically changing the composition of food demand. Higher income urban populations have more diverse diets that feature a variety of high-value food sources which are more resource intensive to produce. This gives the challenge of maintaining and preserving the resilience of both natural and agricultural ecosystems. Based on these developments, projections indicate that global food production must increase by 70 percent by 2050 (Bank, 2012). Because soil is the basic resource in agricultural land use, it is the central element of more sustainable land use management technologies. Soil carbon has a direct correlation with soil quality and soil fertility. It is a major determinant of the soil's ability to hold and release water and other nutrients that are essential for plants and their root systems to grow. Soil carbon also plays an important role in maintaining the biotic habitats that make land management systems sustainable, resilient, and able to resist degradation. Carbon sequestration, the process by which atmospheric carbon dioxide is taken up by plants through photosynthesis and stored as carbon in biomass and soils, can help reverse the soil fertility loss, limit GHG concentrations in the atmosphere, and reduce the impact of climate change on agricultural ecosystems (Bank, 2012).

Carbon (C) in soils is present in both organic and inorganic forms. In most soils, the majority of C is held as soil organic carbon (SOC). The microbial decomposed tissues from dead animals and plants are termed as soil organic matter (SOM) as the organic constituents in the soil **(**Milne, 2012). Carbon sequestration is the removal of carbon (C) from the atmosphere by storing it in the biosphere (IPCC, 2000). Carbon sequestration is the process of removing additional carbon from the atmosphere and depositing it in another reservoir principally through changes in land use (Mandel and Laake, 2005). This process of transforming carbon in the air (CO_2**)** into soil carbon, long term storage of carbon in the terrestrial biosphere, underground or the oceans reduces the buildup of carbon dioxide concentration in the atmosphere.

Carbon sequestration in soils can be best understood as that carbon from the atmosphere into the soil can be increased and carbon back to the atmosphere can be decreased. Therefore instead of being a carbon source, soils could be transformed into carbon sinks, absorbing carbon instead of emitting it. Soil carbon is an important part of the terrestrial carbon pool (Lal and Kimble, 1997) and soil of the world are potentially viable sinks for atmospheric carbon (Lal, 2002**)**. Estimated that world's soil contains about 1500 Gt of organic carbon to a depth of 1 m and a further 900 Gt from 1-2 m. However, the quality of soil is drastically decreasing in developing countries like Nepal due to the land use changes (IPCC, 2000), lowering carbon sequestration in soil are inadequately understood (Bajracharya et al., 1998).

1.5 Soil Carbon Sequestration in Intensified Agricultural Land

Agricultural intensification essentially implies greater frequencies of farm activities such as tillage, weeding, irrigation, harvesting and post harvesting. Such activities have an important implication on carbon pool in the soil. Therefore, the process of agricultural intensification has considerable influence on the soil management, and thus, on the soil's ability to sequester carbon. With the intensification of inputs, such as, tillage and use of chemical fertilizers, there is a greater chance for the oxidation of carbon present in the soil and hence reduce the capacity of soil to sequestrate carbon. Carbon sequestration in soil can be enhanced by crop rotation, compost manure use rather than chemical fertilizers and effective conservation system (Bierman and Rosen, 2005).

Soil carbon content (SOC) stock is strongly affected by the soil management practices, soil nutrient management, and removal of crop residue, application of agrochemical and land use changes. As the quality and fertility of soil decreases, the carbon holding capacity of the soil also decreases. There is a direct relation between soil quality and soil carbon content (Lal, 2002). With the intensification of agricultural practices, there is a negative impact on the soil fertility and quality as well. The excessive use of chemical fertilizers, use of modern technology and land use changes have an additional burden on the soil quality (Raut et al., 2011a). Land use change and tillage are major activities in the intensified system that helps in the oxidation of soil organic matter which ultimately effect the soil carbon sequestration (Shrestha et al., 2007). Soil carbon content can be enhanced through conversion of upland to rice paddies, integrated nutrient management, use of biosolid and compost, crop rotation that return large quantities of biomass (Lal, 2002).

The degree of involvement of men and women on various farm activities will have an important implication for various soil and crop management practices that regulates the pools and fluxes of soil carbon. Soil management and gender role are poorly studied in mid-hills of Nepal (Dahal et al., 2009)**.** Therefore, there is a need to assess the involvement of men and women in the agricultural activities, how their activities are linked to soil fertility management and how such soil management could contribute to soil carbon sequestration. This study focused on the gender roles of rural women and men in the context of agricultural intensification in Anshi Khola watershed of Kavre district, Nepal, and its impact on soil fertility management and hence on soil carbon sequestration.

2 Problem statement

Recently the major issuse in Nepalese farming is the excessive use of chemical fertilizers and shifting from traditional cultivation to vegetable farming, especially in mid-hills of Nepal. Though, it has improved the socioeconomic conditions of rural farmers, especially women and disadvantaged groups, it has led to negative consequences as far as sustainable farmingis concerned (Twari et al., 2011). More often, past studies focused on problems and prospect of soil degradation (Shrestha et al., 2004**)** and extent of agricultural intensification process in the mid-hills of Nepal (Raut et al., 2011). The agricultural intensification requires input of chemical fertilizers and modern technology like a tractor for tilling,where compaction of soil during tilling will compress soil particles into a smaller volume that reduces the size of pore space available for air and water which will lead to a potential decrease in the soil quality and hence to the soil fertility management (McKenzie, 2010).

Agricultural development which is essentially synonymous with agricultural intensification, is increasingly gaining popularity to deliver income, nutrition, food security and employment opportunity as well**.** But relatively little is known about how intensification affects soil quality or influences the differential roles of men and women (Meinzen et al., 1997). Women carry compost manure from their home to agricultural land and use them whereas men use the tractor for tilling and nitrogenous fertilizer in their land. Recently the involvement of men and women in the agricultural practise has increased with the introduction of intensification in agriculture but the little is know about the way how their activities effect the soil quality.According to Dahal et al, 2009, there has been very few study regarding the gender role in intensification process. Therefore, there is a need to study the differential role of gender, how their activities effect the intensification process and how soil quality has been effected by intensification. Therefor, this study focused on the gender roles in agricultural intensification process in Anshi Khola watershed of Kavre district, Nepal, and its impact on soil fertility management.

3 Research Objectives

The overall objectives of this study was to analyze the implication of gender role on agricultural intensification and its impact on soil fertility management in the Anshi khola watershed in Kavre district of Nepal.

The specific objectives are

1. To examine gender differences in agriculture-related activities.
2. To investigate the impact of agricultural intensification on soil fertility in different land-uses.

4 Conceptual framework

The conceptual framework has been designed to address both gender differences in different agricultural activities in the study area and its impact on the soil fertility management. Household surveys, focus group discussions and key informant interviews has been done to generate an information on gender difference in the intensification process while the soil sample from the field are brought to the lab in Kathmandu University to analyze carbon content in the soil in order to know the fertility in the soil at the site. The conceptual framework for the study is outlined in the Figure 4-1.

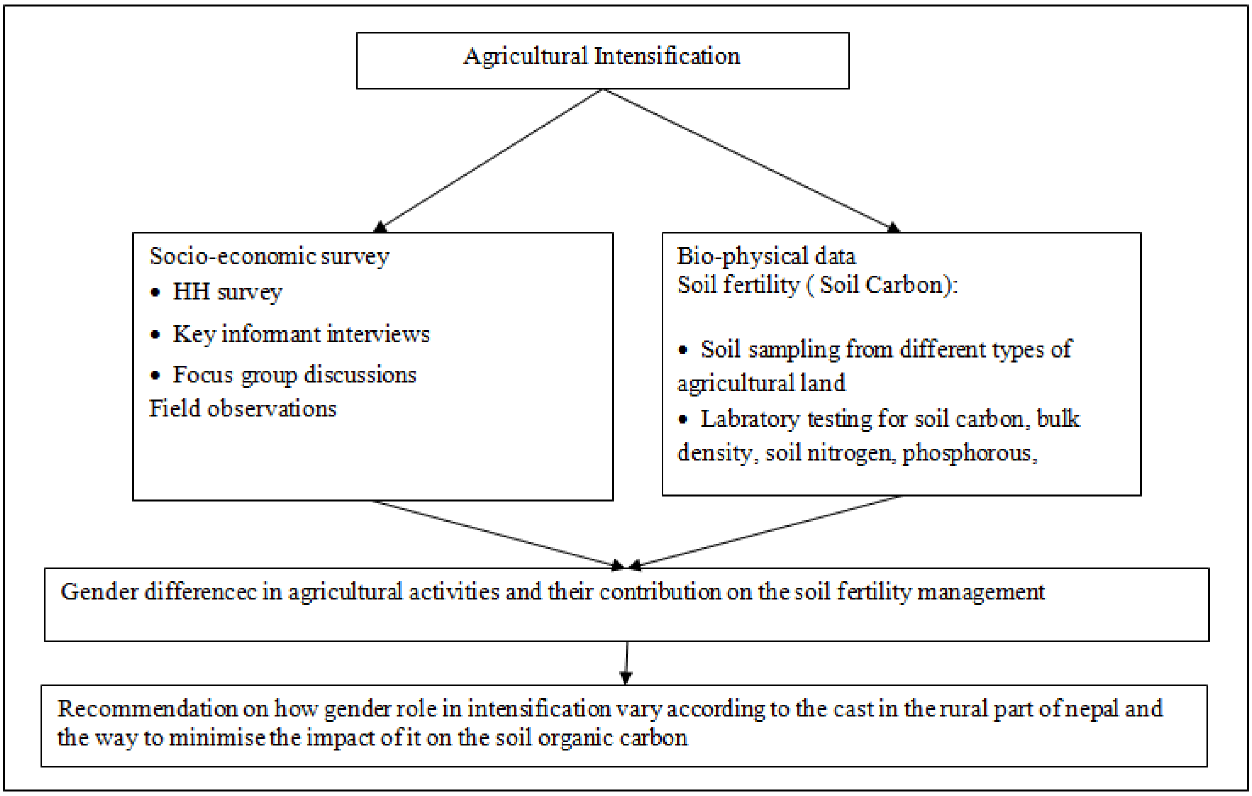


Figure 4-1: Conceptual Framework for the Study

5 Methodology

5.1 Study area

The study area comprises Anshi Khola sub watershed which is located in Kavre district of Nepal. The sub watershed lying between latitudes N 27°41’ and 27°44’, and longitudes E 85°31’ and 85°37’30” extend over an area of 13 square km (Figure 5-1). The elevation of the watershed ranges from 800 m to 2000 m on the hill slopes. The climate is warm sub tropical with annual rainfall of 1389 mm. The annual maximum temperature in the area is 25^{o}C and the annual minimum temperature is 17^{o}C, with annual relative humidity of 74% (Dahal et al., 2007). The watershed has four village development committees (VDCs), namely Mahadevsthan (ward number (the sub-unit of a VDC) one and two), Nayagaon (ward number one, five, six, seven, eight and nine), Anaikot (ward number six, seven and nine) and Devitar (ward number five), made up of a total of 12 wards encompassing 1038 households.

Keeping in mind where agricultural intensification is practiced, the study area was selected as representative of mid-hill watershed of Nepal within proximity of urban markets. As this study aims at looking the gender role in AI where we need both different caste groups and different economic group, the site also represents a heterogeneous socioeconomic situation with various caste and wealth status groups involved in agriculture. The area does not, however, represent remote watersheds in Nepal, such as in the Midwest and Far-West Region, which could differ according to the socioeconomic conditions of farmers, proximity to markets, infrastructure development and inputs in the agricultural sector (Dahal, 2010).

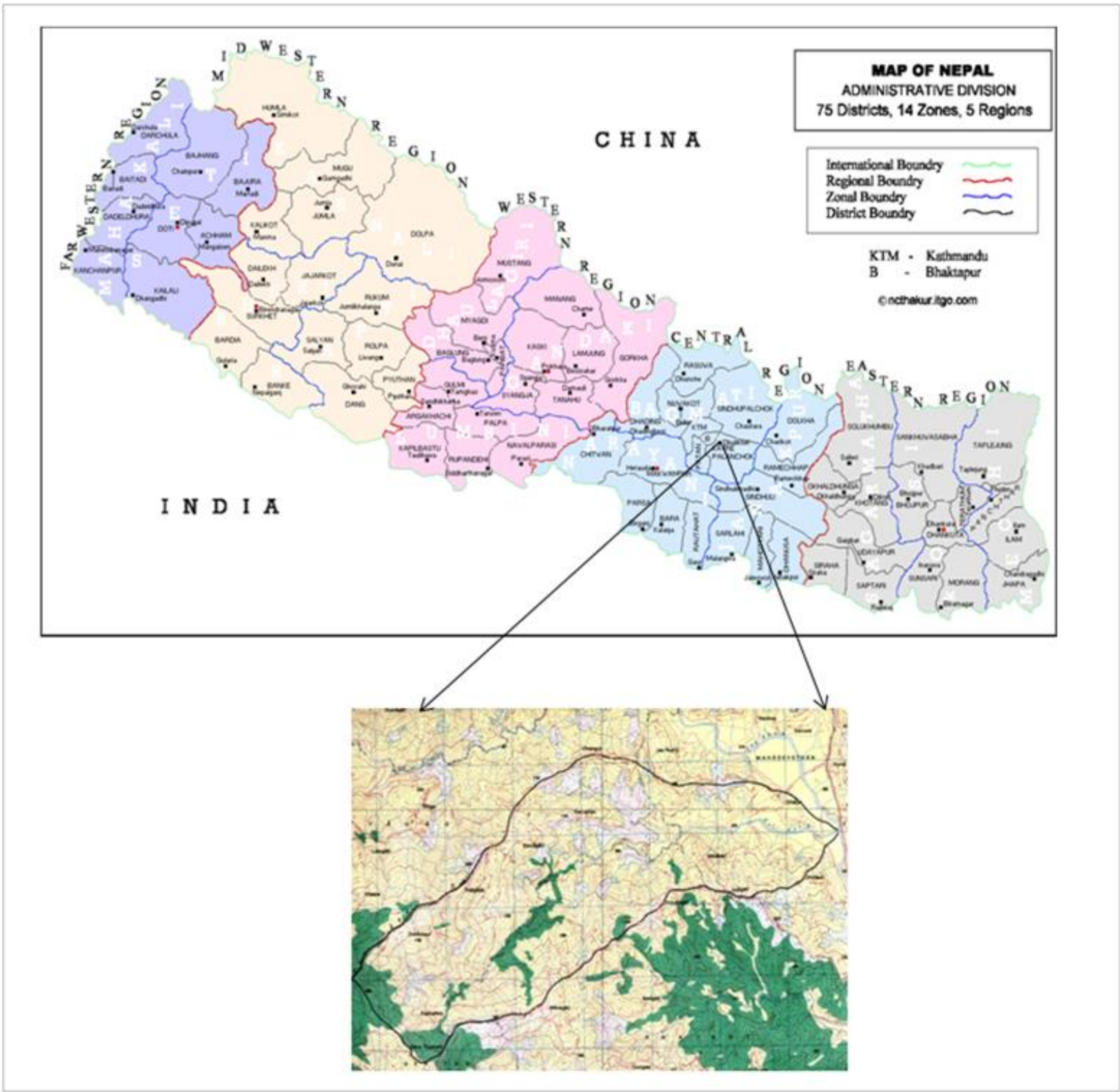


Figure 5-1: Location of surveying area

Land use type in the study area is usually of two basic types where cultivate land is 80.6%**,** followed by the bushy grazing area consisting 9.9% and remaining 8.4% is a forest area. The upper part of the watershed is occupied by the patch of forest with red clay soil while the lower moderately slope and flat areas are mostly used for the intensified cultivation (Raut, 2012). The description of the cultivated lands is summarized in Table 5-1.

Table 5-1:Cultivated land-use types in Anshi khola

Land-use types	Description	Types
Khet	Cultivated lowland areas with bonded and levelled terraces	galkhet: with irrigation
		tarkhet: no irrigation
Bari	Rain-fed upland, levelled or sloping terraces	pakhobari: less productive, separate plots, usually moderate slopes and away from home
		GhariBari: close to homestead

Adopted from Agricultural Intensification Processes and Greenhouse Gas Emission from Soils: Astudy from Nepal and India (Raut, 2012)

5.2 Research Methods

5.2.1 Data collection methods for objective one

Data collection was conducted through household surveys, focus group discussions (FGDs), key informant interviews and direct observation.

Household Questionnaire survey

The survey was conducted in 310 households. These households were the same households that were chosen for the survey in 2009 using a random sampling procedure to collect information on the trends of agricultural intensification such as status of landholdings, trends of fertilizer use, cropping pattern, irrigation facilities, labor investment priority, livestock, and the status of institutional support services. A structured questionnaire comprised both close and open-ended questions were prepared. The survey was conducted by me and two trained enumerators. In a Nepalese context, the head of the household is usually the decision maker. Thus, the heads of selected households were interviewed using the structured questionnaire. Information was collected on the involvement of men and women labor on land preparation, tillage and seedbed preparation, plantation, fertilization, weeding, pest and disease management, irrigation, harvesting and marketing.

Focus Group Discussion

Purposive sampling was used for selection of participants of FGDs. Group discussions were conducted among different caste groups. According to legal code of 1854 (Dahal et al., 2009), the caste in the watershed can be categorized into three: higher, medium and lower caste. In each caste group, one FGD for women and one FGD for men were conducted. The FGD was conducted separately among men and women as suggested by few women who mentioned that they could openly discuss the absence of men. A total of 6 FGDs was conducted. The size of the group was from 7 to 11. The purpose of the gathering was explained briefly, and a semi-structured discussion lasting 2 to 3 hours followed. The groups discussed on the gender roles on the choice of crops, fertilizer application, different agricultural activities such as land preparation, weeding, plantation, harvesting. Each group also discussed on the involvement of men and women in the local institutions such as a user group.

Key Informant Interviews

The selection of key informants was undertaken by using purposive sampling procedure. A total of 5 key informants interviews were undertaken. Key informants were chosen based on women and men headed households. Therefore we have chosen 2 key informants from women headed and 2 key informants from men headed households. One of the farmers who was a member of local cooperative group was also chosen as a key informant. Therefore a total of 5 key informant interviews were conducted. The purpose of taking interviews separately with men and women headed household was to assess gendered labor implications of land preparation, plantation, weeding, and irrigation, fertilizer application, harvesting and marketing. Direct field observations were also made.

5.2.2 Data collection method for objective two

Soil sampling

Soil samples were taken, one from each plot. Profiles were dug at center part up to 1m depth for deep soils and up to bedrock for shallow soils. Soil sample at different depths (0-15 cm, 15-30cm, 30-60cm, and 60-100cm) were taken. A core ring sampler (4.8 cm diameter and 6cm long) was used for bulk density. Collection of soil sample was basically classified into three different groups.

1. Dhaitar Khet (Figure 5-2)
2. Khotang Bari (Figure 5-3)
3. According to the economic standard of the people i.e. lower class, middle class and higher class (Figure 5-4)

In each case, 4 replicate sample were collected to provide the replicability of the data. The total samples should be 64+96=160 as per the chart but due to the geographical location we found a rock after some depth in some cases so the total numbers may vary according to this. Along with this, the middle class people in some case and in low economic class people, they donot have intensive farming so the total number of samples is not exactly 96, it’s less than that. These samples are then analyzed in the Kathmandu Laboratory.

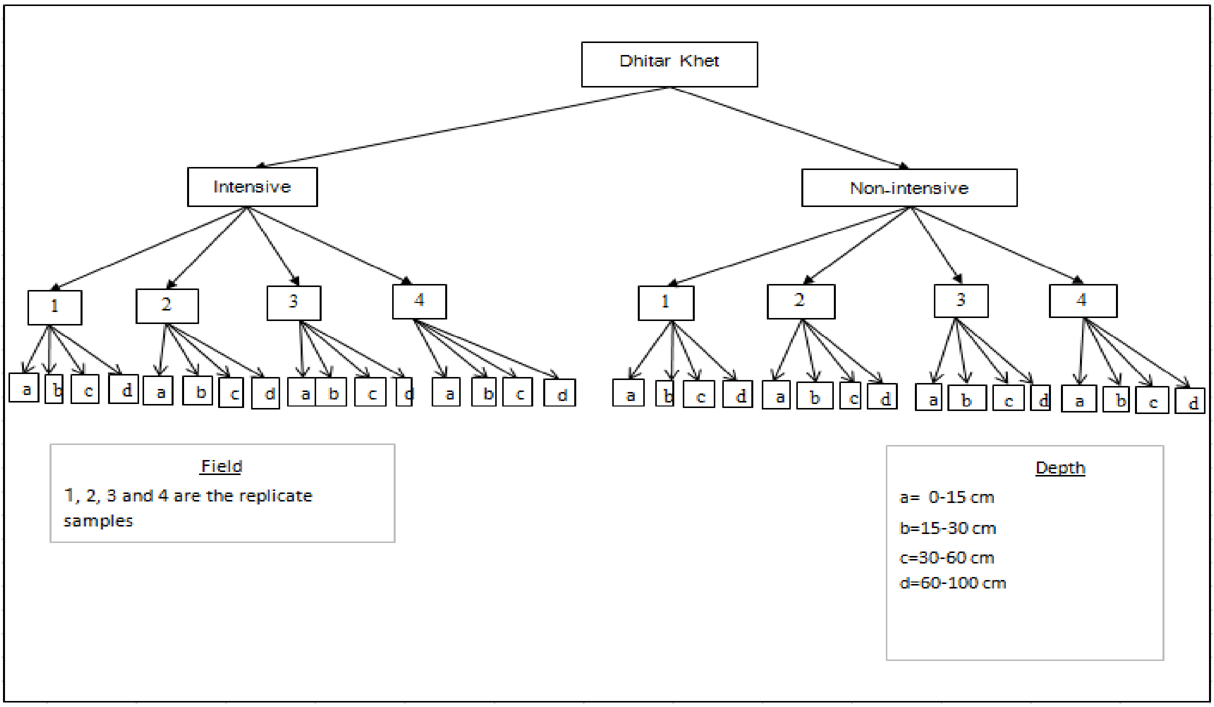


Figure 5-2: Collection of soil sample from Dhaitar Khet

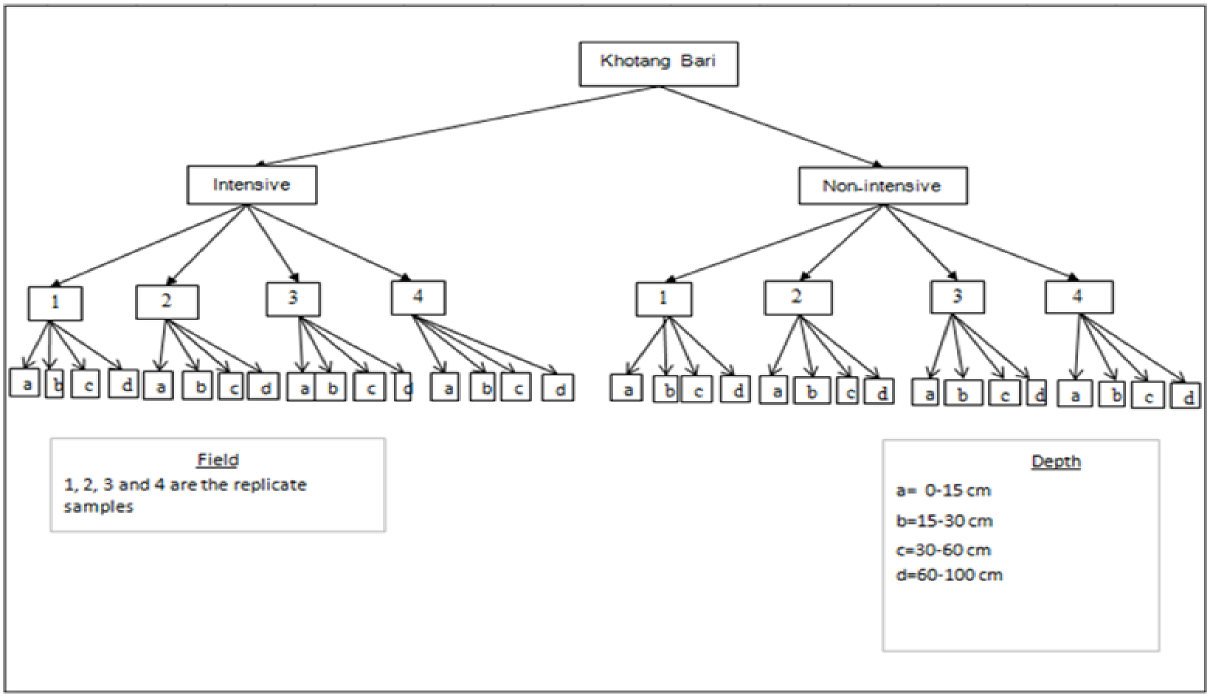
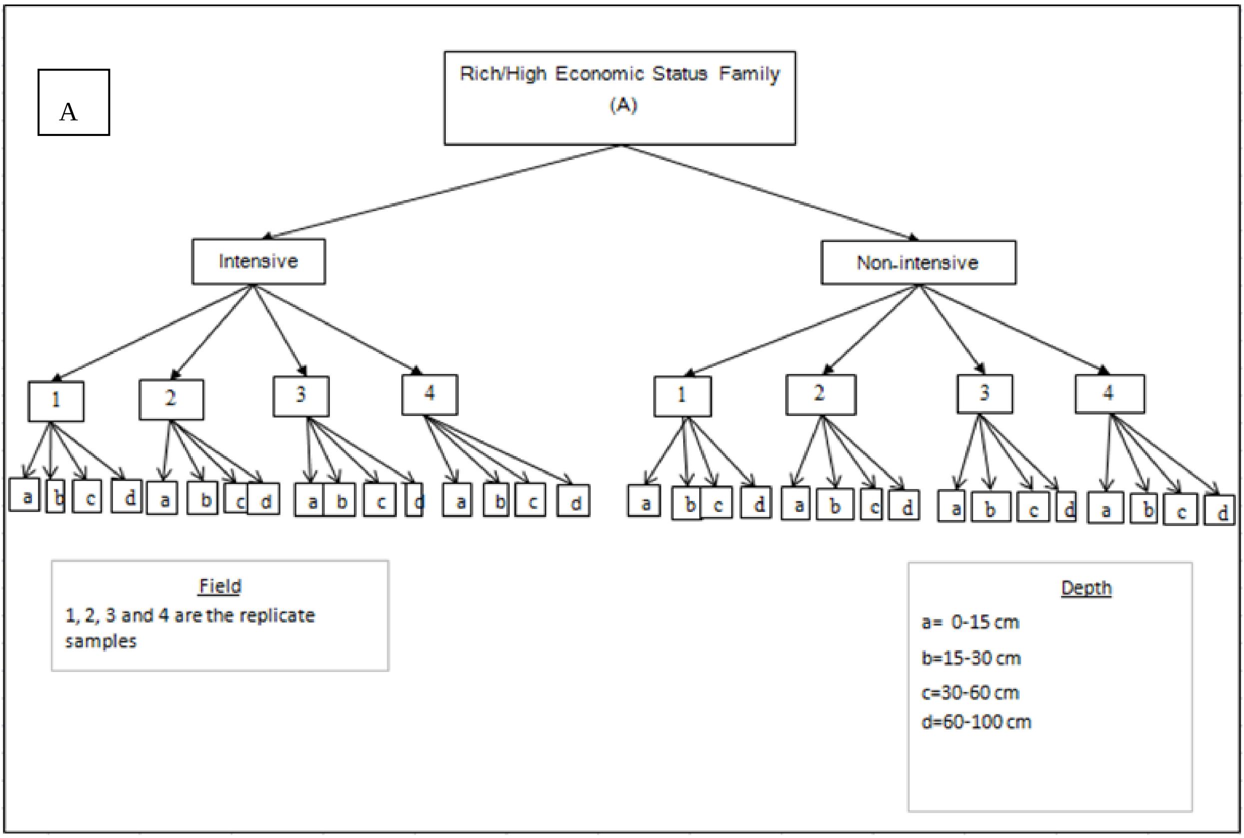
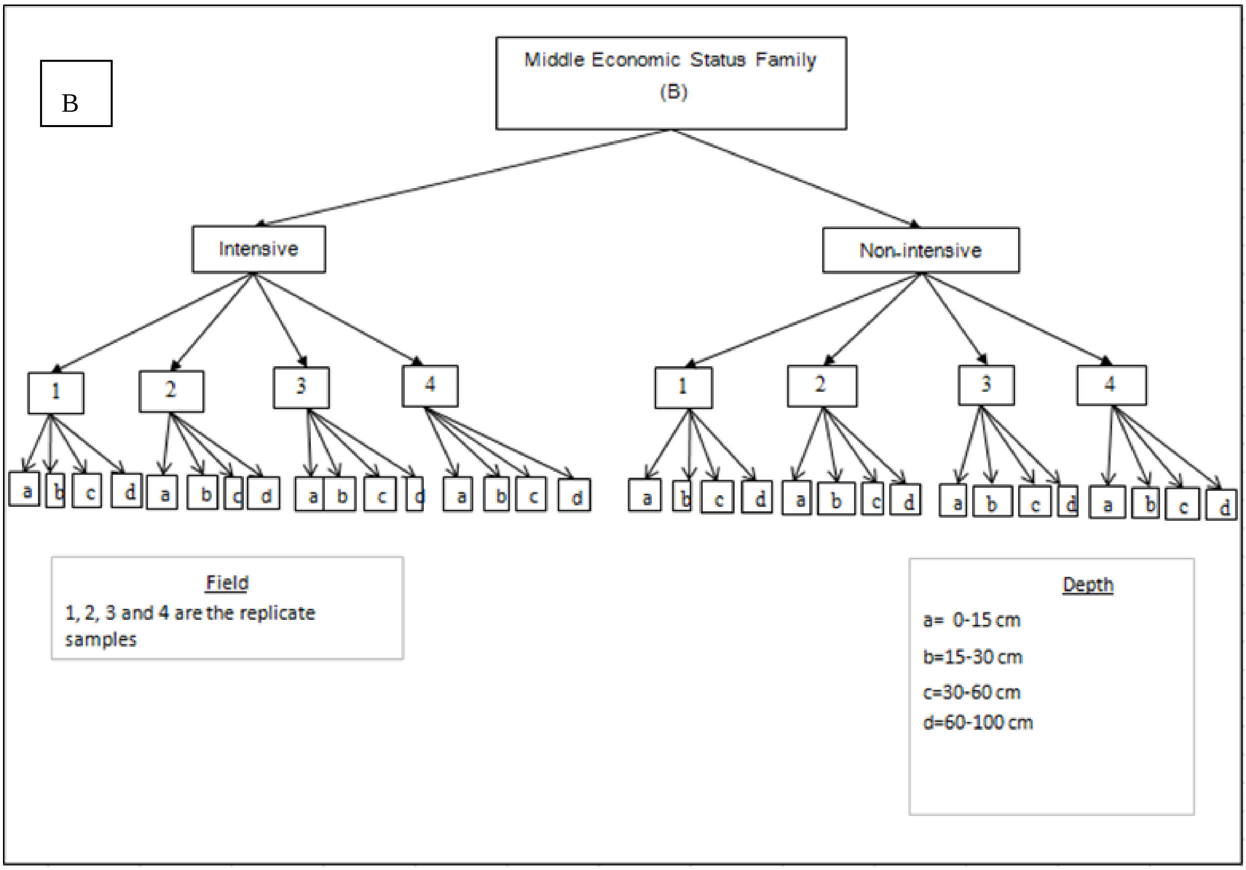


Figure 5-3: Collection of soil sample from Khotang Bari


A
Rich/High Economic Status Family
(A)
Intensive
Non-intensive
1
2
3
4
a
b
c
d
Field
1, 2, 3 and 4 are the replicate samples
Depth
a= 0-15 cm
b=15-30 cm
c=30-60 cm
d=60-100 cm


B
Middle Economic Status Family
(B)
Intensive
Non-intensive
1
2
3
4
a
b
c
d
Field
1, 2, 3 and 4 are the replicate samples
Depth
a= 0-15 cm
b=15-30 cm
c=30-60 cm
d=60-100 cm

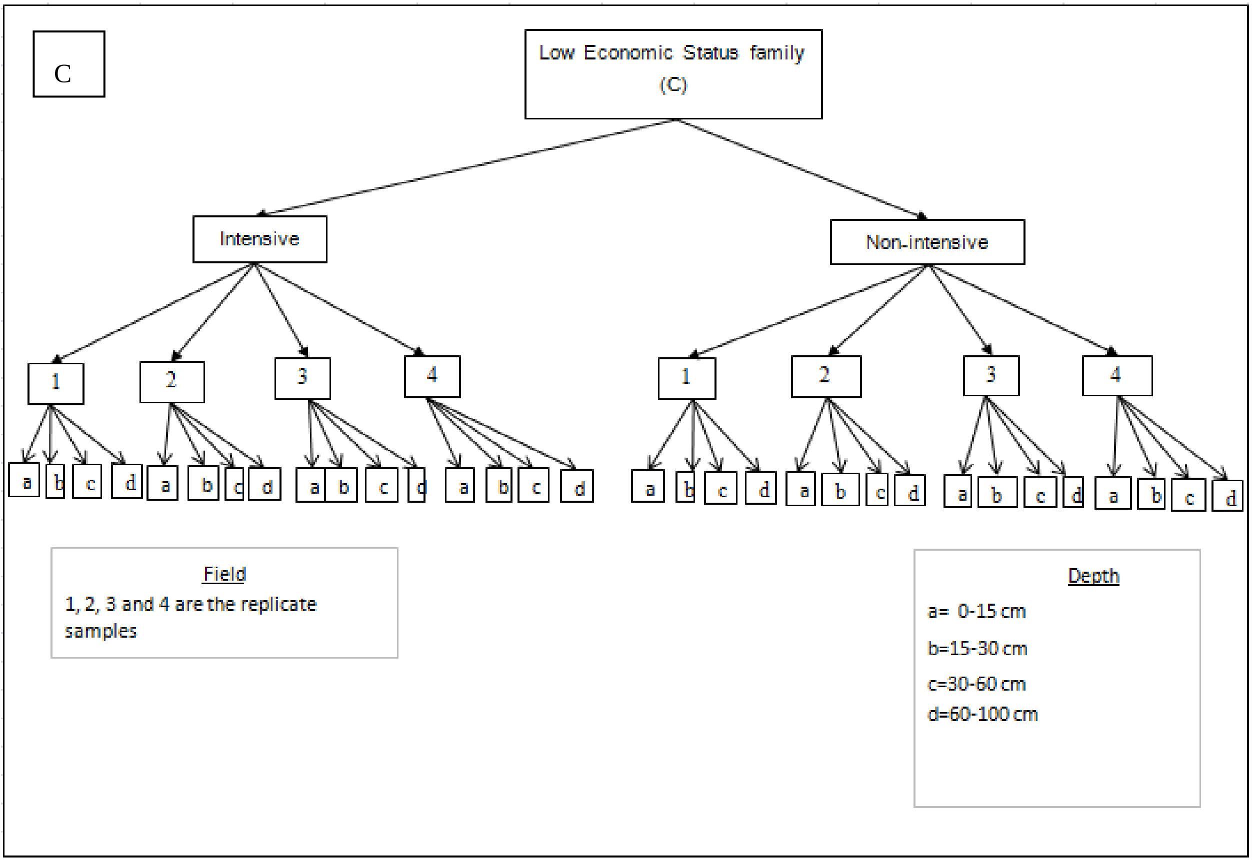


Figure 5-4: Collection of soil sample A, B and C class family

Where A = Rich/High Economic status family

B = Middle Economic status family

C = Low Economic status family

Laboratory analysis

Analysis of soil physical and chemical parameters was performed in the Kathmandu University Laboratory in Dhulikhel, Nepal. Bulk density (BD) was measured by drying intact soil cores taken by steel cylinders (101.42 cm^3 volume) at 105^oC. The sampled top soil (0-15 cm) was air-dried and sieved through a 5 mm sieve before analysis. Soil organic carbon (% of SOC), total nitrogen (N %), soil available phosphorous and potassium were analyzed using standard methods (Nelson and Sommers, 1982; Bremner and Mulvaney, 1982; Olsen and

Sommers, 1982; Knudsen et al., 1982). Soil moisture content on each date of flux sampling was measured using a soil moisture meter (TDR 200 field Scout, Spectrum Technologies Inc).

Soil organic carbon (SOC) in the soil samples was determined by dry combustion method (Schumacher, 2002). The following formula was used for the estimation of bulk density of soil (Pearson et al., 2007).

$$Bulk\ Density = \frac{ODW}{CV - \left(\frac{RF}{PD}\right)}$$

Where, ODW= Oven-dry mass of fine fraction (<5 mm) in gram

CV= Core volume (cm^3)

RF= Mass of coarse fragments (> 5 mm) in gram

PD= Density of rock fragments (g/cm^3)

The density of rock fragment = 2.65 g/m^3

The soil carbon stock was calculated by using the equation given by Pearson et al., (2007).

C (t / ha) = soil bulk density, (g / cm^3) × soil depth (cm) × % C

6 Results and Discussions

6.1 Result and discussion of gender differences in agricultural activities

With the introduction of intensification in the study site, there seems to be a serious increase in workload which has clearly allocated agricultural tasks between man and women. Focus group discussion revealed that household tasks like cooking, washing utensils and fetching water are almost equally shared among women and men in the Gurung, Tamang and Rai caste groups. Male Brahmin and Chhetri still considered the household tasks as women’s tasks. However, women from these castes are comparatively more educated and aware than those of other caste groups. Therefore, it appears that decision-making levels and ,access to resources for women are greatly affected by socio-cultural norms and beliefs of the castes. However, the strict labor division of this is a man's task and that is a woman's task is slowly being changing in the society (Dahal, 2010). In the mean time, there is quite a difference in the division of work in the lower caste like blacksmiths (kami**)**, lather workers **(**sarki) and tailors. The gender-based involvement for different activities is presented in Table 6-12.

There are several agricultural activities in the production of one single crop. For the purpose to make this study simple, each activity has been analyzed precisely and the workload and time requirement has been shown in the tables below. Considering the one production period in the Khet land and Bari land, percentage of workload has been shown in the tables for each activity which will make easier to compare the workload division between the men and women in the study area.

6.1.1 **Pre-tillage activities**

Table 6-1 presents the average hours of work needed to carry out pretillage activities for land preparation and the percentage of workload required for the pretillage in the study area. In line with the practice of land preparation, the first phase is the pre-tillage which involves cutting and retention of vegetative debris and crop residues while the same are gathered and disposed or burnt**.** In the pre tillage practices, results from group discussion indicated that women are involved in cutting herbaceous and small woody vegetation using local sickle so that men can plough land for the land preparation (Nyanga et al., 2011). Table 6-1 shows that 227±11 hours for Gal khet, 240±14 hours for TarKhet, 185±9 for gharbari and 115±6 hours for pakho Bari are needed for the pretillage activity which are 14±0.7%, 18±1%, 17.6±0.9% and 16.6±0.9% respectively of total workload for one crop production. Since Tar Khet is dry land compared to the galkhet so it need more hours for the land preparation. According to Nyanga et al. (2011), physical force demanding work like digging is carried out by the male members of the family while a small portion of land preparation like breaking the clod and clearing the land before tillage is carried out by the female in all caste groups which we can be predicted from the group discussion (Table 6-12).

Table 6-1: *Men hours and Workload for pretillage (mean ± SD)*

Land type	Man hours per hectare	% of workload
Gal Khet N=295	227 ± 11	14 ± 0.7
Tar Khet N=306	240 ± 14	18 ± 1
Ghar Bari N=305	185 ± 9	17.6 ± 0.9
Pakho Bari N=287	115 ± 6	16.6 ± 0.9

where N = No. of respondants

6.1.2 Tillage Activity

The tillage operations, defined as mechanical manipulation of soil, are performed to achieve the desired seedbed to provide the optimum environment for seed germination and plant growth. Men farmers are the ones who mostly plough land. It is mostly women farmers who break clods after ploughing is done. The gender based division of ploughing and breaking clods is same among all three caste groups. In the past, ploughing was done by people from lower castes. But with the adoption of intensification, men farmers from higher caste are also involved in ploughing. This finding was inconsistent with findings from Tiwari et al. (2011) who investigated that lower caste farmers are themselves involved in intensification that created labor shortage and therefore, higher caste farmers have to involve in ploughing their own land. Before intensification was adopted in the study area, ploughing was carried out using oxen or hand hoe (called as kodali in local language). Farmers are now using mostly tractors to plow flat lands and oxen in narrow terraces. From Table 6-2, it is seen that 7.8±1%, 8.8±1%, 17.8±1.8% and 14.4±1% of the workload are needed to produce a single crop in galkhet, Tar Khet, Ghar Bari and pakho Bari respectively. There is the great difference in the percentage of workload in the Khet land and Bari land. This is due to the use of tractors for the tillage activity on the Khet land where human force is generally used for the tilling of Bari land. Hence approximately double time is required for the tillage of Bari land in comparison to the Khetland. From the focus group discussion, it has been seen that ploughing is mostly done by the men in all three caste groups while women are involved in breaking the clods. This division of labor is equal in all three caste groups.

Table 6-2 Man hours and Workload for Tillage (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	126 ± 17	7.8 ± 1
tarkhet N=306	109 ± 14	8.8 ± 1

gharbari N=305	187 ± 19	17.8 ± 1.8
pakhobari N=287	97 ± 8	14.4 ± 1

where N = No. of respondants

6.1.3 Seedbed preparation

Land development is the costly operation in farming. It involves seedbed preparation, planting and bund making. The seedbed preparation for sowing/planting of different crops is almost equally done by both male and female by using a hand hoe called khodali by male and khodalo by female in local language. Dahal (2010) also supports that with the intensification in the study area the seedbed preparation work is equally divided between both sex groups.

The questionnaire survey revealed that comparatively less workload is a need for seedbed preparation which is almost 6.5±0.9%, 5.2±0.5%, 1.5±0.2% and 0% of the total work need to produce a crop in galkhet, tarkhet, gharbari and pakhobari respectively (Table 6-3). As Gal Khet is considered as the most productive of all others as well as Khet land are used for the intensive cultivation, it has been given a little more time for the seedbed preparation whereas pakho Bari is generally used for maize or millet production which do not need seedbed preparation. In pakho Bari, sowing of seeds take place as soon as land tilling is completed. Ghar Bari may be used for potato plantation one time in a year and maize and millet in the other season so it needs some workload for the seedbed preparation. According to the field visit and group discussion, female from all caste groups actively participate in seedbed preparation in all types of land. According to the Dahal (2010), men are busy in the social work so that this less physical force demanding work is given responsibility for women in the study area.

Table 6-3 Man hours and Workload for seedbed preparation (mean ± SD)

	Man hours per hectare	% of workload
Galkhet N=295	105 ± 14	6.5 ± 0.9
Tarkhet N=306	70 ± 6	5.2 ± 0.5
Gharbari N=305	16 ± 2	1.5 ± 0.2
Pakhobari N=287	0	0

where N= No. of respondants

6.1.4 Plantation

Just before the monsoon really starts people from all over Nepal start to plant rice and Nepal is lush with green. Due to the lack of irrigation facility in the TarKhet, farmers have to depend on the monsoon rain for the plantation. Therefor, they have to run in their field as soon as the rain begins. So it may take a few days to a few weeks to complete planting in the tarkhet where as the irrigation facility is available in the Gal Khet where they can complete the plantation work in a day or two. Hence 2.5% less workload is necessary for the Gal Khet as compared to the TarKhet. While talking to the Bari, generally maize or millet plantation is preferred and in this case both Bari takes almost same workload.

Focus group discussion in Table 6-12 clear show the women are actively participated in the plantation. Planting rice is almost done by the female with the very negligible support from the men. According to the Dahal (2010), men are busy in the social work so that this less physical force demanding work is given responsibility for women in the study area. This is same in all caste groups where female involvement is appreciable in the plantation.

Table 6-4: Man hours and Workload for Plantation (mean ± SD)

	Man hours per hectare	% of workload
Galkhet N=295	137 ± 19	8.5 ± 1.2
Tarkhet N=306	143 ± 18	10.7 ± 1.4
Gharbari N=305	142 ± 12	13.5 ± 1.1
Pakhobari N=287	94 ± 11	13.6 ± 1.6

where N = No. of respondants

6.1.5 Bund-making

Generally bund (aali in local language) is carried out for the plantation of rice to hold the water in the field. It helps to prevent the seepage of water from the land. Since there are many terraces in the Tar Khet so more work is necessary to complete the bund in the land where galkhet is flat land and have comparatively less boundary so that it needs less work to complete the bund. It is generally used to retain the water in the land which is not necessary in the Bari land so there is no work necessary in the Bari land.

According to the focus group discussion and direct field visit, we have seen that bund making is a more physical force demanding work so men are mostly involved in the bundmaking in the first two caste group whereas in lower caste men are always out from the home in the city to work so female are also involved in the bundmaking (Table 6-12).

Table 6-5: Man hours and Workload for Bundmaking (mean ± SD)

	Man hours per hectare	% of workload
Galkhet N=295	61 ± 7	3.7 ± 0.4
Tarkhet N=306	59 ± 6	4.4 ± 0.5
Gharbari N=305	0	0
Pakhobari N=287	0	0

where N = No. of respondants

6.1.6 Irrigation

In today's world, as we see the rapid growth in global population, agriculture becomes more important to meet the needs of the human race. However, agriculture requires irrigation, and with every year we have more water consumption than rainfall, it becomes critical for growers to find ways to conserve water while still achieving the highest yield. The farmer-managed irrigation systems were built locally called kulo, operated and maintained by the farmers themselves in the study area with little or no help from the state or outside agencies. The locally available stream is diverted to some Galkhet for the irrigation purpose which is very limited and the major cause of dispute among the people in the study area. There are no irrigation facility in the tarkhet and the Bari land so that we do not consider in the workload.

Usually, the infrastructure is simple and lacks provision for water control and management. In other words, they run on the tradition of self-help. As the farmers have to wait for their turn to irrigate their land, they may have to go to their field at the midnight sometime to check the continuity of the water on their land. So this was the responsibility of men in all the castes except in the lower caste where mostly male member are out from their home in the city to earn their living. In this case, irrigation is sometimes done by the female but almost men are responsible to irrigate their land (Table 6-12).

6.1.7 Manuring (Fertilizer application)

The various sources of plant nutrients in the Nepalese farming system have been identified (Atreya, 2005). Among them chemical fertilizer is becoming gradually a major source**.** However, earlier in the introduction of mineral fertilizer in Nepal in 1952, crop production mainly depended on farmyard manure (Pandey, 2000). In this study area manuring is mainly of two types, one is farmyard manure which is a mixture of the solid and liquid excreta of farm animals along with litter (i.e., the materials used for bedding purposes of cattle) and left over material from roughages or fodder fed to the cattle and the other one is chemical fertilizer.

With the introduction of intensification in the study area, the workload for the men are usually increased as the planning, buying and spraying of the nitrogen fertilizer and the pesticides. With the traditional agricultural practices, farmyard manure are only used in the land where women are mostly involved. This has been noticed in the group discussion which is shown in Table 6-12. The Questionnaire survey shows that around 15.4±1.5%, 12.6±1.7%, 11.3±1.8% and 12.6±1.6% of workload is given in the Galkhet, Tarkhet, gharbari and pakhobari respectively for the buying and application of chemical fertilizers. Generally galkhet is used for intensive cultivation (three crops round in a year). Therefore a greater care is given for the decision of buying and application of chemical fertilizers. Along with this, Khet is little far from the home so that it takes little more time to transfer farmyard manure to the field which also account for the increase in the workload for the farmers.

Similarly from the focus group discussion, it has been seen that male member is mostly active in buying chemical fertilizers from the market but the application of chemical fertilizers is equally divided between both sex groups except in lower caste where men are mostly involved in both buying and spraying of chemical fertilizers. But farmyard manure is carried and applied by women in the field in all three castes**.**

Table 6-6: Man hours and Workload for Manuring (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	249 ± 25	15.4 ± 1.5
tarkhet N=306	168 ± 23	12.6 ± 1.7
gharbari N=305	119 ± 19	11.3 ± 1.8
pakhobari N=287	87 ± 11	12.6 ± 1.6

where N = No. of respondants

6.1.8 Pesticide application

Traditionally, farming in Nepal was organic in nature and was therefore, ecologically sound and sustainable for human and other living organisms. Until the 1950s, Nepali farmers were unaware of agro-chemicals. They were dependent upon their rich traditional wisdom to control pests. The use of Agrochemicals such as fertilizers and pesticides started with the growth of population and transfer of traditional farming to modern agricultural with the establishment of Agricultural Development (DOA) in the early 1960s (Devkota, 2009).

Pesticides are chemical substances used to kill animals, plants, insects and pests in agriculture, domestic and institutional settings. The main groups of commonly used pesticides in the study area include herbicides, insecticides, fungicides, fumigants etc. Moreover, pesticides are mostly used by vegetable farmers in the study area where they have access to vegetable markets (Kafle and Shah, 2012). Due to lack of training and education programs for safe use of these pesticides, Nepalese farmers are not much aware about the risks and rarely follow proper safety methods when using it. Pesticides are applied at higher doses than needed (Giri, 2005), causing waste of pesticides and reduced farmer's profits. Generally, farmers make a decision for applying pesticides once they notice pests in the field, irrespectively of damage level (Giri, 2005).

Application of pesticides is a risky task and the dose of application is very important for the proper growth of plants, they are applied by the men which is also in co-relation to the document from Nyanga et al. (2012) . Similarly, Galkhet is used for the intensive cultivation so grater care is given for the application of pesticides. Hence 10.9±1% of workload per hectare is given to the galkhet where only 7.6±1% in Tarkhet and 6.6±0.5% in gharbari are provided. pakhobari is usually used for non-intensive cultivation which include the cultivation of maize and millet so the farmer do not use pesticides on this Bari land. According to the result from the focus group discussion (Table 6-12), we saw that men are mostly involved in the buying and spraying of the pesticides. But discussion with female group in the two upper castes reveled that they are also involved in the application of those chemicals. This has been changed recently as the women are also getting training from the different INGOs and NGOs in the study area. On the other hand, raising the education level among the females in the study area has also influenced in the involvement of female in the application of those chemical fertilizers and pesticides in the upper caste groups. Where lack of education, training and backward social construction of the lower caste female make them away from the involvement in the chemical fertilizers application and involvement in the buying decision. In this case men are only involved in the lower caste.

Table 6-7: Man hours and Workload for Pesticide Application (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	177 ± 18	10.9 ±1
tarkhet N=306	101 ± 13	7.6 ± 1
gharbari N=305	59 ± 5	6.6 ±0.5
pakhobari N=287	0	0

where N = No. of respondants

6.1.9 Weeding

Weeding is the botanical component of pest control using physical and chemical methods to stop weeds from reaching a mature stage of growth when they could be harmful to crop production. In order to reduce weed growth, many "weed control" strategies have been developed in order to control the growth and spread of weeds. Weeds are often a major threat in farming practice in Nepal and it seems as a key bottleneck for a promotion of sustainable crop production in the study area (Oerke, 2006).

Almost equal workload is given for the weed control in Khet land and Ghar Bari but around 2.6% of more workload is given to the pakho Bari. This is because pesticides are used on both Khet land and gharbari land which helps to reduce weeds in the field. Whereas pesticides are not used in the pakhobari which need more workload for the weed control. According to the group discussion and field visit, it has been seen that women are mostly involved in the wedding. Where men are busy in their social work and preparing for the marketing of the products.

Table 6-8: Man hours and Workload for Weeding (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	188 ± 18	11.6 ± 1
tarkhet N=306	159 ± 15	11.9 ± 1
gharbari N=305	122 ± 14	11.6 ± 1.3
pakhobari N=287	98 ± 11	14.2 ± 1.6

where N = No. of respondants

6.1.10 Harvesting

The harvest is the process of gathering mature crops from the fields. Reaping is the cutting of grain or pulse for harvest, typically using a sickle, or reaper for example sickle is used to harvest rice and khodali and khodalo in local language is used to harvest potatoes. The harvest marks the end of the growing season, or the growing cycle for a particular crop**.** On smaller farms in the study area with minimal mechanization, harvesting is the most labor-intensive activity of the growing season**.** Averagely around 11.6±0.9% of total workload is given to harvest the crop in all Khetland and Ghar Bari where 15.1±1.4% of workload is given to the pakho Bari. This difference of 3.5% is due to the geographical location of pakho Bari which is far from the home and shipping of the product to the home take longer time than shipping from the other lands.

According to the questionnaire survey, harvesting in the study area is done by both men and women where storage, packing, shipping from the field to the home is the major responsibility of men. With the introduction of intensification in the study area, responsibility for men has been drastically increased in comparison to the female member of the society. This is inconsistence in all two upper caste groups where lower caste has little difference in the involvement. In this case, men are out of the home to earn so that women are mostly involved in the harvesting of the products.

Table 6-9 Man hours and Workload for Harvesting (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	191 ± 15	11.8 ± *0.9*
tarkhet N=306	161 ± 12	12.12 ± *0.9*
gharbari N=305	117 ± 12	11.1 ± *1*
pakhobari N=287	104 ± 10	15.1 ± *1.4*

where N = No. of respondants

6.1.11 Process before marketing

Harvesting in general usage includes an immediate post-harvest handling, all of the actions taken immediately after removing the crop**,** cooling, sorting, cleaning, packing up to the point of further on-farm processing, or shipping to the wholesaler or consumer market**.** Comparatively less workload is required for the processing which is averagely 5.3±0.5% of total workload for the Khet land and Ghar Bari whereas 8.2±1.3% of the workload is required for the pakho Bari. Since this Bari is a steep land without transportation facility so the product from the field has to be carried manually to the nearby subway or excess road. Hence it requires little more workload than in the other lands.

According to the questionnaire survey, it has been seen that processing like sorting, storing, cleaning, drying and carrying the product to the market is usually done by the women. This is because men are busy in the preparation of marketing the product. So women are mostly involved in the processing of their products. This is inconsistence in all three caste groups where the involvement of the female is mostly appreciable.

Table 6-10: Man hours and Workload for Process before Marketing (mean ± SD)

	Man hours per hectare	% of workload
galkhet N=295	93 ± 8	5.7 ± 0.5
tarkhet N=306	59 ± 5	4.4 ± 0.4
gharbari N=305	63 ± 7	6.0 ± 0.5
pakhobari N=287	57 ± 9	8.2 ± 1.3

Where N = No. of respondants

6.1.12 Marketing

Since the male member is almost responsible for the economic flow in the family and due to the education level and social construction, marketing of the product is mostly done by the male members. Since they have to go to the market to sell their product which is far from their home so male members are mostly active in marketing their products. From the questionnaire, it is seen that averagely 4.3% of workload is given to the marketing of the food product (Table 6-11). Where the difference in the workload may be due to the types of food products in different lands. In the Khet land, farmers usually grow rice and potatoes which have a greater market value and need less time to sell them. Where as maize and millet are grown in the pakho Bari which has less product value in the market. So it needs more time to sell and return back to the home.

Table 6-11: Man hours and Workload for Marketing (*mean* ± *SD)*

	Man hours per hectare	% of workload
galkhet N=295	63 ± 11	3.8 0.7
tarkhet N=306	59 ± 10	4.28 ± 0.7
gharbari N=305	40 ± 7	3.0 ± 0.7
pakhobari N=287	37 ± 4	5.3 ± 0.6

Table 6-12: Gender segregation in agricultural activities among prevailing caste in study area during focus group discussions (FGD)

Agricultural activities	Higher caste		Middle caste		Lower caste	
	Men FGD	Women FGD	Men FGD	Women FGD	Men FGD	Women FGD
Tillage						
Plough	Men	Men	Men	Men	Men	Men
Breaking clods	Women	Women	Women	Women	Women	Women
Fertilizer						
Carrying farm yard manure (FYM) to the field	Mostly women	Mostly women	Mostly women	Mostly women	Mostly women	Mostly women
FYM Spreading	Mostly women	Mostly women	Mostly women	Mostly women	Mostly women	Mostly women
Decision on buying chemical fertilizers	Both	Both	Both	Both	Mostly men	Mostly men
Application of chemical fertilizer in field	Both	Both	Both	Both	Mostly men	Mostly men
Pesticides						
Pesticide buying	Mostly Men	Mostly Men	Mostly Men	Mostly Men	Mostly Men	Mostly Men
Pesticide spraying	Mostly Men	Mostly Women	Mostly Men	Mostly women	Mostly Men	Mostly Men
Irrigation						

	Mostly Men	Mostly Men	Mostly Men	Mostly Men	Both	Mostly Men
Choice of crop	Both	Mostly women	Both	Mostly women	Mostly Men	Mostly men
Agricultural training	Mostly Women	-IPM women -Distance training-men	Mostly women	IPM-women	No training	No training

6.2 Result and discussion of soil chemical and physical properties

6.2.1 Soil physical and chemical properties

The soil carbon contents and bulk densit*ies for* different depth*s at each of the* sites are presented in the

Table 6-13 The mean values and standard deviations are based on four replicate plots at each location (site). Both the upland (Khotang Bari) and lowland (Dhaitar Khet) sites had loam type of soil with moderately to strongly acidic pH (Dahal, 2010).

Table 6-13:Bulk density and Soil Carbon content for various land use types (mean ± SD)

	Depth (cm)	Bulk Density (gm/cc)	SOC (%)	SOC Stock(t/ha)
Intensive farming in Khotang Bari	0-15	1.29 ± 0.11	1.85 ± 0.33	136.29±0.38
	15-30	1.24 ± 0.06	0.87 ± 0.07	
	30-60	1.53 ± 0.23	0.78 ± 0.14	
	60-100	1.29 ± 0.25	0.94 ± 0.22	
Non-Intensive farming in	0-15	1.14 ± 0.12	1.3 ± 0.25	137.24±0.4
	15-30	1.20 ± 0.16	1.18 ± 0.24	

Khotang Bari	30-60	1.26 ± 0.13	1.19 ± 0.35	
	60-100	1.14 ± 0.13	1.07 ± 0.31	
Intensive farming in Dhaitar Khet	0-15	1.22 ± 0.07	2.06 ± 0.27	162.41±0.5
	15-30	1.45 ± 0.14	1.63 ± 0.20	
	30-60	1.40 ± 0.13	1.0 ± 0.39	
	60-100	1.39 ± 0.13	0.85 ± 0.55	
Non-Intensive farming in dhaitar Khet	0-15	1.08 ± 0.21	1.4 ± 0.18	170.63±0.2
	15-30	1.48 ± 0.14	1.54 ± 0.31	
	30-60	1.46 ± 0.03	1.2 ± 0.23	
	60-100	1.5 ± 0.04	1.02 ± 0.30	
Intensive farming in A class farmer	0-15	1.29 ± 0.14	1.87 ± 0.32	161.61±0.17
	15-30	1.42 ± 0.08	1.4 ± 0.13	
	30-60	1.29 ± 0.05	1.21 ± 0.02	
	60-100	1.34 ± 0.08	0.91 ± 0.26	
Non-Intensive farming in A class farmer	0-15	1.34 ±0.01	0.61 ± 0.39	160.44±0.13
	15-30	1.51 ±0.02	1.01 ± 0.67	
	30-60	1.45 ± 0.01	1.22 ± 1.03	
	60-100	1.38 ± 0.02	1.31 ± 0.95	
Intensive farming in B class farmers	0-15	1.19 ± 0.04	0.76 ± 0.01	191.98±0.01
	15-30	1.38 ± 0.04	1.89 ± 0.02	
	30-60	1.33 ± 0.01	1.37 ± 0.03	
	60-100	1.42 ± 0.02	1.49 ± 0.02	
Non-Intensive farming in B class farmers	0-15	1.27 ± 0.11	1.2 ± 0.44	179.03±0.17
	15-30	1.33 ± 0.10	1.47 ± 0.23	
	30-60	1.36 ± 0.11	1.44 ± 0.17	

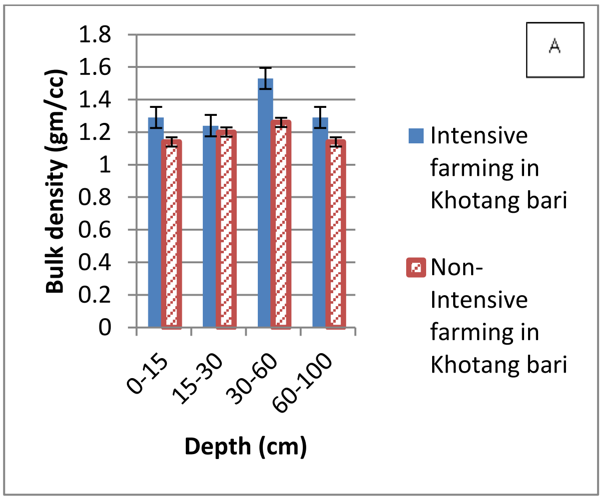
	60-100	1.28 ± 0.02	1.33 ± 0.13	
Intensive farming in C class farmers	0-15	1.43 ± 0.01	1.17 ± 0.04	109.84±0.02
	15-30	1.48 ± 0.05	0.75 ± 0.04	
	30-60	1.54 ± 0.01	0.5 ± 0.02	
	60-100	1.48 ± 0.02	0.76 ± 0.02	
Non-Intensive farming in C class farmers	0-15	1.43 ± 0.13	1.62 ± 0.64	132.00±0.5
	15-30	1.31 ± 0.17	1.17 ± 0.40	
	30-60	1.34 ± 0.17	1.06 ± 0.56	
	60-100	1.36 ± 0.10	0.58 ± 0.17	

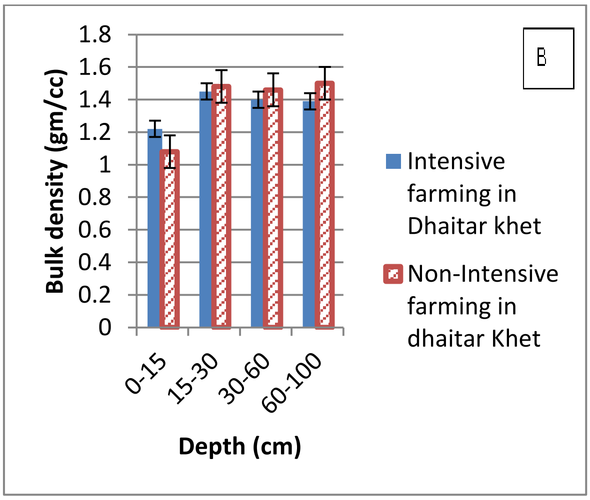
As expected a gradual increase in bulk density with depth was found in intensive and non-intensive Khet lands, which ranged from 1.08 ± 0.21 gm/cc to 1.5gm/cc. This trend was not seen in all other land types where the bulk density is almost constant throughout all depths. The bulk density of soil will generally be lower after the tillage operation (Lampurlanés and Cantero-Martínez, 2003). The data were collected in march 2012, where Khet land was ready for the monsoon rice plantation and potato plantation so that the top layer of soil has been just disturbed that have caused low bulk density in the upper soil layers. But the upland area was barren when the samples were collected so that the bulk density was nearly constant throughout the depth reflecting compaction and consolidation of the surface layer.

According to Ferrero et al. (2001) bulk density increase with depth, which was clearly seen at the lowland site. The net increase of bulk density with depth is much greater in Khet land which is almost 0.42gm/cc in non-intensive Khet land and 0.17gm/cc in intensive Khet land but there is relatively less increasement in all other land types. This difference in the Khet land was likely due to the fact that the upper soil had undergone a tillage operation for rice plantation in this Khet land when the soil data was collected.

Comparatively bulk density was higher in the Khet land than in the Bari land in both intensive and non-intensive farming system. Since tractor is used for the tillage operation in the Khet land where human force is used in the Bari land. This has caused compaction of soil in the Khet land than the Bari land. Upper two layer has a relatively low bulk density which is 1.29 ± 0.11 gm/cc and 1.24 ± 0.06 in intensive Bari land whereas the value is 1.14 ± 0.12 gm/cc and 1.20 ± 0.16 gm/cc for non-intensive Khet land, respectively, which is statistically significant ($p<0.001$) which is also in accordance to the (Arvidsson, 1998) finding that bulk density decrease with increasing organic matter content. Since upper layer has a relatively high organic matter.

Bulk density is higher in the class C land which is 1.54 ± 0.01gm/cc (intensive land) and 1.36 ± 0.10gm/cc (non-intensive) followed by 1.42 ± 0.02 gm/cc (intensive land) and 1.36 ± 0.1 gm/cc (non-intensive land) in B class followed by 1.42 ± 0.08 gm/cc (intensive land) and 1.51 ± 0.02 gm/cc (non-intensive land) in class A. Application of organic matter in the soil helps to decrease soil bulk density (Hagan et al., 2010). Since class C farmer has least number of animals and economic sources to supply organic matter and other nutrient in their land which effect in the relatively higher bulk density in their land.





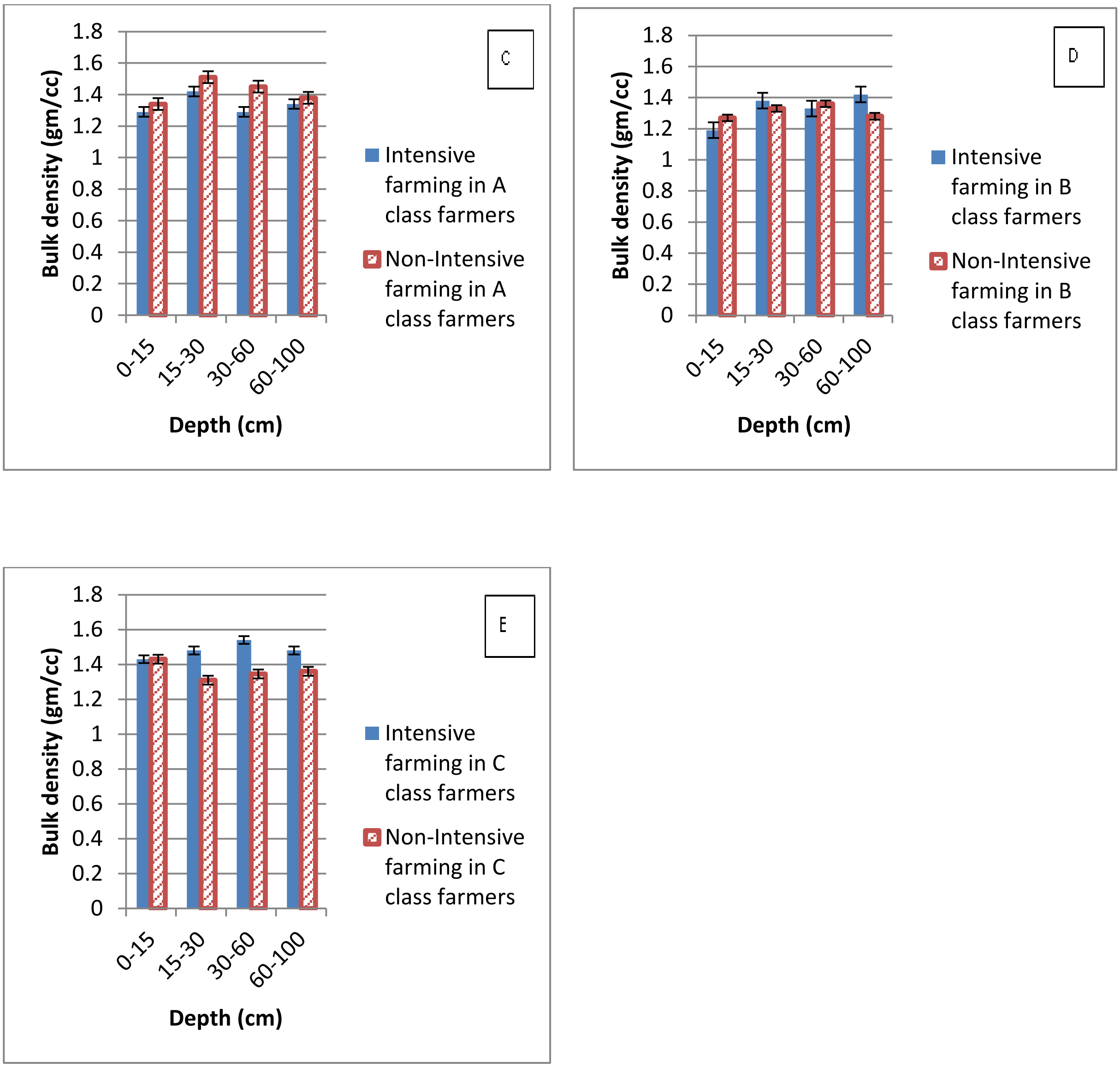


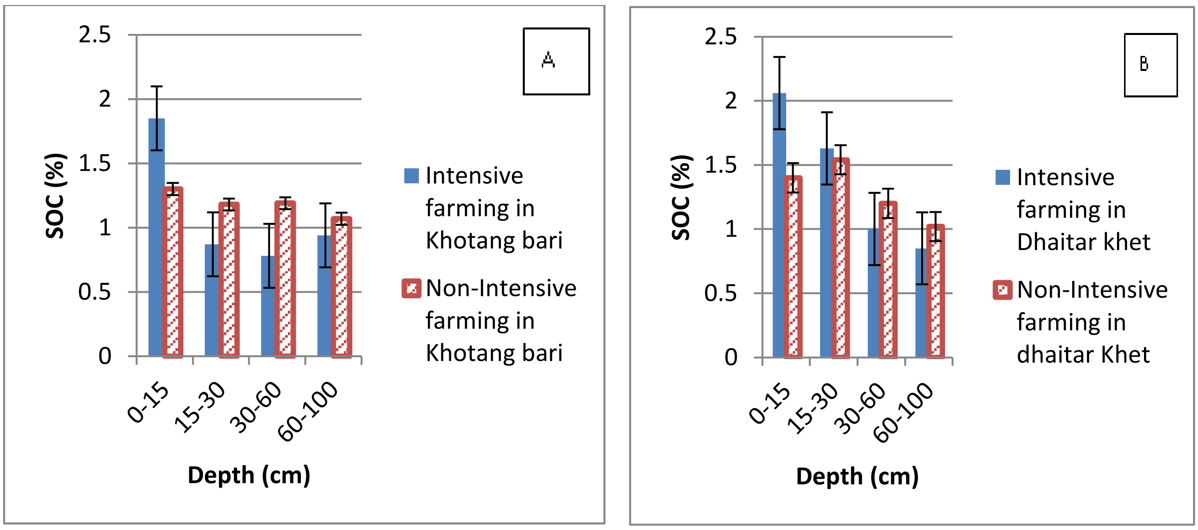
Figure 6-1: Graphical presentation of bulk density (mean ± SD) in various land use types

6.2.1.2 Soil carbon content

There was a gradual decrease in carbon content with depth in all land types except in class A non-intensive land and both types of land in class B. The SOC is higher in the first layer in all types of land except in class C type. From the Table 6-13 we found that SOC value was significantly higher ($p < 0.001$) in the intensive land use system except in class B and class C type. The SOC present in the surface layer (0-15cm) of intensive Khet land is 2.06 ± 0.27 % which was higher than intensive Bari land (1.85 ± 0.33 %) whereas, other types of land had even less SOC than Bari land. This revealed that there was an increased supply of organic matter from FYM in Khet land.

The significantly higher ($p < 0.001$) value of carbon stock was recorded *the intensive Khetland and* 2.06 ± 0.27 % followed by the intensive Bari land 1.85 ± 0.33 % and intensive A class 1.87 ± 0.32 %. Since soil carbon is affected by the addition of FYM and cropping pattern, carbon stock is significantly higher in *the intensive land* than that of non-intensive land (Shrestha et al., 2006). With the introduction of intensive agriculture in the mid-hills of Nepal, there is *a dramatic increase* in the use of organic as well as inorganic fertilizers and intensive cultivation of cash crops like potato, vegetable etc, which also contribute for soil carbon stock (Post and Kwon, 2000). From the

Figure 6-2, it is seen that the considerable low value of soil carbon was recorded in the surface layer of intensive (0.76 ± 0.01 %) and 1.2 ± 0.44% in non-intensive B class land, which is due to exposure and high temperature during the soil sample collection, since soil carbon is affected by the soil exposure and has the negative relation to the temperature (Burke et al., 1989).



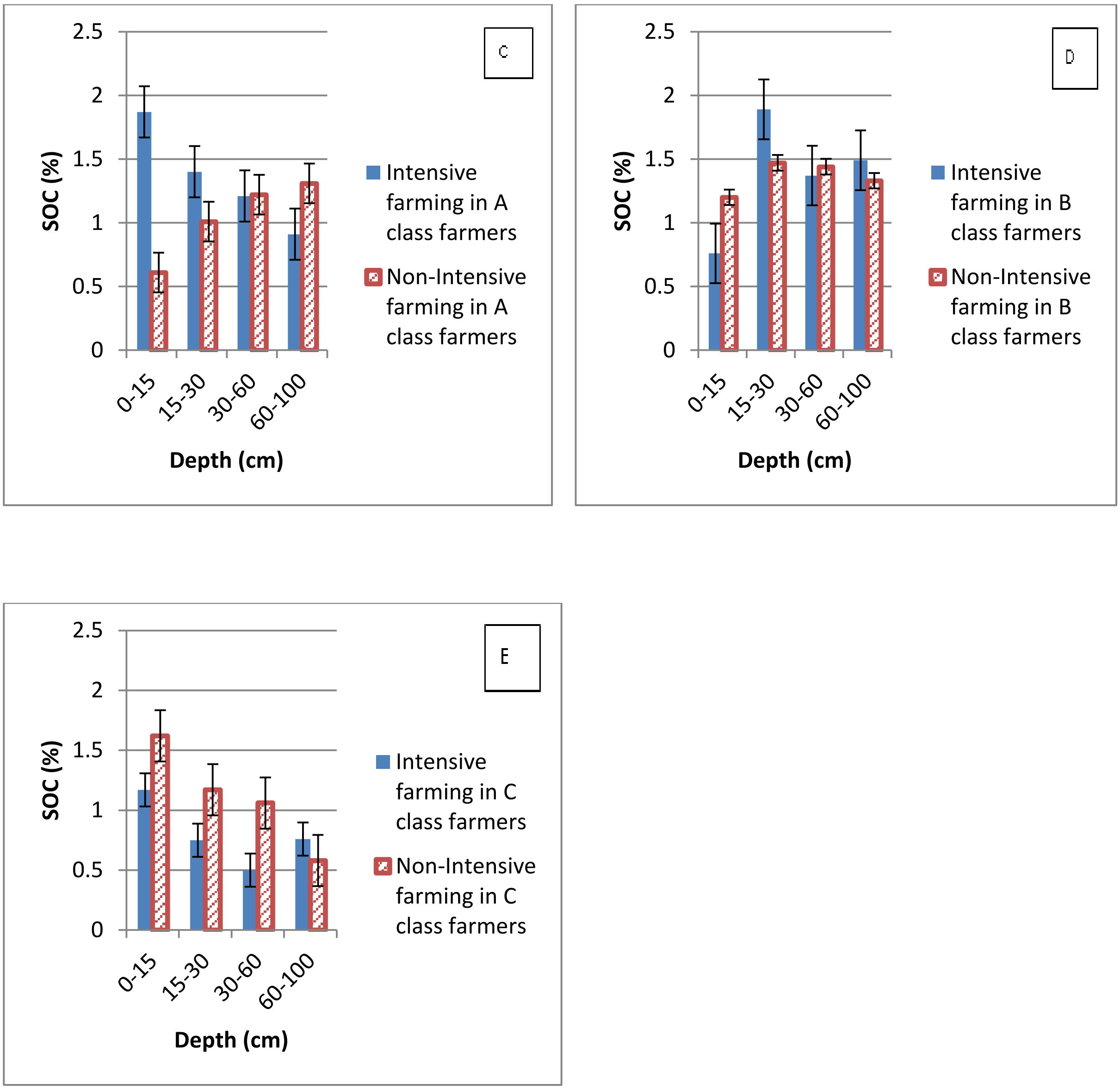


Figure 6-2: Graphical presentation of soil carbon content (mean ± SD) in various land use types

Table 6-14: Soil Nitrogen, Phosphorous and Potassium content for different landuse types (mean ±SD)

Location	Depth	Nitrogen (%)	Phosphorous (ppm)	Potassium (ppm)
Intensive farming in Khotang Bari	0-15	0.1± 0.17	77 ± 29	106.5 ± 67
	15-30	0.06 ± 0.02	61 ± 8	44.3 ± 5
Non-Intensive farming in Khotang Bari	0-15	0.11 ± 0.01	58 ± 24	67.3 ± 12
	15-30	0.08 ± 0.02	44 ± 15	59 ± 6
Intensive farming in Dhaitar Khet	0-15	0.13 ± 0.05	57 ± 21	50.3 ± 24
	15-30	0.1 ± 0.05	53 ± 25	46.6 ± 19
Non-Intensive farming in Dhaitar Khet	0-15	0.2 ± 0.01	56 ± 10	54.2 ± 16
	15-30	0.11 ± 0.01	45 ± 5	53.1 ± 22
Intensive farming in A class farmers	0-15	0.15 ± 0.06	56 ± 25	136.2 ± 3
	15-30	0.07 ± 0.01	35 ± 4	108.4 ± 6
Non-Intensive farming in A class farmers	0-15	0.13 ± 0.02	118 ± 78	106.8 ± 61
	15-30	0.05 ± 0.03	60 ± 33	69.6 ± 44
Intensive farming in B class farmers	0-15	0.18 ± 0.01	57 ± 1	140.2 ± 55
	15-30	0.11 ± 0.01	37.6 ± 5	115 ± 5.51
Non-Intensive farming in B class farmers	0-15	0.24 ± 0.1	80.2 ± 4	96.4± 75.61
	15-30	0.08 ± 0.01	42.1 ± 17	72.5 ± 42
Intensive farming in	0-15	0.1 ± 0.02	52.8 ± 5	65±7

class C farmers	15-30	0.05 ± 0.01	39 ± 2	49 ±6
Non-Intensive farming in C class farmers	0-15	0.10 ± 0.03	58.5± 32	89.5 ± 9
	15-30	0.06 ± 0.01	42.5 ± 7	76.8± 49

6.2.1.3 Soil Nitrogen

As can be seen from the Table 6-14, soil were generally of moderate fertility with medium soil nitrogen. The result indicates that total nitrogen in the soil were somewhat higher in 2 cropping system than 3 cropping system which is statistically insignificant ($p > 0.05$). The highest value of soil nitrogen is seen in class B non-intensive land (0.24 ± 0.1 %) followed by intensive class B land (0.18 ±0. 01%) followed by non-intensive Khet land (0.2 ±0. 01%). This was expected due to the higher input of FYM and fertilizers in class B land and Khet land. The use of chemical fertilizers like urea increase the amount of nitrogen in the soil as well as surface and ground water (Zhu and Chen, 2002). The lowest value of soil nitrogen is seen in the class C land (0.05 ± 0.01%). This was expected due to the fact that this class group is more interested to move in the city area for their living rather than they give time in their land and with the low income source unable to use expensive chemical fertilizers in their farmland. From the group discussion (Table 6-12), this was noted that mostly men are out in the city area for labour and women are mostly business in taking care of their children. The result above shows that soil nitrogen is higher in the top layer of soil in all types of land which is due to application of FYM and fertilizers which make no or little difference in the soil below 15cm.

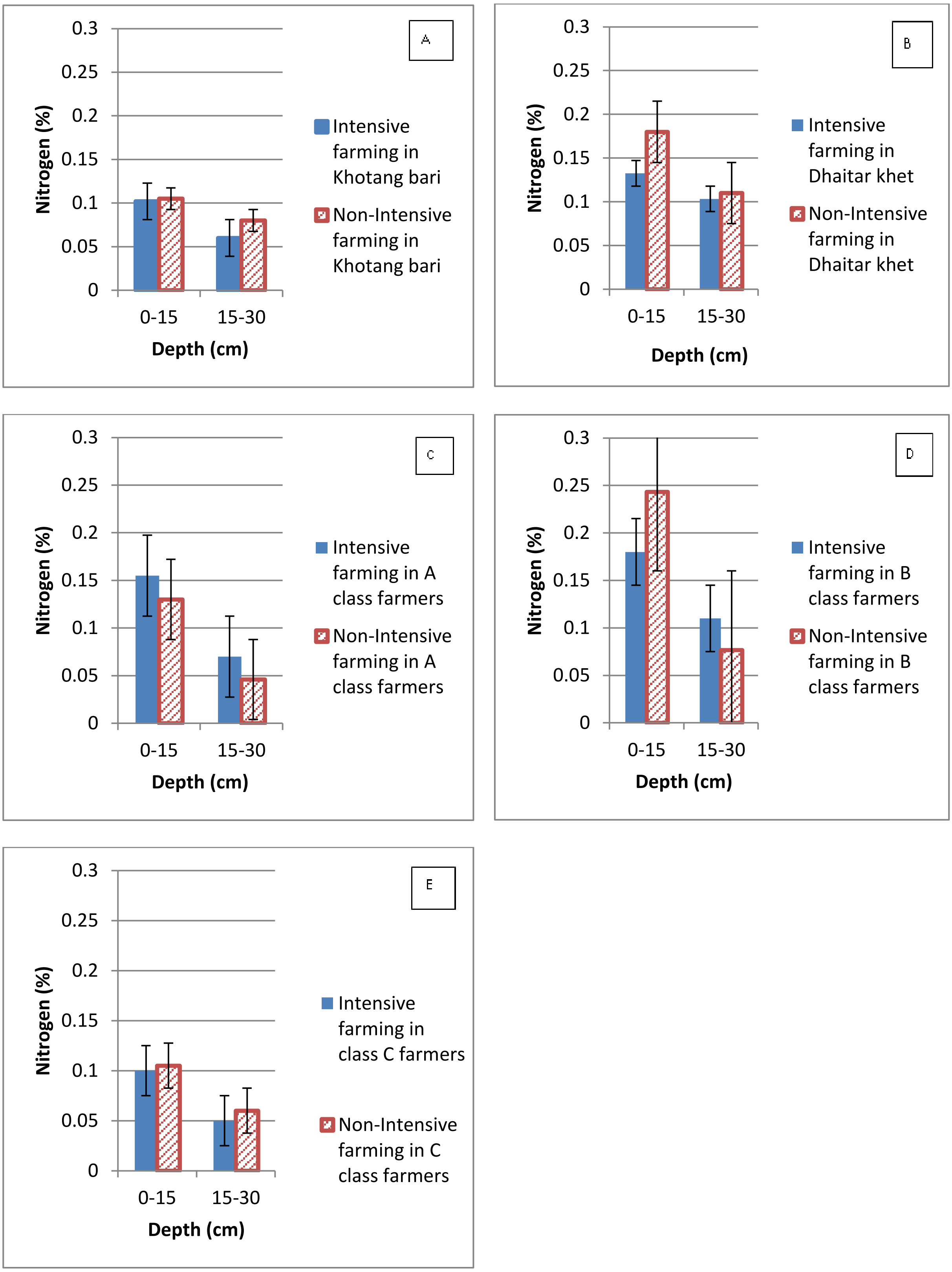
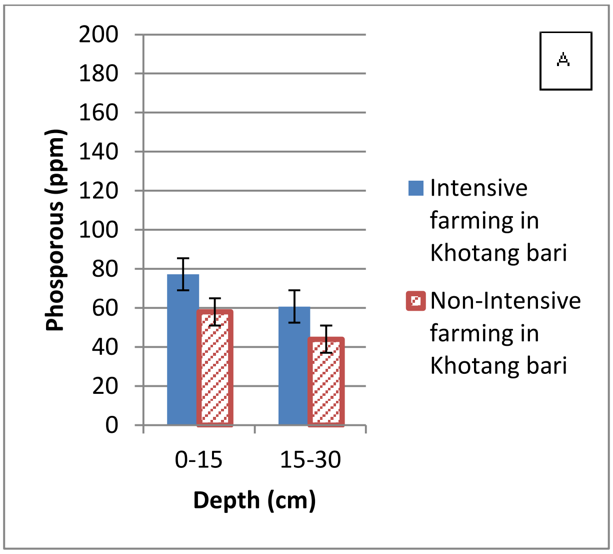
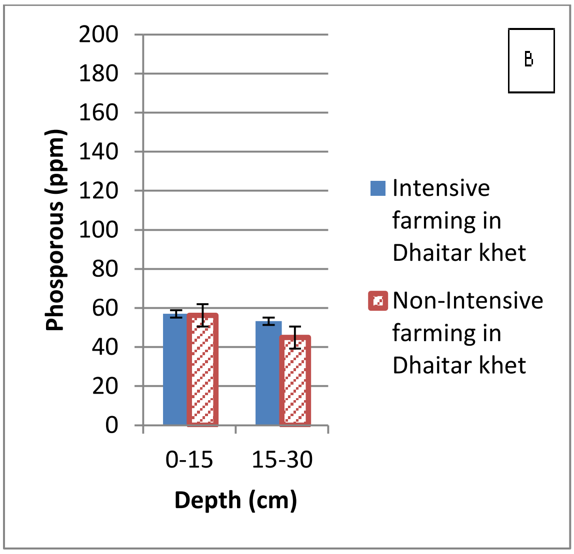


Figure 6-3: Available nitrogen content in various land use types

6.2.1.4 Phosphorus

The result show that the amount of phosphorus decrease with the soil depth in all types of land. The application of farm yard manure and chemical fertilizer DAP (N=18%, P=46%), available in the market increase soil phosphorus in the upper layer in all types of land (Dahal, 2010). The amount of phosphorus is significantly higher ($p<0.005$) in the intensive land use system in the surface layer in both Khet land and Bari land. But this trend is not seen in class A, class B and class C type land which is statistically insignificant. The highest value of phosphorus is found in class B non-intensive land (80.2 ± 4 ppm) followed by non-intensive class A land (118 ± 78 ppm) but all other land type has almost the same level of soil phosphorus.





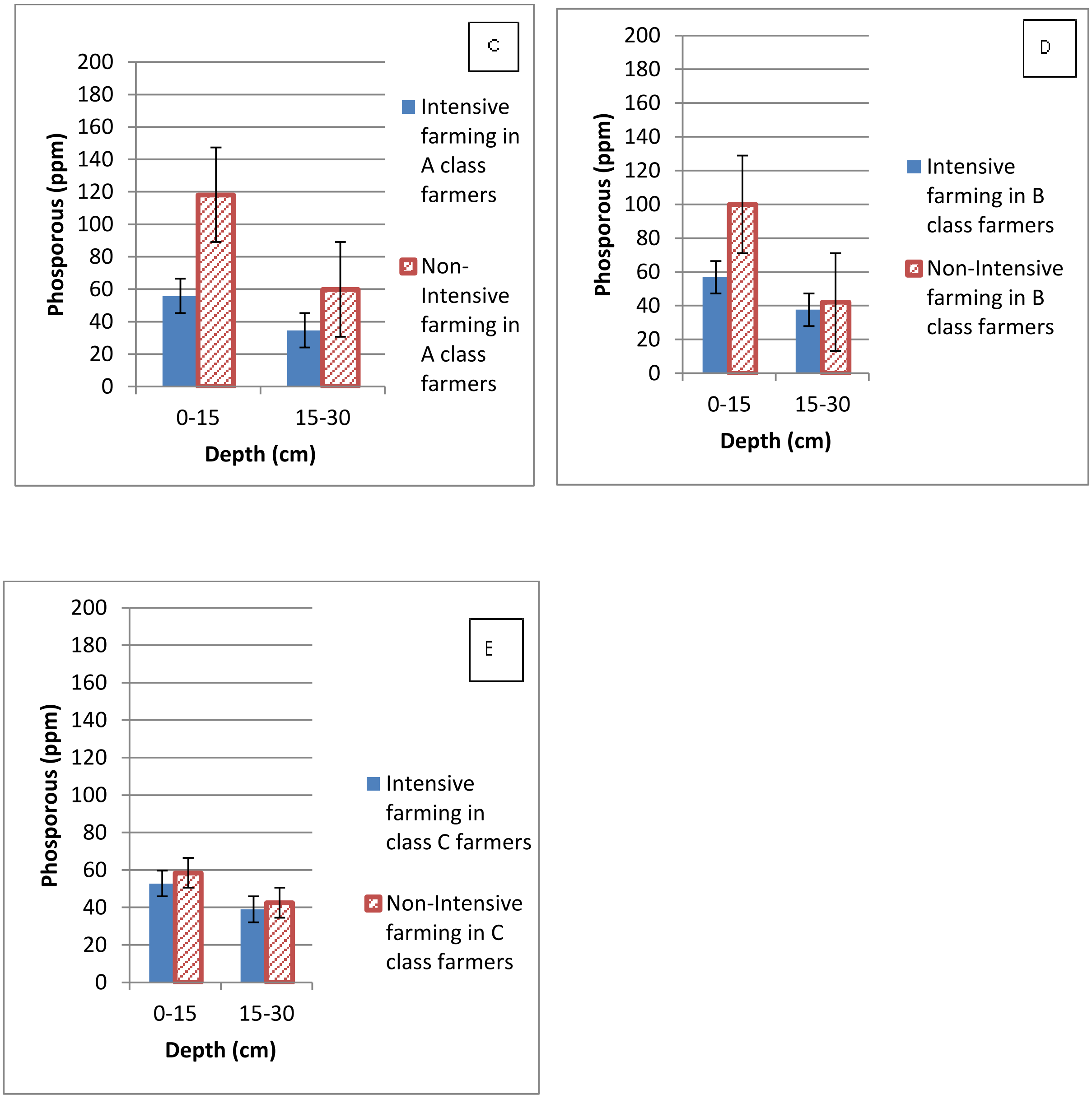
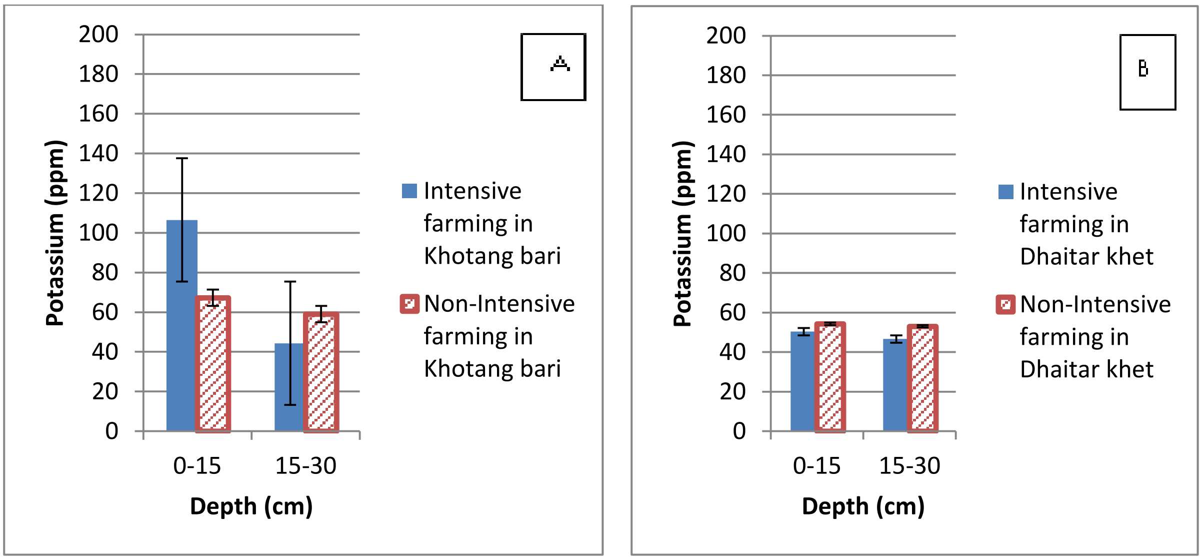


Figure 6-4: Available phosphorus in various land use types

6.2.1.5 Potassium

Along with the application of farmyardmanure, inputs of nitrogen, phosphorus and potassium are provided through chemical fertilizers, Urea (N=46%), DAP (N=18%, P=46% and muriate of potash (K=52%). This practice is even more in the intensive agriculture (Dahal, 2010). This result indicates that the amount of soil potassium is significantly higher in intensive agricultural land than in the non-intensive land. This trend is not followed in class C type land where value of non-intensive land (89 ± 9ppm) is higher than an intensive land (65 ±11ppm). This is due to the fact that fertilizer might have applied in the non-intensive recently and limitation of this study that the sample were collected once from the field. The highest value of potassium is found in class B intensive land (140.2 ± 55 ppm) followed by class A intensive land (136.2 ± 3 ppm) followed by Khotang Bari (106.5 ± 67ppm). There is a gradual decrease of potassium with depth in all types of land which is statistically significant.



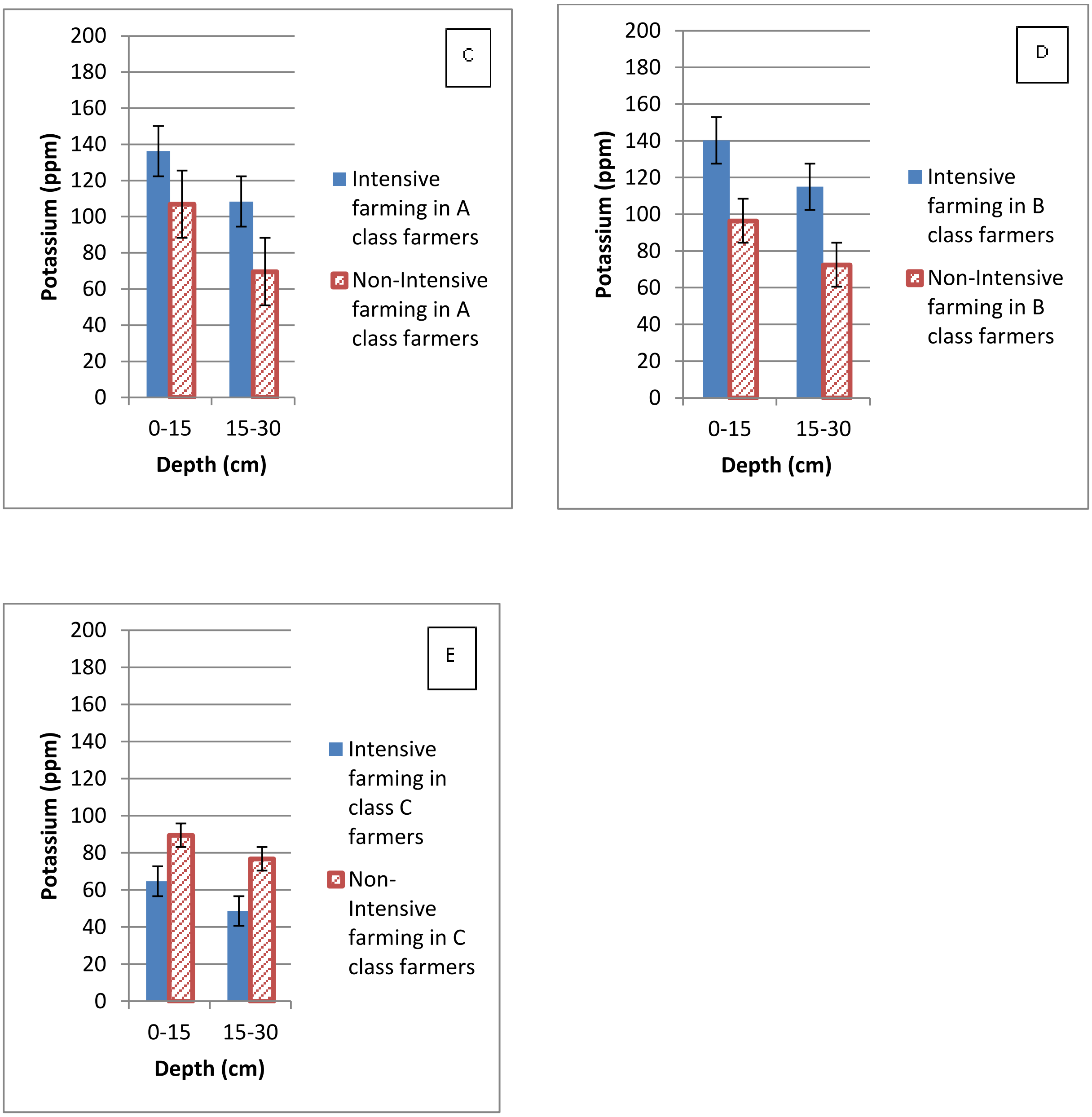


Figure 6-5: Soil potassium content in various land use types

7 Conclusions

This study has shown that, with the onset of intensification, both men and women are participating equally in new types of agricultural tasks. The workload in terms of hours is actually increasing for both men and women; however, tasks are simplified due to the adaptation of new technology in comparison with earlier days. During the FGDs, farmers reported that land preparation and ploughing are done only by the ox until around 1980 but now this has been changed to hand-tractor in much of the irrigate lowlands (Dahal 2010). With the intensification in agricultural practice, men are more involved than they used to be previously. From the results of Table 6-12, we can say that men are more involved in the agricultural activities than before.

Historical evidence shows that social norms confined women within households, affecting their literacy, mobility and outdoor participation. However, in recent years, participation of women in the decision making processes has increased. Most farmers realize that awareness and education have helped to bring women expressed the fact that women (from all castes) involvement in credit and saving tends to be more successful than that of men. Since the study area is one of the most intensified site in the mid hill of Nepal, there are many trainings given by NGOs, INGOs where the involvement of women are seen very active in first two caste group but there has been least or no participation by the women of lower caste group. This is because of different social constraints as well as the least approach of economical week group of the society. Public awareness, education and income saving rose along with the intensification process in this watershed. The impact of intensification, however, was not observed on an equal basis among all households, as this is influenced by wealth class, caste and proximity (Dahal 2010). Hence, this study concludes that with the introduction of agricultural intensification in this watershed, agricultural labor has been divided between both sex groups in the society. As seen, outdoor works are generally given to the male members in the family, and indoor works are mostly done by the female. However, there appears to be an equal contribution of both men and women in the intensification process.

There is a gradual expectant decrease of soil carbon, nitrogen, phosphorus and potassium with depth in all types of cultivated lands but the bulk density did not show such pattern. With the introduction of intensive agricultural practice in this study site, there is maximum use of chemical fertilizer as well as FYM to increase yield (Dahal 2010). Hence intensive agricultural land had a significantly higher value of soil carbon, soil nitrogen, phosphorus and potassium but the bulk density was also higher indicating the negative consequences of soil compaction. The highest values of nitrogen, phosphorous and potassium were seen in the surface layers of class A and class B types of land, which was attributed to the recent use of fertilizers in the field. Thus, this study revealed that there is an increasing use of fertilizers in the intensive agricultural practice compared to the traditional one.

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