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Agriculture intensification in Nepal: changes in socio-economic conditions and intensification indicators in Anshi Khola watershed

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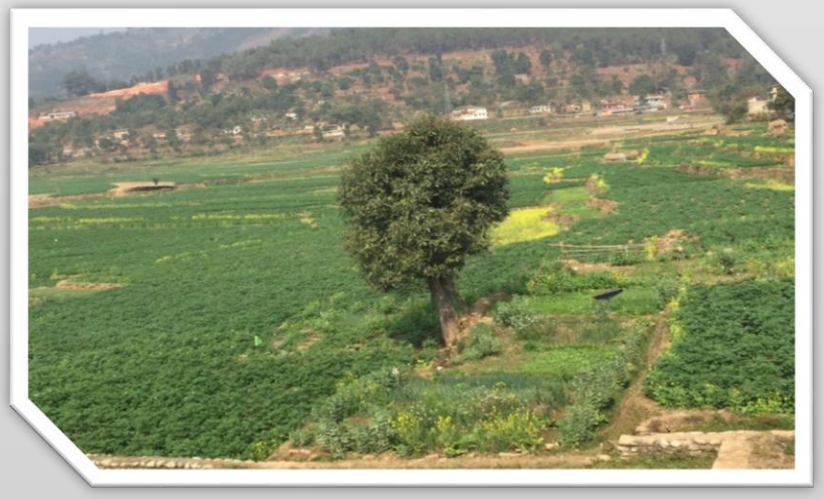
AGRICULTURE INTENSIFICATION IN NEPAL

Changes in Socio-Economic Conditions and
Intensification Indicators in Ansikhola Watershed



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Declaration

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

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Abstract

This study deals with the changes in socio-economic conditions, intensification indicators and its impact on the agricultural income of farmers in a decade time in Ansikhola watershed of Nepal. Both quantitative and qualitative methods have been used for examining these changes. This study takes the reference of wealth categories of households (A, B and C) before ten years to compare it with the two-different present socio-economic categories (A, B and C) based on the Net Yearly Agricultural Income (NYAI) and status of socio-economic indicators at the current situation.

The study has shown that middle-income families have been largely increased in the watershed. Though intensification is viable mainly to category A households, major benefiters are the C category households. They are benefitting mainly because of getting engaged in wage labor, using lesser inputs and having relatively very lower agricultural expenses than category B and A households. Though, male-headed households specifically cultivating paddy and two vegetables had higher agricultural income, but the substantial dropping of category A households suggested that this increased income has not been enough for them to remain in the former socio-economic standard. The study recognizes that decreased manpower, increased agricultural inputs use and subsequent costs, water scarcity, unfair urban markets and excessive reliance on chemical fertilizers are limiting the benefits of agricultural intensification in the watershed. Hence, it recommends for the need of necessary policy and institutional reforms for enhancing the benefits of intensification in the watershed.

Keywords: *agricultural intensification, socio-economic conditions, intensification indicators, agricultural income, watershed, changes*

Acronyms

APP	Agricultural Perspective Plan
NYAI	Net Yearly Agricultural Income
CAT	Change in status of Agricultural Technologies
CINS	Changes in status of Agricultural Infrastructures
CMP	Changes in status of Manpower
CM	Changes in status of Markets
CLD	Change in status of Land Degradation
CSF	Change in status of Soil Fertility
CSUB	Change in status of Subsidies
CWP	Change in Women's Position
CAPRO	Changes in status of Agricultural Problems
CN	Crops New
HCF	Households' Chemical Fertilizer use status
HFY	Households' Farm Yard Manure use status
RCSF	Reasons for the Change in status of Soil Fertility
RCLD	Reasons for the Change in status of Land Degradation
PCCF	Percentage change in Chemical Fertilizer use status
PCFY	Percentage change in Farm Yard Manure use status

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Introduction

Agricultural intensification is a progressive process (Carswell 2000) that is driven by many interrelating factors (Raut et al. 2011c). The major driving factors of agricultural intensification are population pressure, markets' access, employment opportunities and institutional policies (Carswell 1997). In general, agricultural intensification is undertaken with the increased cultivation of crops, increased use of agricultural inputs and is facilitated by increased availability and access to markets, infrastructures, machinery, and technologies. It is considered as a major agricultural development opportunity for developing countries like Nepal. Since 80% of the Nepalese population are dependent on agriculture, agricultural intensification is of great importance for Nepal (Raut et al. 2011c). Hence, intensification practices have been rising specifically in semi-urban areas of Nepal since more than two decades (Raut et al. 2010). Agricultural intensification in these areas has been characterized mainly by the cultivation of increased numbers and types of cereal crops including vegetables annually.

Specifically, this study seeks to examine the changes in the socio-economic conditions of the farmers due to agricultural intensification in the Ansikhola watershed of Nepal in a decade time. For this, it uses the socio-economic categories A, B, and C representing rich, medium and poor households from the study of Dahal et al. (2009). These wealth categories were created by the study of the status of socio-economic indicators such as household assets, land holding, cattle holding, job, education, agricultural production status, buying and selling of seeds in the watershed before ten years. These former categories have been compared with the present categories of the farmers derived through the study of the existing status of socio-economic indicators by examining the differences in ten-year time. Nonetheless, the major objective of this study is to understand the socio-economic changes due to agricultural intensification. Hence, another category based on Net Yearly Agricultural Income (NYAI) was formed to compare the socio-economic differences caused by agricultural intensification in a decade time. This study is thus likely to build understanding on both socio-economic opportunities and challenges faced by the farmers due to changing agricultural practices in the watershed.

This study also examines the changes in intensification indicators and analyzes its impact on the agricultural income of the farmers in the watershed. For this, this study selects the study of

the intensification indicators such as crop types, manpower, infrastructures, subsidies, agricultural technologies, markets, the status of women, soil fertility, land degradation, chemical fertilizer use, farmyard manure use and agricultural related problems of the watershed. In addition, it seeks the reasons behind the changes in the use chemical fertilizers, farmyard manure, changes in soil fertility, soil erosion and land degradation. Further, the relationship in between the changing intensification indicators and NYAI was explored. This understanding is thus assumed to reveal the potential impacts on farmers' socio-economic conditions and prospects to sustainable agricultural intensification in the watershed. In this context, this study is considered important to understand the future courses of intensification in the watershed and in other similar areas.

Overview of Nepalese Agriculture System

Agriculture is the major occupation of the farmers living in Nepal. Since, Nepal is divided into three different geographical zones viz. mountains, hills and plain lands where diverse types of crops are cultivated in different zones. Nonetheless, the major crops grown in most parts of Nepal are paddy, maize, millet, and wheat (Dahal et al. 2009). Among the cereals, paddy and wheat are the major crops of plain lands whereas maize and millet are the major crops of the hills (Grabowski 1985). Most of the farmers in Nepal are doing small-scale agriculture with the average landholding of 0.133 ha (Partap 1999).

Agriculture is the main source of Nepalese rural economy and a major employment providing sector specifically for farming communities. It is providing employment for more than eighty percent of the Nepalese population (Raut et al. 2010). Apart from agriculture, livestock rearing is another important farming activity of Nepal. Although agriculture is the major backbone of Nepalese economy, there has not been sufficient investments by the government for the development of necessary agriculture infrastructures in Nepal. Consequently, most of the rural agricultural systems in Nepal are rain fed and relies on the local climatic conditions.

Permanent agriculture system was started in Nepal from earlier 19th century (Rasul & Thapa 2003). In 1952, the government of Nepal initiated a new agricultural plan to provide information on improved seeds, fertilizers and agricultural tools to farmers. It was a crucial step for Nepalese agricultural development (Dahal 1997). However, agricultural development in Nepal did not begin significantly until the mid-20th century. Thereafter, the national agricultural policies and plan of Nepal have increasingly focused on changing subsistence farming system into professional and competitive agricultural system through sustainable

agricultural development (Dahal et al. 2009). Nevertheless, in most parts of Nepal, agriculture is still in subsistence form and conditions of farmers have not yet significantly improved.

One of the major initiatives of government for agricultural development in Nepal is the formulation of Agricultural Perspective Plan (APP) that aimed for the agricultural development of Nepal. APP has focused on the need for improved irrigation, increased fertilizers, technologies and infrastructures for increasing yields. For instance, it has identified major solutions to agricultural development through yield increasing technological changes, intensive use of land and cultivating high yielding crops (Raut et al. 2011c).

Nepalese agriculture has many issues. For example, landholding decrease is one of the key issues of Nepalese agriculture. Study by Dahal et al. (2009) showed that the average land holdings in Nepal was decreased by "0.17 ha; from 0.96 ha in 1991/1992 to 0.79 ha in 2001/2002". Increased soil erosion is another major issue of Nepalese agriculture. Increased intensification practices are likely to add up the risks of erosion. Tiwari et al. (2009) argue that soil erosion increases with the cultivation of the increased crops thereby destroying farm productivity through the loss of soil nutrients. Hence, soil nutrient loss has become one of the issue of the existing agriculture in Nepal. Moreover, Study from Raut et al. (2011c) showed that the lack of soil nutrients was a major concern among the farmers in the watershed.

Agricultural Intensification in Nepal

Agricultural intensification implies increased agricultural production through increased annual crops cultivations. Specifically, intensification is determined by the increase of annual cropping patterns, increase of crop types, intensive use of inputs and other land use activities (Brookfield 1984). In Nepalese mid hill semi-urban context, intensification has replaced the conventional practice of farming of two crops in a year into the plantation of three and more crops including vegetables in a year (Dahal et al. 2009). However, agricultural intensification in mid hills of Nepal is characterized by the extensive use of chemical fertilizers and pesticides (Raut et al. 2010).

Agricultural intensification is quite popular specifically in mid hills semi-urban areas of Nepal because it is likely to meet the increased food demands of the closer urban areas. Christaller (1933) argues that urban centers consist of large non-agricultural populations that exert a substantial demand for agricultural products. Semi-urban areas of Nepal thus have great potential of intensification since they are in close proximity to markets and own better

infrastructures (Dahal et al. 2009). Ansikhola watershed, being an important semi-urban agricultural zone, is meeting the food demands of nearby cities, specifically of Kathmandu and Dhulikhel. Since intensification has provided increased income opportunities through the better linkages with the urban markets, farmers with relatively smaller landholdings and limited off-farm income have also adopted intensification practices in the watershed (Raut et al. 2010).

Agricultural intensification in Nepal is believed to have important socio-economic implications. Studies from Katwal and Sah (1992) showed that agricultural intensification offered important socio-economic benefits to the Nepalese farmers. Also, it has the merits of food security, increased employment, increased decision making, improved local institutions and local economy of the farmers (Raut et al. 2010). Since intensification increases the annual harvests through the cultivation of more number crops in a plot, it thus provides higher production and income opportunities to the farmers. Raut et al. (2010) argue that intensification in mid hill semi-urban areas of Nepal have been benefitting the farmers through increased income and employment opportunities.

Agricultural intensification is considered to have some negative effects as well. Alauddin and Quiggin (2008) argue, intensification is harmful to soil fertility, land, and natural resources management. Increased tillage activities in farms because of cultivation of more crops in intensified farming makes soil susceptible to erosion and degradation (Tiwari 2009). Since intensification practices in Nepal have relied extensively on the excessive use of chemical fertilizers and pesticides in recent years, farm sustainability has been largely challenged. Further, unsustainable agriculture practices pose the risks of natural resources over usage in form of inputs which has detrimental environmental effects (Baumol & Oates 1988)

Socio-economic Implications of Intensification

Agricultural intensification is getting popular in semi urban areas of Nepal because it is considered to offer important socio-economic benefits to the local farmers. Studies from Katwal and Sah (1992) showed that farmers who were engaged in intensification had higher agricultural income than those who were not engaged in intensification. Since agricultural intensification has been largely favoring vegetable cultivation, farmers are getting higher income opportunities because of the good market demands of vegetables. Raut et al. (2011c) argue that farmers from the Ansikhola watershed have gained good cash income by selling vegetables due to its higher market demands.

Intensification through vegetable cultivation is considered profitable in both socio-economic and sustainability terms in Nepal (Tiwari et al. 2009). For example, intensified vegetable farming in some mid hills of Nepal has contributed to the triple increase in household income over the past five years (Katwal & Sah 1992). In addition, Tiwari et al. (2008) argue, intensification has made farmers to include nutritious food in their diets as well because of cultivation of green vegetables. Hence, current trends of increased cultivation of potatoes and other vegetable crops have shown farmers' move towards the intensified agriculture in the watershed (Dahal et al. 2009). Since the watershed has increased access to markets and infrastructures in recent decades, the move to intensification has become easier.

Agricultural intensification is likely to meet the increased food demands of the increased population (Schroeder 1985). It is also preferable when there is very little scope for expansion of cultivation land due to the pressure of increased population (Pingali & Rosegrant 2001). It also makes farmers to adopt better quality of life through increased agricultural production and income. It is thus considered crucial for local socio-economic security, food security and agricultural development in developing countries like Nepal (Raut et al. 2010). Moreover, higher farm income from intensification improves the socio-economic conditions of farmers and increased food harvests help farmers to attain food security (Katwal & Sah 1992). Intensification has also provided local employment opportunities in the local markets of agricultural inputs such as fertilizers, pesticides and agricultural products (Raut et al. 2010).

Studies on Sustainable Agricultural Intensification

Sustainability is the core issue of agricultural intensification. Sustainability is about fulfilling the present needs thereby considering future necessities (Redclift 1987). The notion of sustainability applies to the farming system as well (Dahal et al. 2009). The crucial factors of sustainable agricultural development are productivity, stability, sustainability, and equitability (Conway 1985). Sustainable agricultural intensification is thus important for delivering improved agricultural outcomes through ecologically sustainable methods. It includes the use of high yielding varieties, terracing, legume intercropping, cover crops, appropriate crops selection, use of both organic and inorganic fertilizers (Raut et al. 2010).

Excessive applications of chemical fertilizers have become a major issue in Nepalese mid hills intensified agriculture in recent years (Raya 2013). Study from Raut et al. (2011c) also showed that many farmers of the Ansikhola watershed applied high doses chemical fertilizers and pesticides to increase the productivity of their farms. The reason was mainly due to the low

price of urea and ignorance of farmers on the balanced use of fertilizers (Raut et al. 2011c). Study from Bajracharya and Sherchan (2009) showed that increased use of chemical fertilizers was leading acidification of soil in the hill areas of Nepal. Moreover, excessive chemical fertilizer use is counter-beneficial in the long run because it brings risks to the ecosystem, soil, and human health. Dutcher (2007) argues that excessive use of chemical fertilizers in intensified farms puts great risks upon the human health, wildlife and surrounding agrobiodiversity. In this context, this study finds that it is critically important to understand the ongoing changes in the use of the chemical fertilizer by the farmers in the watershed.

Pretty (2008) argues that agricultural system is considered sustainable only if it generates better economic, social and environmental outcomes. This is because sustainable agricultural intensification tends to offer higher production outputs with minimum environmental and human health risks. Conway (1985) argues that sustainable agricultural intensification reduces the negative environmental outcomes with increased contributions of natural capital and offers better flows of environmental services. In addition, it enriches the livelihood through higher production and protects the land from degradation (Dahal et al. 2009). Hence, sustainable agricultural intensification is assumed important for correcting the unsustainable trend of intensification activity.

Objectives

The overall objective of the study is to evaluate the impacts of agricultural intensification in terms of changes in the socio-economic conditions of the farmers and selected intensification indicators in the watershed of Nepal.

The specific objectives are as follows:

- To study the changes in socio-economic conditions of the farmers due to agricultural intensification in the watershed in a decade time.
- To study the changes in the status of intensification indicators and its impact on NYAI of the farmers in a decade time.
- To understand the perceptions of the farmers towards the changing status of intensification indicators and agricultural intensification in a decade time.

Study Area Description

Ansikhola watershed is one of the popular agricultural zones of the Kavre district of Nepal. It lies in between N 27^0 41' latitude and E 85^0 31' to 85^0 37' longitude and is extended about thirteen square kilometers. The watershed is about 7 km away from the Kathmandu– Melamchi road in Araniko highway (Dahal et al. 2009). This study was conducted in the households from twelve wards of four Villages Development Committees (VDCs) namely Mahadevsthan, Devitar, Anaikot, and Nayagaun.

The watershed is a semi-urban mid hill zone which lies at the closer distance to Dhulikhel and Banepa markets. It is about 60 km far from the capital city, Kathmandu and is connected to the capital through direct road network (Dahal et al. 2009). These markets are important for the farmers to sell their farm products and buy necessary farm inputs and accessories. Closeness to the bigger markets, increased roads and markets have helped the farmers of the watershed to actively engage in intensification in recent decades.

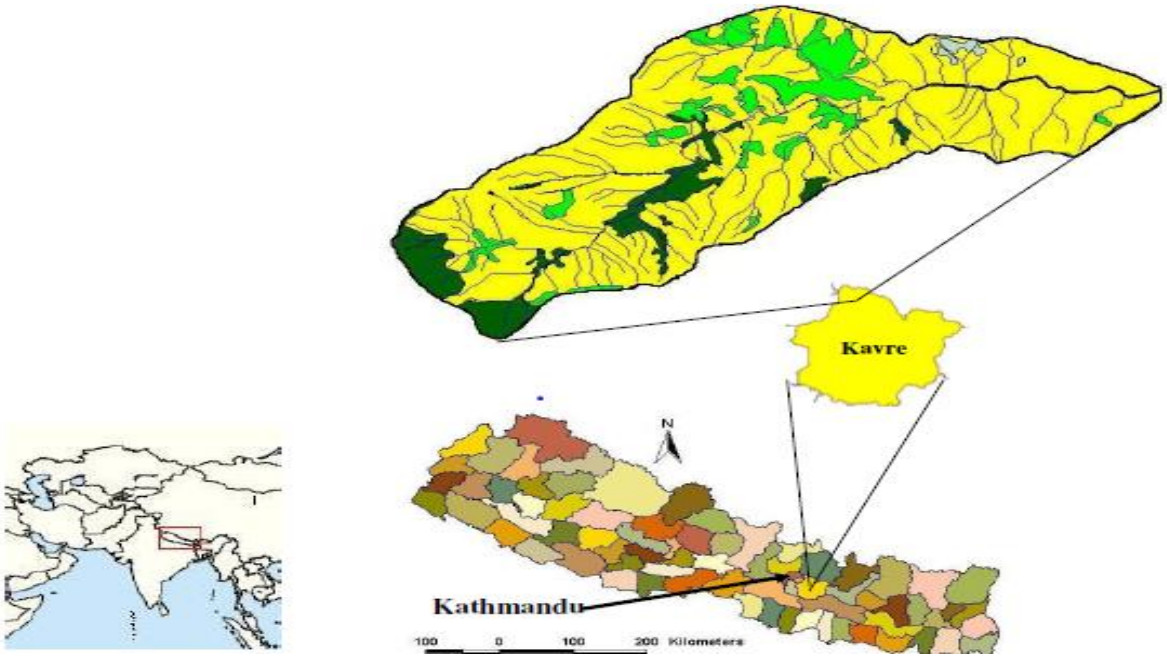


Figure 1: Map showing study area, Kavre district, with reference to Nepal and South Asia, source: (Dahal et al. 2009).

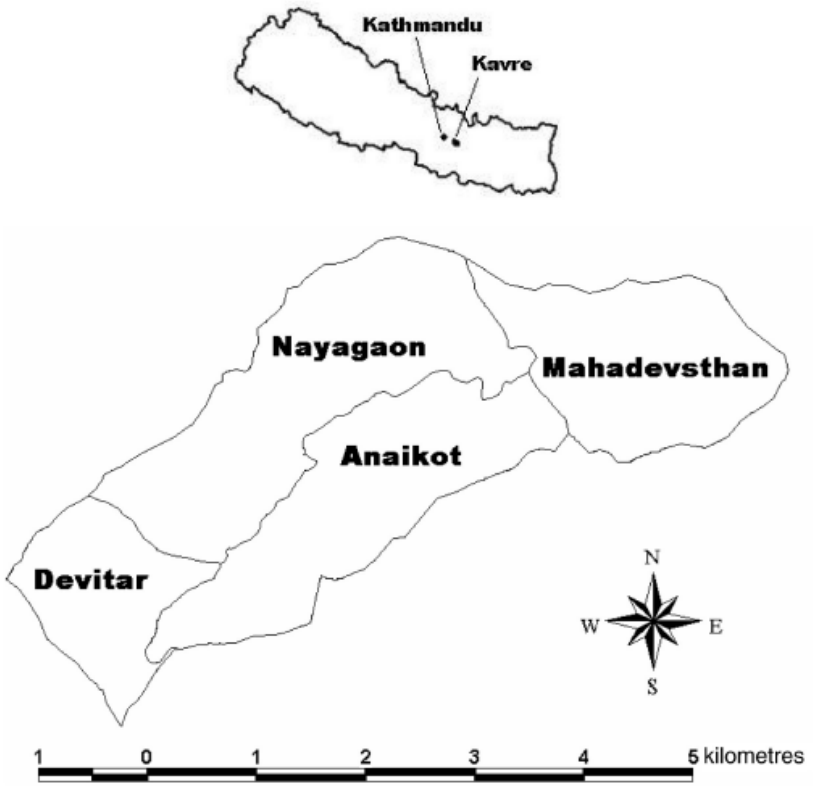


Figure 2: Map showing four village development committees of the watershed with reference to map of Nepal, source: (Dahal et al. 2009).

As shown in figure 2, among the four VDCs of the study area, Mahadevsthan lies in the lowland part of the watershed whereas other three VDCs are in the highlands. The lowland part of the watershed is mainly occupied by the Brahmin and Chhetri caste households whereas the uplands are occupied mainly by Rai, Gurung and Dalit caste communities. Regarding settlements, "The Gurung, Tamang and Rai caste are settled in non-irrigated terraced upland areas whereas Brahmin and Chhetri caste households are settled in flat lowland areas (Dahal et al. 2009)".

According to Raut (2012), the watershed consists of overall cultivable land of 80.6%, 9.9% of bushy grazing area and 8.4 % of the forest area. The watershed can be distinguished in between the plain lowlands and hilly upland areas. The upper part of the watershed is characterized by the red clay soil whereas the lower side is moderately sloped and flatlands and is specifically favored for intensified farming (Raut 2012). For example, lowland areas are mostly the *khetlands* which are favorable for the cultivation of potatoes, tomatoes and other paddy crops whereas highlands are mostly the *bari lands* which favor the cultivation of wheat, millet, maize and short-term vegetables (Dahal et al. 2009). Lowlands farmers are specifically in advantage

of intensification because of having suitable flat lands for cultivation of potatoes and other vegetables.

The crop rotation in the *Bari* system had maize-millet (two crops) and maize-potato-mustard (three crops) whereas the *Khet* system had paddy-paddy and paddy-potato-paddy as two and three crops rotation system (Dahal et al. 2009). Nonetheless, the cropping is generally mixed type in the whole watershed area. Most of the farmers are recently engaged in triple annual cropping in recent years which mostly included paddy-potato-paddy (Raya 2013).

Regarding land use, table 1 below provides an overview:

Table 1: Agricultural Intensification Processes and Greenhouse Gas Emission from Soils: Study from Nepal and India, Source: (Raut 2012)

Land use type	***Description***	***Types***
Khet	Cultivated lowland areas with Smoothed, flat terraces	Galkhet – irrigation potential Tarkhet– no irrigation potential
Bari	Rain-fed upland, smoothed and mostly sloping terraces	Pakhobari – less productive, mostly sloping, away from home *Gharbari* – use for vegetable gardening, near to home

Context of The Study

The study was conducted among 260 households from total 1038 households of the watershed earlier selected by Dahal et al. (2009). Study of the same households makes us examine the relative changes in 10-year time. However, some of the households interviewed before had already migrated from the watershed because of the earthquake effect, abroad and urban jobs.

The lowland areas of the watershed are relatively densely populated than the upland areas. Moreover, households from lowland areas are assumed to be relatively more prosperous than the households from the upland areas. This might be due to increased roads, markets, technologies and training' access in the lowland areas. Moreover, benefits of intensification are likely to be higher in lowland areas because of the favorable soil for the cultivation of potatoes, green vegetables, and rice which has higher market prices and demands in the markets. Raut et al. (2011a) argue, a major step of intensification in the watershed is to cultivate

the crops with higher market demands like potatoes and other vegetables. This is the main reason why vegetable farming has gained popularity in the watershed.

The intensification process in the watershed began with the shift from conventional two-cropping system to a triple-cropping system that integrated spring rice and cash crops cultivations along with high-yielding varieties (Raut et al. 2011a). Current intensification activity is the watershed is characterized mainly by the cultivation of the increased crops combining with tomato, potato, and other green vegetables. Intensification is beneficial for the farmers due to increased crop harvests annually unlike conventional agricultural practices. Moreover, intensification has helped local farmers to make suitable choices of crops as well. Dahal et al. (2009) argue that besides increased variety and number of crops, intensification has helped farmers to avoid the cultivation of crops which had severe pest challenges in the past.

Conceptual Framework

This study refers to the baseline data of Dahal et al. (2009) in which households of the watershed were categorized into three socio-economic categories A, B, and C (rich, medium and poor consecutively). However, this study uses two different bases in forming the socio-economic categorizations of the households to compare it with the prior categorization. The first categorization is solely based on NYAI of the farmers. Since NYAI is the yearly profits gained from agricultural activities including agricultural wage labors after reducing net yearly agricultural expenses. Hence, it is an important indicator to assess the effect of agricultural intensification among the households.

The second categorization of households is based upon the socio-economic indicators such as job, land holdings, education, cattle holdings, annual agricultural production, seeds buying and selling status as per study from (Dahal et al. 2009). The socio-economic categorizations currently formed are separately compared with the prior socio-economic categorization to understand the overall changes in socio-economic conditions of the farmers. Apart from this, this study examines the changes in intensification indicators and its impact on NYAI of the farmers. Understanding the changes in intensification indicators are important because it is likely to affect NYAI of the farmers and their socio-economic conditions. The study also considers important to separate the intensification adapters and non-adapters in the watershed. Since inputs use are likely to be different in intensified and non-intensified farms, it is thus

likely to bring differences in agricultural income of farmers thereby affecting their socio-economic conditions.

Intensified farms is believed to provide better farm income than non-intensified farms. For instance, studies from Katwal and Sah (1992) showed that intensified farms offered better production outcomes and brought higher agricultural income than farms without intensification. However, benefits of intensification might not be always higher with the increased use of higher inputs in intensified farms because inputs costs have grown exponentially in recent decades in Nepal. Hence, the quantity of the inputs used and the prices of inputs strongly influences the benefits of intensification.

The conceptual framework has been designed mainly to understand the effect of agricultural intensification in the watershed. The relevance of this framework is to understand the changes in socio-economic conditions of the farmers, intensification indicators and its impact on NYAI of the farmers. Further, this framework helps us to understand the changing status of socio-economic indicators in the watershed as illustrated in figure 3. This understanding is assumed to explore both the problems and opportunities of the ongoing farming practices in the watershed. For instance, the increased status of markets, manpower, technologies and infrastructures are assumed to provide better farm income and employment opportunities to the farmers whereas increased soil erosion, excessive chemical fertilizers use, decreased farmyard manure and land degradation are likely to decrease farm production thereby increasing agricultural costs. The conceptual framework for the study is presented given below:

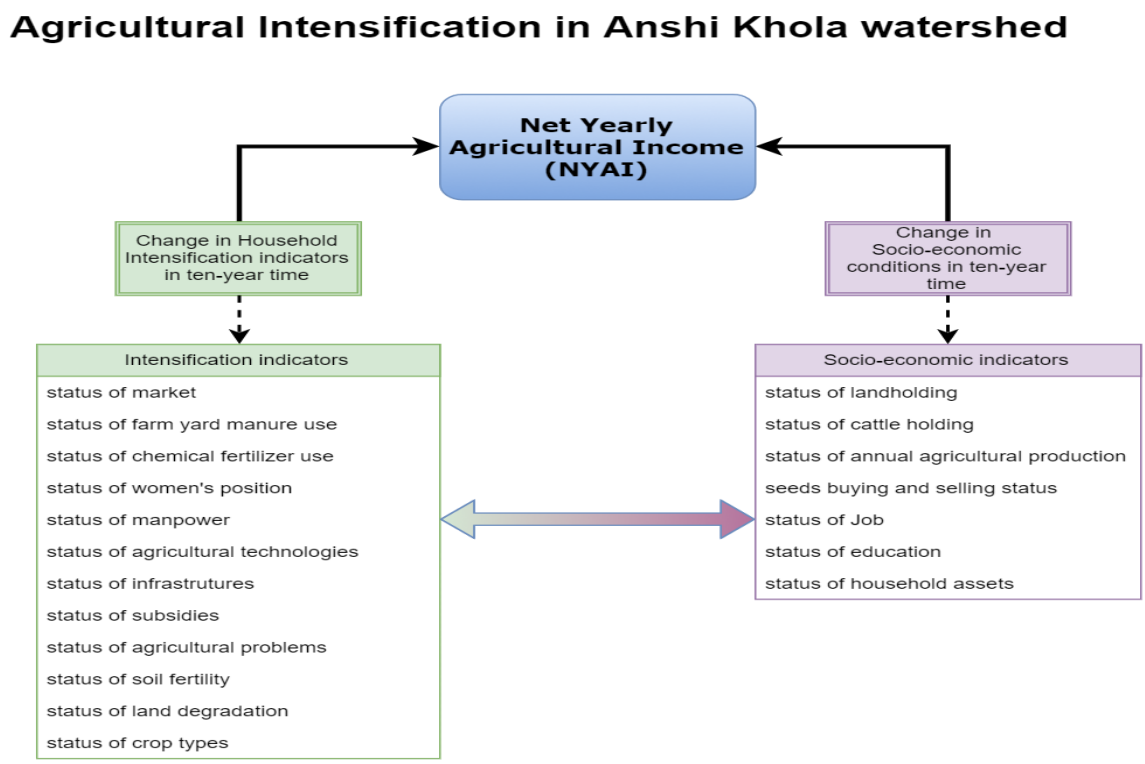


Figure 3: Conceptual framework for analyzing the changes in socio-economic conditions and intensification indicators in ten-year time in Ansikhola watershed

Methodology

The methodology is an important part of any research work which includes the process of designing, planning and conducting a research. It starts with the methods of data gathering and is followed by data analysis to derive necessary results (Silverman 2006). This study of the examining changes in socio-economic conditions, intensification indicators and its impact on NYAI of the farmers in a decade time uses both the quantitative and qualitative research method.

Both quantitative and qualitative designs are important research methods. However, they use different processes, serve different purposes and suit in different conditions. For example, quantitative method is better when we should deal with the observable things and numerical data. Berg and Lune (2004) argues "quantitative research deals better with the counts and measures of things, the extents and distributions of subject matter". In contrast, a qualitative method is used for understanding the experiences and perceptions of the purposively selected people that could provide important and reliable information that fulfills the objectives of the

research. Berg & Lune (2012) argue that qualitative research is effective when we should deal with the people's actions, perceptions, beliefs, and values.

This study uses the quantitative method in the first part for examining the changes in socio-economic conditions and intensification indicators using the data obtained from structured questionnaires. In the second part, the study uses the qualitative method because it deals with perceptions of the farmers mainly obtained from open-ended group discussion session. The qualitative data obtained from group discussion is likely to reveal the important experiences of the farmers regarding the ongoing changes in agricultural activities in the watershed. Since this study uses mixed method approach, it provides a refined understanding of the major effects of agricultural intensification in the study area. In addition, this method tends to reveal the major challenges and opportunities faced by the farmers due to increased intensification practices in ten-year time.

This study selects the same households interviewed before ten years based on random stratified sampling method earlier used by Dahal et al. (2009). It includes the households from different caste, class, and gender distributed along the highlands and lowlands of the watershed. Since this study is likely to reveal the changes occurred in ten-year time, it is thus important to select households from varied socio-economic backgrounds. Since farmers in the watershed are both intensification adapters and non-adapters, and they have been categorized into three wealth backgrounds. Their different status is likely to reveal the varied experiences of the farmers regarding the ongoing agricultural activities, intensification indicators' and its impact on farmers' income in the watershed.

Responses from the same households previously studied are likely to reveal the information on how the socio-economic conditions, intensification indicators and its impact on the agricultural income of farmers changed in a decade. Nonetheless, all the households previously studied have not been included in this study because of outmigration of some of the households. The majority of households that have migrated to cities are mainly the families with higher wealth status Dahal et al. (2009).

Among 260 households selected for the household survey, almost 67 percent of the households were undertaking intensification (HH_int) whereas 33 percent of them were not undertaking intensification (HH_Non int). Intensification adapters and non-intensification adapters have been mainly differentiated based on their annual crops cultivation patterns as used by Raut et

al. (2011c) according to which, the former are the ones who has cultivated at least three crops per year whereas the latter are the ones who are continuing with the traditional agricultural system i.e. cultivating two crops in a year. In the group discussion of 18 participants, 10 of them were the intensification adapters whereas 8 of them were non-intensification adapters.

The major part of the analysis on the changed status of socio-economic, intensification indicators and its impact on NYAI has been done through quantitative research method. This method mainly converts the quantitative numerical data into statistical diagrams and descriptive tables. Similarly, qualitative research method has been used mainly to understand the farmer's perceptions of changing the status of intensification and socio-economic indicators. The information from qualitative group discussion is considered to cross-check the findings from the quantitative method.

The household questionnaire survey was conducted in January 2017 with the help of two trained enumerators. Among the 1038 households of the watershed, 260 households were taken for an interview which almost accounted for 25 percent of total households. During the interview, household heads were given priority and if no households were presented, then second senior member was selected for the interview. Since the study modifies the earlier structured questionnaire of Dahal et al. (2009), important information on changed socio-economic conditions and intensification indicators before ten-year and now were collected through filled out questionnaire forms. For group discussion, two working days were used for understanding the perceptions of purposively selected respondents representing different wealth classes, gender, and caste. The non-probability purposive sampling method was used for selecting the informants because they were considered to have varied and interesting experiences for meeting the needs of our qualitative research.

Household Questionnaire Survey

The study uses the questionnaires from Dahal et al. (2009) along with the revised modifications to compare the changes on socio-economic conditions of the farmers, intensification indicators and its impact on NYAI in the watershed in ten-year time. In addition, the study examines the agricultural inputs use over time and reasons for the changes in ten-year time. This is important because it creates an understanding of how changing inputs use trends have affected the socio-economic conditions of the farmers. Since not any laboratory tests were performed, hence the study completely relies on the farmer’s responses to the structured questionnaires.

This study also attempts to examine the relationship between intensification indicators and NYAI of the farmers. This relationship would assume to explain how the changing status of intensification indicators are likely to influence the benefits of intensification in the watershed. Moreover, this study gathers responses in finding the reasons behind the changes in 10-years time. Reasons that explain changes in farmers' inputs use and other intensification indicators are likely to reveal the farmers' perceptions of how these changes are affecting the farming activity and their socio-economic conditions in the watershed. These findings are quite important because it tends to influence the future courses of intensification in the watershed.

Quantitative Research Method

The quantitative research method is one of the most convenient research methods which mainly derives results from the structured closed questionnaires. "Quantitative research refers to counts and measures of things, the extents, and distributions of the subjects (Berg & Lune 2004)". Quantitative research creates the patterns of the data through coding process and when systematically put into the program helps a researcher to analyze the data. Field (2009) argues, quantitative method is better in dealing with the observable things, numbers and statistical data. The study thus utilizes this method for exploring NYAI, agricultural expenditures, agricultural production, changes in socio-economic and intensification indicators. Further, bar graphs, box plots, and descriptive tables have been used to illustrate the statistical results.

Qualitative Research Method

The qualitative data was collected through open-ended group discussion. The group discussion was conducted among 18 participants who were purposively selected from all the twelve wards of four VDCs. These participants were representing the different class, caste, and gender and were both intensification adapters and non-adapters as well. Since both gender and caste category defines a structural socio-economic division in the context of Nepal, this discussion is assumed to provide important in-depth information regarding their experiences on the changes in socio-economic and intensification indicators in a decade time.

Since intensification activity has been on the rise in the study area, farmers are likely to experience both challenges and opportunities due to intensification. In addition, this discussion is considered important to provide relevant information on constraints, possibilities and farmers' motivation on existing agricultural activity. Further, this discussion session is believed to offer reliable information in understanding the probable future courses of intensification in

the watershed. The findings from this session are thus likely to cross-check and complement the results from the quantitative method.

Mixed Method Research

Mixed method approach is considered beneficial since it takes the merits of both quantitative and qualitative methods. Since both methods are used side by side, this approach is likely to meet the needs of the researcher in a subtle manner by bringing important findings to meet the aim of a researcher. Creswell and Clark (2007) argue, mixed method approach combines the strengths of both these methods thereby avoiding the weakness of a single method. Mixed method approach is also likely to triangulate the results obtained from a single method thereby offering reliable and valid results.

Data Analysis

The data collected from household questionnaire survey and group discussion was analyzed separately. Quantitative raw data was first imported into Microsoft Excel and put into a systematic format with the necessary coding in various others excel sheets. The systematically recorded data in excel was then imported into R studio software. Through R studio, necessary statistical results, diagrams, and descriptive summaries were generated that would verify the results. Important results have been expressed mainly using the tables, bar graphs, and box plots. Through ANOVA test, p-value, f-value, degrees of freedom, mean of squares and sum of squares for important variables were generated thereby identifying the significant relationship of the variables with NYAI. Log of NYAI was taken to simplify the income level of the farmers. Further, linear regression method has been used to generate the value of R-square.

The qualitative data that had been recorded were transcribed and coded with many colors thereby identifying and marking major themes and patterns were identified. The important trends identified has been presented in the results section along with the quantitative results. These trends are likely to explain the interesting tendencies on existing status of intensification and socio-economic indicators along with the challenges and opportunities of the ongoing farming practices. It is assumed important to support and complement the results obtained from quantitative research.

Research Ethics

During the data collection, farmers were properly briefed about the purpose of the study. Information was collected taking their full consent. They were not forced to answer all the questions. Sufficient chances of quitting were provided even at the middle of the interview. They were assured that information obtained from them would be used only for the academic purpose. They were also made aware of the possible risks of this study. Moreover, they were assured that information would be kept secret.

Results and Discussion

Changes in Socio-economic Conditions of the Farmers in Ten-year Time

This section mainly seeks to examine the changes in the socio-economic conditions of the farmers due to agricultural intensification in the watershed in a decade time (from 2006 to 2016 A.D). NYAI is considered as a major determinant to bring important socio-economic changes of farmers in the watershed. Since NYAI is the net income obtained by farmers only from agricultural activities including the agricultural wages. It thus avoids the income from other sources. In a global context, Carswell (1997) argues that socio-economic conditions of the farmers are clearly associated with both agricultural production and subsequent agricultural income of farmers. In case of Nepal, Dahal et al. (2009) also considered that agricultural income and profits are the major determinants of the farmers' socio-economic conditions. Hence, it is important for farmers to have better agricultural income for the upliftment of their socio-economic conditions. Moreover, increased agricultural income helps farmers to invest in health, education, and quality of life. For instance, Study by Dahal et al. (2009) suggested that farmers reported that they could afford their children's education because intensification has enhanced their economic conditions. In this connection, agricultural intensification is considered as a viable opportunity for farmers to upgrade their socio-economic conditions by improving their agricultural income.

In figure 4 below, Cat_AI represents the category of households based on NYAI and Cat_b10 represents the category of households before ten years used in Dahal et al. (2009) study. Similarly, Cat OF represents the category of households at present based on the socio-economic indicators selected in the prior study which included landholding, household assets, job, education, cattle holding, agricultural production, seed buying and selling status.

The result below suggests that substantial increase of B category households occurred whereas A category households have been significantly reduced in both Cat_AI and Cat_OF in ten-year time. In contrast, C category households have decreased in Cat_AI and thus appears to have been upgraded to B category. This suggests that agricultural intensification provided maximum benefits to the poorer households who seem to have significantly increased their NYAI in ten-year time.

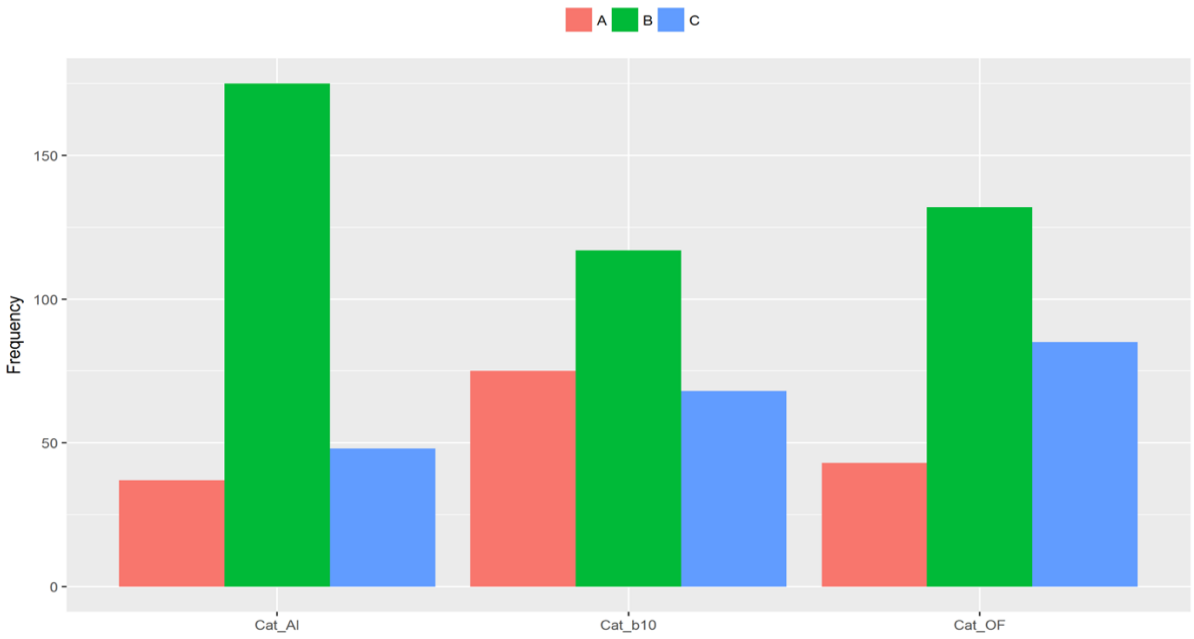


Figure 4: Cat_b10 representing category of households ten years before and Cat_OF representing current category based on socio-economic factors such as household assets, job, education, agricultural production, seed selling status, landholding, and cattle holding status

Since category C farmers (in Cat_b10) were the households with extremely lower agricultural income, owning less than 0.5 ha of agricultural land or having no lands at all, owning no cattle and with very lower or zero level of agricultural production (Dahal et al. 2009). They are thus assumed to engage in agricultural wages labor of bigger farmers to maintain their livelihoods. It seems that C category farmers are utilizing the increased job opportunities from intensification. Tiwari et al. (2008) argue, intensification has mainly supported the small-scale farmers to engage in farming activities of larger farmers with more landholdings. Moreover, they are unlikely to use more inputs as A and B households because of less or no landholdings and were less exposed to intensification.

Further, as shown in table 2 below, the study finds that category C has very lower average agricultural expenses as compared to A and B category households. Similarly, category B households has medium average agricultural expenses and medium average NYAI since they also get engaged in intensification and worked for agricultural wages for A category households. For example, Dahal et al. (2009) argue, most of the middle and poor class of farmers of the watershed worked on daily agricultural wages for rich farmers despite doing their own agricultural tasks. In contrast, category A households possessed relatively more landholdings (more than 1 ha), usually hired more farm labors, relied on more inputs and had higher agricultural expenses because of increased involvement in intensification practices. Study from Tiwari et al. (2008) also suggested that big farmers who owned relatively larger farm plots usually hired local people for cultivation and transport of vegetables in the markets. As per our study, C category farmers were mostly involved in these jobs thereby enhancing their NYAI.

As shown in table 2 below, though average NYAI is larger for the category A farmers due to participation in intensification activity, they used almost 40 percent of their farm income in agricultural expenses. Similarly, category B farmers used around 28 percent of their agricultural income in agricultural expenditures and have medium income level whereas category C farmers used only 15.5 percent of income in the agricultural expenditures. Nonetheless, their NYAI is relatively very lower than A and B category farmers. Since C category farmers were less engaged in intensification and had less income from agricultural sales, they were likely to gain NYAI through increased employment opportunities and increased daily wages rates with the extensive intensification practices in the watershed. These income opportunities thus helped many of the C category farmers to get into medium wealth status whereas increased agricultural expenses pushed the former A category farmers into middle-income category.

Table 2: showing the average annual agricultural expenses, NYAI and percentage of income used in agricultural expenditures of the Cat_b10 farmers

HH categories in Cat_b10	**Average annual agricultural expenses**	**Average NYAI**	**Percentage of agricultural expenses**
Category A	114,420 NPR	1,73,280 NPR	39.77%

Category B	46,348 NPR	1,20,347 NPR	27.8%
Category C	12,603 NPR	68,265 NPR	15.58%

Hence, the higher agricultural expenses of A category farmers show that their net profits of agriculture are likely to have been affected by the increased costs of inputs and labor expenses. It thus implies that adoption of intensification might not be alone sufficient for farmers to improve their income and maintain their socio-economic standards. This result has thus challenged the oversimplified perception that agricultural intensification uniformly benefits all the households irrespective of any context. Also, Dahal et al. (2009) argue, benefits of intensification are likely to be influenced by access to inputs, roads, markets and socio-economic context of the farmers.

In table 3 below, it can be observed that category A households in Cat_AI have been reduced by 52 % i.e. from (75 to 36), category B households have been increased by 53.5 % i.e. (114 to 175) and category C households have been reduced by 32% (from 71 to 49) in a decade period. Similarly, the result (between Cat_OF and Cat_b10) suggests that A category of households have been reduced by 44 % i.e. (from 75 to 42) whereas there has been an increase in B and C category households by 17% and 18 % respectively in ten-year time. This result suggests that the status of the prior selected socio-economic indicators is likely to have been dropped from higher to medium and to poor state. For example, the watershed is likely to experience a decrease in the household assets, cattle holdings, land holdings and agricultural production of the farmers in ten-year time.

Further, the study has shown that category A in Cat_AI has the highest number of households in intensification with 83% (30 out of 36). Category B has 69% of households in intensification (121 out of 175) and category C has almost 47% (23 out of 49) in intensification. This result suggests that agricultural intensification is more viable to category A households followed with category B and C consecutively. Hence, farmers' socio-economic condition is important to understand his or her viability to intensification. Raut et al. (2011c) argued that factors such as higher income, large landholding size, irrigation facilities and credits' access have motivated the farmers to adopt agricultural intensification in the watershed. In addition, farmers with less landholding and weak financial status are unlikely to practice the agricultural intensification because it required initial investments and irrigation facilities (Dahal et al. 2009). Hence, C

category farmers of the watershed were mainly dependent upon the traditional cereal based farming and worked for the bigger farmers to gain extra income.

The result further infers that the watershed experienced the remarkable rise of middle-income families (with about 67 % of the category B farmers as per Cat_AI) due to medium level of NYAI (average 1,20,347 NPR) in ten-year time. Meanwhile, there has been only 14 % of A category and 19 % of C category farmers. It is thus not straightforward that farmers will always increase NYAI when they are engaged more in intensification since the benefits of intensification are likely to be lost with the increased agricultural expenditures through the excessive use and higher expenditures of inputs, technologies, and labor. Since current intensification practices in the watershed have been relying upon the use of maximum inputs, specifically chemical fertilizers and pesticides (Raut et al. 2011a) and increased labor costs, this is thus likely to impact upon the farmers' income and socio-economic conditions. However, all the households irrespective of doing intensification or not might be benefitted by increased agricultural employment opportunities due to intensification. As per our study, C category farmers in Cat_AI are the major opportunity takers in the watershed as only 47 % of them are the intensification adapters who significantly upgraded their income despite their non-intensification status. However, it is not that farmers undertaking intensification are only in category A and B as per NYAI. Some of the reasons for non-intensification adapters to be in A and B categories (in Cat_AI) are might be because of increased annual agricultural production. Moreover, they might have got fairer prices on the sale of the harvests in the markets, might have invested less in wages labor by making themselves involved, or might have used inputs effectively to maintain their agricultural income and socio-economic position.

Table 3: Categorization of households in intensification and non-intensification along with the households in Cat_AI, Cat_b10, Cat_OF, and percentage of households in intensification

Categories	**HH_Int**	**HH_Nonint**	**CAT_AI**	**Percentage of intensification**	**Cat_b10**	**Cat_OF**
A	30	6	36	83.33	75	42
B	121	54	175	69.14	114	134
C	23	26	49	46.93	71	84

In the qualitative group discussion, farmers stated that they experienced major changes in the socio-economic indicators in ten-year time. For example, changes in household assets was a prominent one. Majority of the farmers stated that change in household assets was because of

the earthquake that occurred before two years which destroyed many of the farmers' houses, agricultural storehouses and barns. However, money obtained from increased foreign and urban jobs despite agricultural income have supported them to maintain their household assets. The decrease of land holdings due to the land division was also a notable pattern in the watershed. Land division among the family members with the separation of family members is another reason for the decrease in landholdings in the watershed (Dahal et al. 2009). The trends of landholdings decrease had occurred in the watershed in earlier decades as well. For example, study from Raut et al. (2011a) also suggested that the watershed experienced the decrease of landholdings from 0.76 ha in 1989 to 0.63 ha to 2009. The decrease in land holdings is an important barrier for farmers in attainment for household livelihood and food security (Thapa & Niroula 2008). Tiwari et al. (2008) argue, the socio-economic conditions of the mid-hills farmers have been largely affected in recent decades by the decrease of farmlands per capita.

Farmers reported that their decrease in landholding status is also linked with the outmigration of young manpower through increased urban and abroad jobs since more than three decades. Increased outmigration has mainly caused labor shortage in the watershed. For instance, Study by Raut et al. (2011a) showed that decreased in household labor in 1999 is associated with the seasonal migration of male to the urban areas. Decreased manpower is thus linked with increased agricultural expenses of the farmers along with the increased rates of daily wages in the watershed. Study from Tiwari et al. (2008) showed that daily wages in the middle mountains region of Nepal have also increased by 50 percent during the last five years. Increased agricultural expenses are thus likely to cut off the benefits of intensification.

In the group discussion, farmers also reported that significant decrease of cattle holding occurred in the watershed ten-year time. The watershed had experience of decreased livestock before some decades as well. Study from Raut et al. (2011a) showed that "livestock numbers decreased significantly from 1989 to 2009 in the watershed. For example, the average of 1.37 LSU (Livestock Standard Unit) in 1989 decreased to 1.07 LSU in 2009". Farmers perceived that cattle holdings' decrease in the watershed is associated with the decreased availability of fodder, increased animal feed prices and decreased manpower to take care of the cattle. The implication is that they have less farmyard manure to use in their farms and decreased livestock income from the sales of dairy products.

The decrease of A category households and the increase of B and C category households in Cat_ OF is thus considered to be associated with decreased landholdings, decreased household assets, decreased cattle holdings in the watershed. The degraded conditions of these socio-economic indicators thus negatively impacted the agricultural income and socio-economic conditions of the farmers. Hence, policy and institutional reforms are likely to be necessary to upgrade the status of socio-economic indicators in the watershed.

Changes in the Status of Intensification Indicators in Ten-year Period

This section deals with the changes in the status of intensification indicators in the watershed in ten-year time. Since NYAI is assumed to be influenced by the changes in crop types, cost and use of farm inputs, markets, infrastructures, subsidies, technologies' use, labor costs, quality of soil, agricultural production, women's position and sale of the harvests. This study thus seeks to understand how NYAI is influenced by the ongoing changes in the above-indicated intensification indicators. As an example, the change in the cultivation of certain crop types is likely to increase NYAI of the farmers. Study of Tiwari et al. (2008) showed that cultivation of vegetable crops offered higher income than the cultivation of cereal crops in middle mountainous region of Nepal.

It is quite important to understand the major determinants of agricultural intensification in the watershed. Understanding determinants at different scales help us to gain context-specific knowledge and solutions to address the complexities of intensification activities. In a global scale, increased crops cultivations, increase labor use, change in technologies, fertilizers, improved seeds, modern machinery, irrigation, and multi-cropping are considered to be major the determinants of agricultural intensification (Carswell 1997). Moreover, Dahal et al. (2008) identified that high-value crops (in terms of market value and production), fertilizers, cropping patterns, road access, irrigation, inputs, and institutions are some of the major determinants of intensification in Nepal. Similarly, Raut et al. (2011c) suggested that the changes in cropping patterns, fertilizer use, farmyard manure use, distance to markets, irrigation, mechanization, and institutions mainly indicated the changes in the intensification indicators in the watershed. This study focuses mainly on the changes in cropping patterns, crop types, fertilizers use, technologies, manpower, markets, infrastructures, subsidies, agricultural problems, soil fertility, land degradation and women's position in ten-year time.

The benefits of intensification are assumed to be largely influenced by the changing status of intensification indicators. On one hand, better availability and access of the roads, markets,

infrastructures, farm machinery, technologies, manpower, subsidies and improved women's status are likely to enhance the socio-economic conditions of the farmers through increased production and increased agricultural income. For example, the commercial production of agricultural goods, agribusiness, and its distributions are likely to be supported by the access to roads (Dahal et al. 2008). In addition, the use of modern machinery helps farmers to utilize the available lands more effectively (Raut et al. 2011c) thereby facilitating for improved production and income. Apart from this, the process of mechanization is likely to bring significant positive changes in the farming system as well (Raut et al. 2011a).

On the other hand, excessive chemical fertilizers use, poor infrastructures, decreased annual production, soil quality declination, unfair markets influenced by middlemen, crops with lesser economic value, crops requiring higher inputs, higher costs of inputs, manpower crisis, gender biased agricultural decision making, lesser access of technologies and subsidies are likely to degrade the socio-economic conditions of the farmers thereby decreasing NYAI of the farmers. For example, unfair markets have become an important problem for the farmers of Nepal. Studyby Pokhrel (2010) revealed that middlemen were undervaluing farmers' products by paying lower price thereby creating an unfair situation. This cartel system existed in many areas of Nepal since most of the farmers are poor, less educated and powerless in general.

Soil quality is assumed to be a prominent issue for the farmers. In intensified farms, the challenges of soil quality maintenance remain much higher. For example, Dahal et al. (2009) suggested that cultivation of three crops from two crops remarkably increased soil erosion and nutrient loss thereby decreasing production in the watershed. Hence, promotion of soil quality is considered crucial for maintenance of higher agricultural income in the watershed. This is because NYAI is assumed to be reduced by the decreased agricultural production through poor soil quality. In this context, understanding the changes in the intensification indicators is quite important as this tends to reveal the quality of ongoing agricultural practices and benefits of intensification in the watershed.

Since the households from the watershed are distributed from the highlands to lowlands, they are likely to have the different status of availability and access to many of the intensification indicators. For example, access to infrastructures, training, and markets are generally more in lowland areas than in upland areas. Also, intensification indicators such as technologies, machinery, and irrigation are likely to be influenced by the financial capacity of the farmers

and lands available to them. For instance, access to technologies is largely dependent upon the type of cultivable land and the financial status of the farmers (Raut et al. 2011c).

In group discussion session, farmers from the lowlands specifically stated that there has been an increase in agricultural technologies, training, infrastructures and markets opportunities than the farmers in the upland areas in ten-year time. Further, C category farmers stated that they have lower potential in using technologies and inputs because of their weak financial status in comparison to B and A category households. This might be because technologies' and agricultural inputs' affordability are likely to depend upon the farmers' financial conditions and his or her ability to access credits and get financial support. Adugna (1997) argues that farmer without cash and no access to credit had difficulty to use modern technologies whereas farmers with credits access showed greater willingness to buy the agricultural inputs (Raut et al. 2011c).

In the group discussion, farmers perceived that soil quality loss is another major issue of the watershed. Tiwari et al. (2008) argue, increased intensification practices specifically vegetable cultivation caused soil quality loss and higher nutrient loss, unlike cereal production. Farmers perceived that their farms' soil has been heavily deteriorated because of the extensive use of agrochemicals. They also stated that excessive use of agrochemicals and pesticides is diminishing the soil productivity. Hence, they had greater willingness to check the soil quality of their farms. Further, they revealed that their dependence on chemicals has significantly increased with the increased vegetable cultivations, specifically potato. Study from Brown and Shrestha (2000) also suggested that commercial vegetable production, specifically potato in Nepal is linked with the increased demands of nutrients and excessive reliance of farmers on chemical fertilizers..

Farmers also stated that water scarcity has emerged as a major issue for decreased agricultural production in the watershed in recent years. Some of the farmers expressed that water scarcity is associated with the huge earthquake which dried out many local water sources. Hence, increased water scarcity is likely to degrade the farm production in the watershed thereby bringing subsequent loss to the farming economy. Merz et al. (2003) argue that water shortage situation is likely to affect the production of crops like potato, wheat and many other cash crops like tomato. Apart from this, increased intensification practices in the watershed are likely to require more water in coming days and likely to create the possibility of bigger water scarcity. Merz et al. (2003) argue that increased intensification activities tend to reduce the available

water resources. Further, increased water scarcity is likely to negatively impact the intensification activities in the watershed and farmers' agricultural income.

Agricultural intensification is believed to be strongly facilitated by the presence of extension services. Thapa and Rattanasuteerakul (2011) argue that extension services enable the farmers to use new agricultural technologies. In a group discussion, farmers reported that there is no considerable presence of extension services that provide guidance and advice to them. Raut et al. (2010) also argue that extension services were quite ineffective in the watershed. Consequently, they have experienced many farm-related problems. However, farmers stated training opportunities have increased in recent years specifically in the lowland areas. For example, farmers from Mahadevsthan reported that they have increased training opportunities such as Integrated Pest Management (IPM) and vegetable production organized mainly by Non-Governmental Organizations. Agricultural training tends to help farmers to perform better agricultural practices. For example, IPM was considered effective to control the pests (Neupane 2003) and supports for higher agricultural production. Farmers perceived that IPM training has helped them to take proper inputs use decisions, spray pesticides safely, make bio-pesticides and get other technical advices. Tiwari et al. (2008) argue, adoption of IPM training has increased farmers' capacity in vegetable production through the utilization of better quality and quantity of compost. This is likely to be an important reason that favored better agricultural production for lowlands farmers.

Changes in the Status of Agricultural productivity, Manpower, Markets and Access to Agricultural Technologies

Agricultural productivity is one of the major determinants of NYAI. It is thus important to understand the changing status of agricultural productivity. In figure 5, CAP refers to the change in agricultural production in the watershed in ten-year time. The results in CAP suggests that 87 % of the farming households have mixed perception of both increase and decrease of agricultural production whereas only 13% of them have the perception of unchanged status. The implication of this result is that farming in the watershed has undergone through continuous fluctuations in the agricultural productivity. This change in annual agricultural production is thus reflecting the subsequent change in NYAI and socio-economic conditions of the farmers. Moreover, the reason behind the higher concentration of the families in category B in Cat_AI might be associated with the medium level of production outcomes in the watershed.

Since agricultural production is one important determinant of farmers' income and socio-economic indicators. Raut et al. (2011b) argue, socio-economic conditions and food security status could deteriorate if agricultural productivity does not improve. Moreover, decreased agricultural production with problems of water scarcity and soil quality loss in the watershed is likely to impact upon the benefits of intensification in the watershed. Hence, Raut et al. (2011b) argue that soil being the basic determinant of improved agricultural harvests, it is important to consider the integrated pest and nutrient management in the watershed.

In the group discussion, farmers stated that they are satisfied with the agricultural production outcomes in ten-year time and reported that their overall agricultural production has increased in ten-year time. However, their major anxiety was that the increased harvests from their farms are associated with the increased use of chemical fertilizers and labor costs increased agricultural investment costs which have reduced the net profits of agriculture. Further, they perceived that increased soil demands of agrochemicals specifically in potato farming has reduced the net profits from agriculture. Hence, existing intensification practices on the increased reliance on chemical fertilizers are likely to diminish the farm sustainability in the watershed. Tiwari et al. (2008) argue, intensified farming practices, specifically vegetable cultivations, dependent on the excessive use of chemical fertilizers, hybrid seeds and other external inputs are likely to threaten the sustainability of the farming system.

Markets are important facilitators of agricultural intensification. Smith et al. (1994) argue that improved access to markets is likely to enable the intensification process. Majority of the farmers in the watershed are thus engaged in market-focused production even though they possessed fewer landholdings (Raut et al. 2011c). For example, 47 percent of the C category farmers are found to be undertaking intensified farming in the watershed. Dixon et al. (2001) argue, increased market access favors the intensification practices thereby making farmers produce vegetables. Hence, markets are considered important to influence the benefits of intensification in the watershed. In addition, improved local markets are likely to help farmers to sell their agricultural harvests on time, buy seeds and necessary inputs whenever needed. It also provides substantial agricultural income and intensification undertaking opportunities for farmers. In addition, the closer distance to the markets from households is also considered beneficial for farmers. For example, smaller distance to local retail shops makes farmers buy necessary chemical fertilizers and pesticides easily thereby increasing the opportunities to take part in intensified farming (Raut et al. 2011c).

As shown in figure 5, CM refers to the change in the local market status in ten-year time. Three numbers have been assigned among which 1 represents better local market status, 2 represents bad local markets and 3 denotes that local market conditions are same in ten years. The result suggests that 79% of the farmers (205 out of 260) have reported the increase of local market status in the watershed. In a group discussion, farmers reported that improved infrastructures and markets in the watershed have provided good opportunities for them to sell their harvests in the markets. Raut et al. (2011a) argue, farmers need better access to roads and markets to sell their agricultural harvests and to buy necessary inputs to engage in intensification. Moreover, good markets and infrastructures tend to increase the benefits of intensification thereby raising farmers' socio-economic conditions. Dahal et al. (2008) argue, the benefits of intensification and farmers' economic conditions tend to improve both with higher agricultural production and good market prices of the harvests.

In the group discussion session, all the participants perceived the increase of local market opportunities in a decade time. Moreover, increased local markets have helped them to take part in intensification as it offered necessary equipment, accessories, tools, and seeds buying opportunities. However, they are quite dissatisfied with the urban markets where middlemen largely influence in decreasing the market price of their agricultural products. Koirala et al. (1995) indicated that farmers in Nepal faced problems of unfair sales prices, poor access to marketing support services and policy constraints on agricultural marketing.

CMP in figure 5 denotes the change in the status of manpower in ten years- time. Understanding the status of the manpower is important because it tends to impact the agricultural costs and efficiency of farmers to timely perform the agricultural activities. Less availability of agricultural manpower tends to increase the agricultural wages thereby increasing agricultural costs. Similarly, delay in agricultural activities with less manpower availability tends to hamper the overall agricultural production and thus NYAI of the farmers. CMP has been assigned by three numbers 1, 2 and 3 which represents an increase, decrease and unchanged status of manpower in ten-year consecutively. Responses from farmers show that more than 96% of the farmers have reported decreased in manpower status (having a higher frequency in 2) whereas very fewer farmers have experienced an increase of manpower status in ten years. This decreased manpower status is likely to influence the process of intensification in the watershed. Raut et al. (2011c) argue that insufficient labor obscures the intensification process. This result has implications on changing socio-economic status of the farmers as category A households

have been fallen in ten-year time which might be related to the decreased manpower. This is because decreased manpower tends to increase the agricultural investment costs through increased labor costs.

In qualitative interview session, farmers revealed that insufficient agricultural manpower has greatly hampered their agricultural activities in recent years. They had thus big worries that they will not have young people to work on farms after ten years. This is because the aging population is being increased and agricultural activities are being affected in the watershed. Further, this condition has shifted the division of labor in the watershed as most of the agricultural responsibilities including the plowing of farms have been transferred to women from men in the watershed.

CAT in figure 5 refers to the change in the status of agricultural technologies. It has been assigned to three numbers where 1 represents an increase of agricultural technologies, 2 represents decrease and 3 represents that the conditions have not been changed in ten-year time. The results suggest that about 73 percent of farmers (190 out of 260) have reported the increase of agricultural technologies in ten-year time. Increased agricultural technologies are assumed to boost the efficiency of farming activities thereby facilitating agricultural intensification. Smith et al. (1994) argue that availability of appropriate technologies tends to increase the speed of the intensification. It is also important to understand the association of an increase in agricultural technologies and farmers' improvement in socio-economic conditions through increased NYAI. For instance, replacement of manual works by the machinery and technologies tend to save both the manual wage costs and time for agricultural production. Dahal et al. (2009) argue that the use of recent technologies in the watershed has made the agricultural tasks easier and effective. In addition, use of mechanized threshing is likely to save the farm labor (Carswell 1997). Nonetheless, hand threshers are only in use in the watershed and lack modern agricultural technologies.

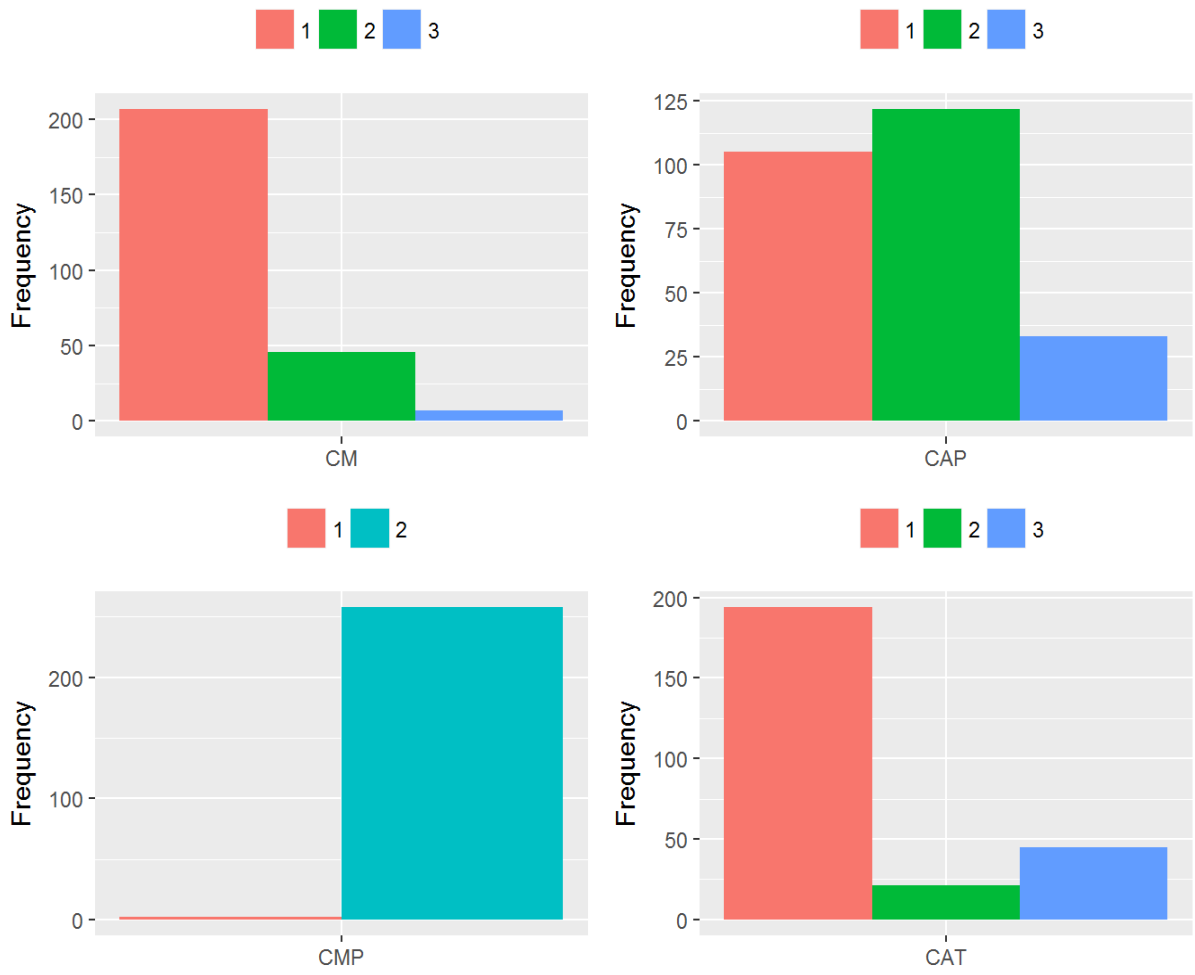


Figure 5: CM representing the trend of change in the status of market, CAP representing the change in the status of agricultural production, CMP represents the change in the status of manpower and CAT representing the change in the status of agricultural technologies in ten-year time

Changes in the Status of Agricultural Infrastructures, Agricultural Problems, Subsidies and Women's Position in Ten Year Time

Agricultural infrastructures are considered important facilitators for agricultural intensification. This is because better infrastructures tend to enhance the benefits of intensification. Agricultural infrastructures include mainly the roads, transport facilities, irrigation facilities, stores and farmhouses that facilitate intensification activity. Smith et al. (1994) argue that improved infrastructures enable the farmers' access of markets thereby reducing the costs of production and improving farm products' sales. In the watershed, the increment of new roads and infrastructures have thus encouraged the intensification activity (Raut et al. 2011a).

Irrigation is an important agricultural infrastructure which favors agricultural intensification. Dahal et al. (2009) argue that irrigation is a major facilitator of intensified farming in the watershed. Presence of irrigation facilities is likely to enhance the farm production thereby helping farmers to increase their income. It also helps farmers to grow more number of crops annually unlike rain-fed agriculture. Carswell (1997) argues, irrigation or better water management is crucial to enhance agricultural production of the farmers. For example, irrigation facilities have increased the crop rotations in Nepal from an average of 1.3 to 2.6 crops per annum (Shrestha & Brown 1995). The establishment of an irrigation canal in the watershed have thus motivated the farmers to adopt three crops in a year (Raut et al. 2011c).

CINS in figure 6 represents the change in the status of agricultural infrastructures in ten-year time. To understand the change, 1, 2 and 3 have been allocated for the increase, decrease and unchanged status of agricultural infrastructures consecutively. The result in CINS suggests that about 59 percent of farmers have reported an increase of agricultural infrastructures in ten-year time. Moreover, increased agricultural infrastructures are likely to help farmers to actively engage in intensification activity.

CAPRO in figure 6 represents the change in the status of agricultural problems in ten-year time. The status of change in agricultural problems have been assigned three numbers in which 1 represents an increase of agricultural problems, 2 represents decrease and 3 represents that the conditions have not been changed. The results in CAPRO suggests that about 60 percent of the farmers have responded the increase of agricultural problems in ten-year time. In a qualitative group discussion, farmers reported that the agricultural problems have increased in the watershed. They revealed that decreased manpower, water shortage, middlemen influence, high input costs, soil infertility and pests are some of the serious issues of the watershed. For instance, despite the increased production, farmers are liable to sell their products at poor prices because of the unfair market conditions. Pokhrel and Thapa (2007) make the point that middlemen are like parasites who tend to take the advantage of farmers' weak bargaining power and cheats them.

Farmers also stated that water scarcity is a major issue for the farmers in the watershed. They also consider that the need for water has increased due to the intensification activity. For example, farmers' cultivation of potato is one of the important reason for their increased necessity of water. Although potatoes have higher market demands, it required more water than regular crops which needed better irrigation facility in the watershed. Hence, with the

assistance of an NGO, farmers from lowlands had expanded and improved the irrigation facility in the watershed by putting up stone constructions at the inlets and along the canals (Raut et al. 2011a). Nonetheless, the uplands areas have very lower irrigation potential in comparison to the lowlands which has brought higher production risks to upland farmers with the increased water scarcity problems in recent years. The issues mentioned above are considered influential in decreasing the annual agricultural production and NYAI of the farmers in the watershed. Benefits of intensification are thus likely to be affected by these issues and thus has reduced the number of categories A farmers in the watershed.

An agricultural subsidy is likely to be promoting the benefits of intensification because it tends to save farmers' agricultural costs. It is generally provided by the state government to the farmers. In Nepal, the subsidy was provided initially in chemical fertilizers by the government which later had the negative impact of the substantial increase of fertilizers using trend (Raut et al. 2011a). CSUB in figure 6 represents the change in the status of agricultural subsidies in ten-year time. Four different values 1,2,3 and 4 are provided for an increase of subsidies, decrease, unchanged and don't know consecutively. The result in CSUB suggests that around 62 percent of the farmers have reported that there has not been any change in the status of subsidies in ten-year time. However, 29 percent of the farmers (around 75) are experiencing the increase of the subsidies in ten-year time. As per the qualitative interview, farmers stated that they are experiencing a minor increase of subsidies mainly on buying chemical fertilizers, seeds, and technologies like hand driven tractors. However, Dahal et al. (2009) argue that through use of hand-driven tractor has made the farmers work easier but productivity and income increase might not be necessarily associated with its use.

The watershed had significant differences in the gender division of labor since a long time (Raut et al. 2011c). It is thus important to understand how the status of women remain changed because this helps to know how gender influences the benefits of intensification in the watershed. Three different numbers 1, 2, and 3 have been provided for the increase, decrease and unchanged status in women's position respectively. The result in CWP shows that about 63% of farmers (163 out of 260) have reported of an increase in women's position in decision making in ten-year time. Studies from Raya (2013) also showed that women's participation in decision making has increased in recent years in the watershed. Moreover, increased awareness and access to education have been considered beneficial for enhancing the women's status in

the watershed. Nonetheless, a considerable number of farmers (around 100 in 260) are experiencing the decrease of women's position in decision making in ten-year time.

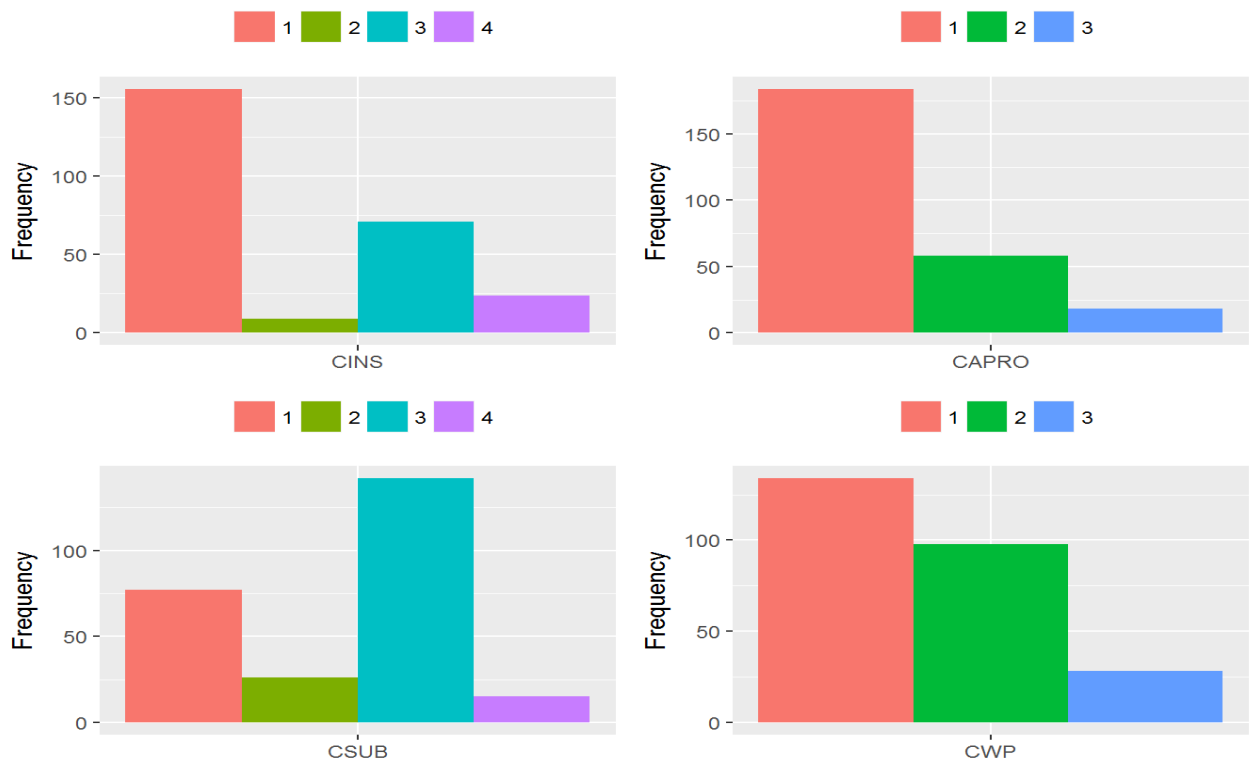


Figure 6: CINS representing the trend of change in the status of insurances, CAPRO representing the change in the status of agricultural problems, CSUB represents the change in the status of subsidies and CWP representing the change in the status of women's position in ten-year time

Changes in The Use of Chemical Fertilizers and Farm Yard Manure

Agricultural activities in the watershed are considered to have relied on the excessive use of chemical fertilizers. In figure 7 below, HCF represents the change in the status of chemical fertilizers in ten-year time in which 0 represent unchanged status, 1 represents an increase and 2 represents decrease status. The result suggests that about 69 percent of the farmers (180 out of 260) have stated that they are using more chemical fertilizers in the ten-year time given through higher value of 1. Raut et al. (2011c) argue that chemical fertilizers use has been increased in the watershed specifically with the cultivation of the cash crops like potato, bitter gourd, and tomato. Moreover, intensification practices in the watershed promoted the use of increased chemical fertilizers as potatoes and tomatoes require a higher level of N (Nitrogen) and Phosphorous pentoxide (Dahal et al. 2009). Hence, the continuous use of chemical

fertilizer has appeared as a big problem in the intensified farms as it is likely to cause the acidification of the soil (Raut et al. 2011a). Nonetheless, farmers need to use considerable amounts of agrochemicals in order to improve their yields (Dahal et al. 2008). Further, increased chemical fertilizers pose serious risks to both human and environment. Since chemical fertilizers applied in the farms flows with the rainwater and reaches to nearby water sources (Dahal et al. 2009). It is harmful to the nearby communities and aquatic ecosystems as well. Hence, it is important for farmers to limit the use of chemical fertilizers to promote sustainable agricultural production and to minimize the negative outcomes from intensified agriculture.

HFY in figure 7 represents the change in the status of farmyard manure in ten-year time in which 0 represented unchanged status, 1 represented increased and 2 for decreased use status. The result suggests that 68 percent of the farmers (177 out of 260) have responded that they are using less farmyard manure in the ten-year time given through higher value in 2. Similarly, in boxplot (Figure 7), PCCF represents the percentage change in chemical fertilizers and PCFY represents the percentage change in farmyard manure among the households in a ten-year period. The result suggests that majority of the households have increased the use of chemical fertilizers since more than 75 percent of the value lies above 0. This trend is quite similar to the earlier trends observed by the previous researchers. For instance, Studyby Raut et al. (2011a) also showed that there has been a significant increase in average amount of urea use from 1989 to 2009 in the watershed. For example, the majority of farmers in the watershed specifically used N (Nitrogen), P (Phosphorus) and K (Potassium) fertilizers excessively.

The result in PCFY infers that majority of the households have reduced the use of farm manure as most of the values lies below 0. Hence, it can be observed that there has been a substantial increase in the use of chemical fertilizers and decrease in the use of farmyard manure in ten years. This trend is likely to push the farming practices into unsustainable direction thereby exacerbating the side effects. Study from Tiwari et al. (2008) suggested that increased labor costs for the production of FYM has subsequently decreased its use in the middle mountainous region of Nepal. This trend of decreased farm manure use is likely to degrade the soil quality of the farms thereby influencing annual agricultural production and thus NYAI of the farmers. Dougill et al. (2001) argue, reduced use of farmyard manure and lack of soil nutrients ultimately impacts the livelihood of the farmers through decreased production and farm income.

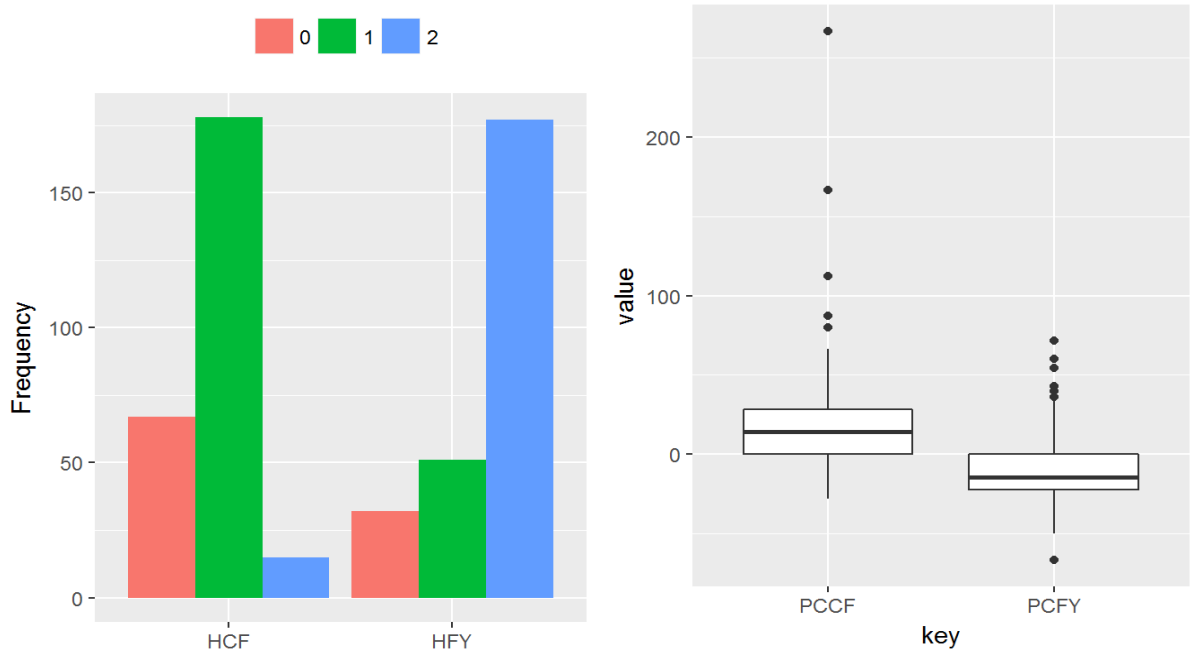


Figure 7 HCF representing households' chemical fertilizer use trend and HFY representing households' farmyard manure use trend in which 0 means unchanged in use responses, 1 means increase in use and 2 represents decrease in use responses, PCCF representing percentage change in households' chemical fertilizer use trend and PCFY representing percentage change in households' farmyard manure use trend

Reasons for the Changes in Chemical Fertilizers and Farm Yard Manure

Changing trend in the use of chemical fertilizers and farmyard manure in ten-year time is considered to have been influenced by a number of reasons. Some of the major reasons farmers reported regarding the change in the use of chemical fertilizers are as follows:

1. To increase production
2. Soil demand of CF
3. Awareness about side effects and high CF costs
4. Everywhere practice
5. Non-applicable because of unchanged CF use status

Explained through figure 8 (in RCCF), among these five reasons, around 41% of the farmers (108 out of 260) responded that their increased use of chemical fertilizer is associated with the soil demands for chemical fertilizers, given through higher value in 2. Similarly, 20% of the farmers (53 out of 260) reported that increased chemical fertilizer use is associated with the need to increase production given through value in 1. Nonetheless, around 33% of the farmers

have unchanged or decreased the use of chemical fertilizer because they stated that chemical fertilizers have higher costs and they have been aware of the side effects of agrochemicals. Raut et al. (2011b) argue, increased use of chemical fertilizers in the watershed has increased the agricultural costs of the farmers. Study from Brown and Kennedy (2005) also showed that the use of chemical fertilizers is more than doubled in the irrigated farms in other countries as well in between 1994 to 2004. Moreover, with the increased trend of using chemical fertilizers, annual agricultural costs are considered to have been increased thereby impacting socio-economic conditions of the farmers.

In the qualitative group discussion, farmers stated that the prices of chemical fertilizers have exponentially increased in ten-year time thereby impacting NYAI of the farmers. One of the major reason for the decrease of category A households might be associated with the increased chemical fertilizers' use and subsequent costs in ten-year time. Hence, households using more chemical fertilizers are likely to hold more agricultural expenses in the watershed.

Similarly, the reasons that explain the changes in the use of farmyard manure as experienced by farmers are as follows:

1. Decreased livestock number and increased chemical fertilizer dependency
2. Higher availability, lower price
3. Awareness, manure good for soil health
4. High price of chemical fertilizers
5. Non-applicable because of unchanged HFY status

The result (in RCFY) suggests that around 60 % of the farmers (156 out of 260) have reported that their decreased use of farm yard manure is related with the decreased livestock number and increased chemical fertilizer dependency, expressed through higher value in 1. Nonetheless, 27% of the farmers (70 out of 260) who have the increased and unchanged status of farmyard manure use in ten- year time was because that they are aware that farmyard manure is good for soil health given through value 3.

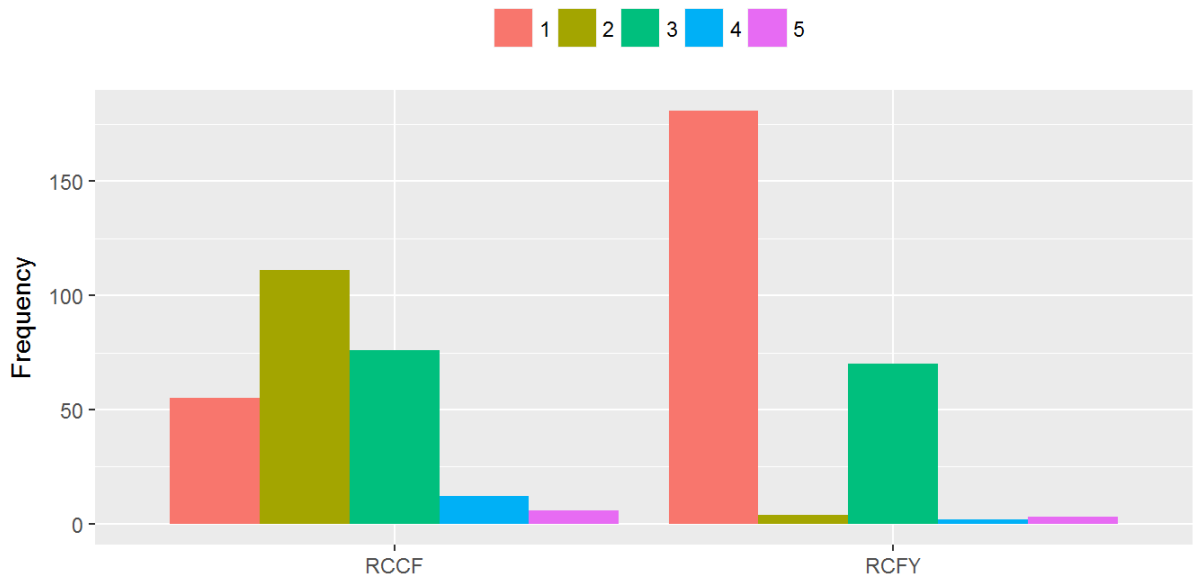


Figure 8: RCCF representing five major reasons farmers reported regarding the change in households' chemical fertilizer use trend and RCFY representing five major reasons for the change in households' farmyard manure use trend as per farmers in ten-year time

Changes in Soil Fertility, Land Degradation, and Soil Erosion along with the Specific Reasons in Ten-Year Time

In Figure 9, CSF represents a change in soil fertility in ten-year time. The result suggests that around two-third of the farmers (175 out of 260) have reported the decrease of soil fertility in ten years-time. Since decreased soil fertility is likely to diminish the annual agricultural production of the farms and thus NYAI of the farmers. Hence, soil fertility declination is likely to be the major reason for socio-economic conditions change among the farmers in the watershed. Raut et al. (2011b) also suggested that soil erosion, nutrient depletion, and soil acidification have been remarkably increased in the mid-hills.

RCSF denotes the reasons behind the changes in the soil fertility. Following reasons (from 1 to 5) are reported by the farmers on the changing trend of soil fertility in ten- year time which includes:

1. Extensive chemical fertilizers use
2. Cultivation of more crops
3. Balance use of chemical fertilizers and farmyard manure
4. Pests and water shortage
5. Non – applicable because of unchanged soil fertility status

The result in RCSF shows that 38 percent of the farmers (99 out of 260) have reported that pests and water shortage is mainly associated with the decrease in soil fertility. Moreover, 31% of the farmers have reported extensive chemical fertilizer use is associated with the decrease of soil fertility in ten-year time. However, 15% of the farmers who responded the increase of the soil fertility reports the reason being the balanced use of chemical fertilizers and farmyard manure.

Soil fertility needs to be maintained in order to meet the basic food and resource needs of Nepal's increasing population (Brown et al. 1999). Maintenance of soil fertility is also crucial for better socio-economic results of intensification. It is thus important for farmers to have better soil fertility but less chemical fertilizer dependence. However, the general trend is quite opposite in the watershed which is likely to cut off the intensification benefits to the farmers. Tiwari et al. (2008) argue, the increased reliance on chemical fertilizers and decreased applications of farmyard manure in vegetable-based farming indicate the low level of sustainability in middle mountains region of Nepal. Further, farmers are using more pesticides to reduce the problem of pests which has long-term negative implications upon the soil and human health. Shrestha and Neupane (2002) argue, farmers, apply pesticides in a regular manner without considering the waiting period in many areas of Nepal thereby harming human health and environment. Nonetheless, this study has not looked over the pesticides use trend in the watershed.

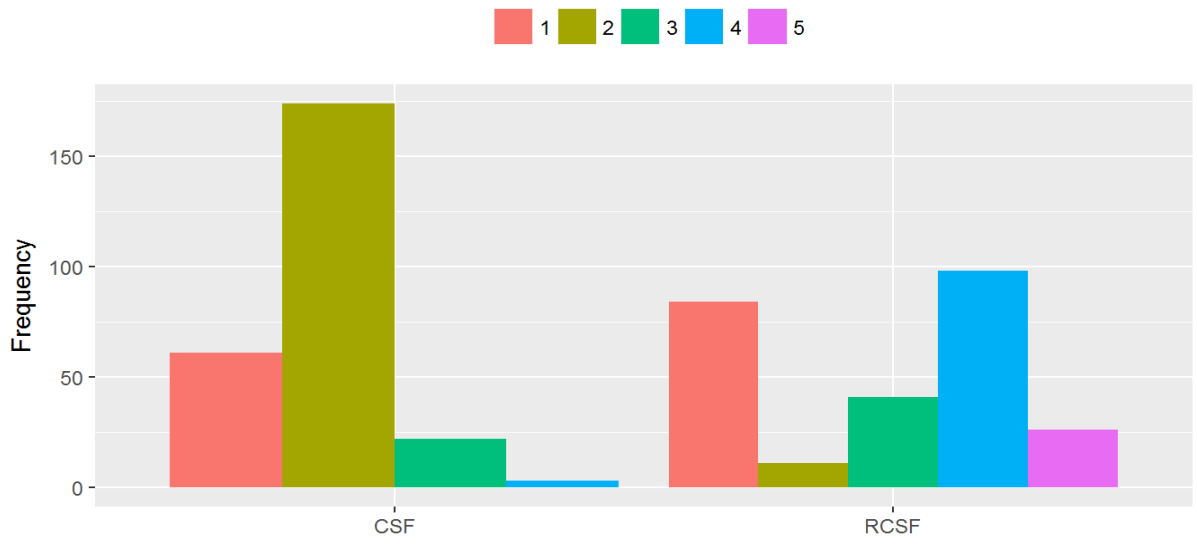


Figure 9: CSF representing the trend of change in soil fertility in which 1 represents increase response, 2 represents decrease, 3 represents unchanged status and 4 doesn't

know response AND RCSF representing five major reasons (given above) for the change in soil fertility trend in ten-year time

In figure 10 below, CLD represents a change in the status of land degradation in ten years. The results in CLD suggests that 42 percent of the farmers (110 out of 260) have reported the increase of land degradation, given through the higher frequency in 1.

RCLD seeks the reasons behind the changes in the soil fertility. The following reasons were reported by farmers that explained the change in land degradation in ten-year time:

1. More tillage and more crops
2. Natural disaster (floods, earthquake, dryness)
3. Massive rainfall
4. better water drainage in farms and grass cultivation
5. Non-applicable because of unchanged land degradation status

The result suggests that 29 percent of the farmers (75 out of 260) have reported that the reason for land degradation is attributed to more tillage activities and more crops cultivation given by value in 1. Karkee (2004) makes the point that excessive use of chemical fertilizers and intensified practices in Nepal without rotational tillage have increased the biological land degradation thereby decreasing the productivity of soils. Further, he identifies that farming on steep slopes has added the risks of land degradation in Nepal. Decreased soil productivity led through increased land degradation is likely to reduce farmers' NYAI and their socio-economic conditions. Likewise, around 39 percent of the farmers in total (101 out of 260) reported that natural disasters mainly earthquake and massive rainfall were also the important reasons behind the land degradation given by 2 and 3. Only small number of the farmers (around 7) who stated that land degradation has remained unchanged or reduced in ten years responded that they have better water drainage and grass cultivation done on their farms.

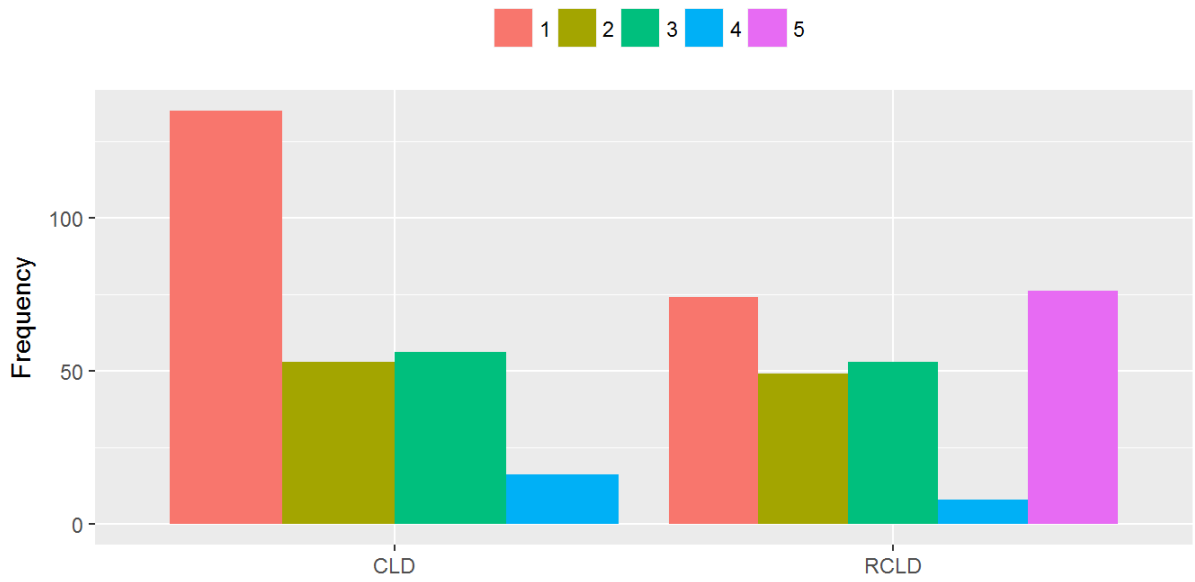


Figure 10: CLD representing the trend of change in land degradation in which 1 means increase responses, 2 means decrease, 3 represents the unchanged status and 4 represents don't know responses and RCLD representing five major reasons for the change in soil fertility trend in ten-year time

In figure 11 below, CSE denotes the change in soil erosion in the watershed in ten-year time. The result suggests that 48 percent of the households (125 out of 260) have reported an increase of soil erosion in ten years. RSE defines the reasons behind the changes in the soil erosion. The following reasons are responded by farmers that explain the change in soil erosion in the watershed:

1. Sloppiness
2. More crops and more tillage
3. less rainfall
4. climate & rainfall uncertainty
5. Non-applicable because of unchanged soil erosion status

The result shows that 31 percent of the farmers (81 out of 260) have reported that more crops and tillage activities have the effect of increased soil erosion in the ten-year time given through value 2. Raut et al. (2010) argue, increased tillage activities are also considered responsible to emit the greenhouse gases such as methane and Nitrous oxide. Further, intensification might be harmful to farmers because of the increased risks of soil degradation through the increased erosion of soils (Raut et al. 2010). Moreover, farmers who responded that soil erosion is being decreased or unchanged had the reason of less rainfall given through value 3. Similarly, a

higher value of 5 in RSE reveals that 76 farmers either do not know if soil erosion has occurred on their farms or do not know the actual reason behind the soil erosion.

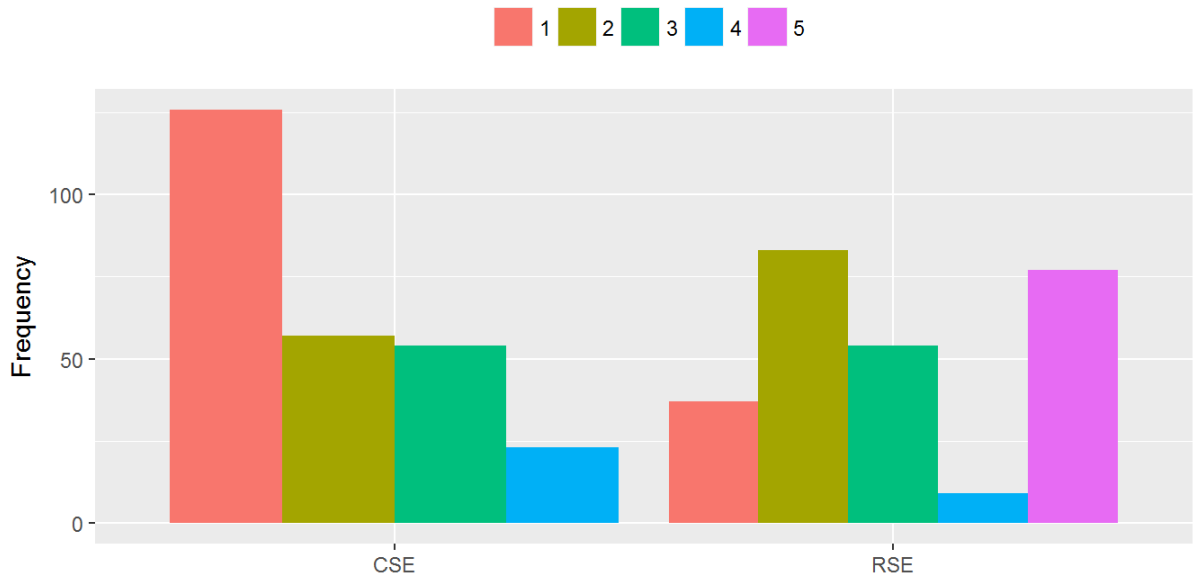


Figure 11: CSE representing the trend of change in soil erosion in which 1 is for increase responses, 2 means decrease, 3 means unchanged and 4 means don't know responses and RSE representing five major reasons for the change in soil erosion trend in ten-year time

Effects of Intensification Indicators on Log of Net Yearly Agricultural Income

Farmers in the watershed have been undertaking both intensified and non-intensified farming practices. In figure 12, HH Non_int represents the households who are undertaking conventional farming practices assigned with value 1 whereas HH_int represents the households undertaking intensification (cultivating at least three crops per year) assigned with value 0. The result in figure 12 suggests that households undertaking intensification have higher NYAI (taken in the log) than households without intensification.

It is also important to recognize the distributions of NYAI among the male and female-headed families. In figure 12, 1 denotes the male-headed households whereas 2 denotes female-headed households. The result suggests that male-headed households are having higher NYAI than female-headed households. The fewer variations in NYAI among the households suggests that there exists significant relationship in between gender and NYAI among the farmers. The implication of the result is that male-headed households are comparatively getting more benefits of intensification than female-headed households. Further, Tiwari et al. (2008) argue, male-headed households are likely to undertake more chances of intensification than female-

headed households. This might be the important reason why NYAI has remained higher among the male-headed households in the watershed.

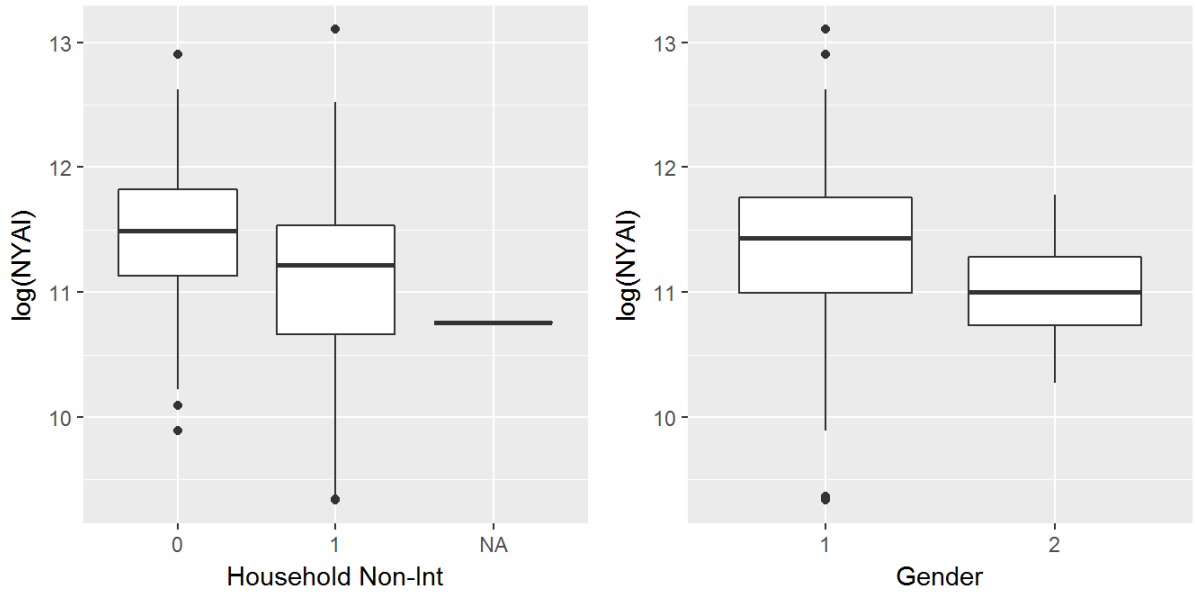


Figure 12: Household Non_int represents households continuing with non-intensified farming in which 0 means households undertaking intensification and 1 means households not undertaking intensification. Similarly, Gender represents both male and female-headed households, 1 representing male headed and 2 for female-headed, and both HH Non_int and Gender are compared with log NYAI

Crop Types and log (NYAI)

It is assumed that cultivation of a certain type of crops is likely to influence the benefits of intensification in the watershed. Since different crops have different market values, inputs requirement, and production potential, it is thus important to recognize which crops remained more profitable to the farmers. In figure 13, numbers 4,6,8,9 and 10 represent different crop types. The result from boxplot in figure 13 suggests that crop 9 has higher NYAI in average followed with 6, 4 and 8. This result suggests that households cultivating two and more vegetables combined with the paddy crops (crop 9) have been offering higher NYAI than all the other crop types of the farmers. For example, vegetable cultivations have thus been significantly supporting farmers through significant income because of the higher market prices of vegetables. Moreover, farmers are likely to do intensive care on their vegetable farming plots along with the use of high yielding varieties and use higher doses of chemical fertilizers unlike traditional cereal cultivation (Tiwari et al. 2008).

After crop 9, the study finds that cultivating potatoes with paddy and tomatoes with paddy provide higher NYAI given by higher value in 6 and 4 respectively. Increased vegetable cultivations have thus been considered profitable for farmers unlike conventional crops in the watershed. Studies from Katwal and Sah (1992) also showed that vegetable farming has enhanced the farmers' income in mid hills of Nepal. Hence, farmers' increased adoption of intensification in the watershed is assumed to be related to the increased income opportunities from vegetable farming. The fewer variations in NYAI among the households suggested that there exists significant relationship in between the CN and NYAI among the farmers. It further implies that benefits of intensification are relatively larger for those male-headed households who cultivate paddy along with two different vegetables (crop 9).

However, massive cultivations of potatoes in monoculture format has challenged the farm sustainability and subsequent income opportunities in the watershed. Intensification without crop diversification is likely to pose serious ecological and social risks as well. Hence, it is important for farmers to cultivate diverse types of crops to maintain farm sustainability. Bhandari and Grant (2007) argue, crop diversification reduces the risks from natural disasters thereby making farmers more adaptive against food scarcity. As potatoes demand more agrochemicals than regular paddy crops, application of chemical fertilizers have thus been substantially increased in the watershed. In addition, cultivation of potatoes has increased the use of pesticides as well. Raut et al. (2011a) argue that intensified farming in the watershed has maximized the use of agrochemicals and pesticides which has both environmental and health effects.

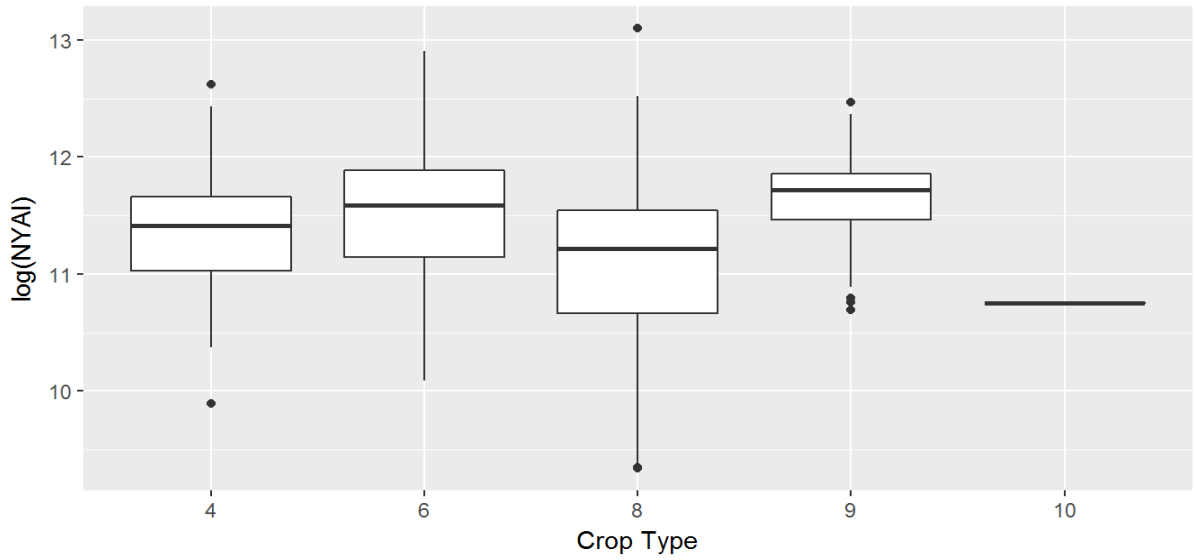


Figure 13: Crop Type compared with log net yearly agricultural income in which 4 represents the households cultivating paddy (rice, wheat, and maize) including potato, 6 represents paddy including tomato, 8 represents the only paddy, 9 represents a combination of paddy and two vegetables (including potato and tomato), 10 is NA.

Effect of CAT, CINS, CSUB, CM and CMP on Log of NYAI

This section looks the effect of changing intensification indicators (agricultural technologies, infrastructures, subsidies, markets, and manpower) on the NYAI among the farmers. These intensification indicators are likely to influence the benefits of intensification and farmers' socio-economic conditions in the watershed. From figure 14 (in CAT), it can be observed that farmers who have responded that they have increased access to agricultural technologies are having higher NYAI given by the higher value of 1 than those with decreased and unchanged status of technologies' use. However, there are larger variations in the NYAI among all types of farmers which reveals that there is no significant relationship in between CAT and NYAI of the farmers. Similarly, the result in (CINS) suggests that farmers who have reported the increased access to infrastructures have slightly higher NYAI than other farmers. However, among the four VDCs of the watershed, Mahadevsthan, lying in the lower part, have better access to roads, markets and other infrastructures in comparison to the villages from upland areas. Hence, they are likely to have higher income opportunities than farmers from other upland areas (Dahal et al. 2009). Looking the relationship in between status of subsidies (CSUB) and NYAI, there has not been many differences in the NYAI among the farmers in the watershed as demonstrated in figure 14. Linking the status of the market (CM) and NYAI in figure 14, the result suggests that there is no significant relationship in between the status of market and NYAI among the farmers. However, farmers who have reported the unchanged status of markets have considerably less NYAI than those other farmers given through lower value in 3.

As group discussion included the farmers from both uplands and lowlands, farmers from upland areas mainly stated that they have relatively fewer changes in the market conditions in comparison to the lowland farmers. This might be one reason why farmers in uplands areas are less benefiting from intensification than the lowlanders. Relating the status of manpower (CMP) and NYAI, the result suggests that farmers who have reported that there has been increased manpower status have higher NYAI than farmers who have reported decreased manpower status. Hence, decreased manpower status can be considered as a major constraint

for farmers thereby influencing the benefits of intensification in the watershed. However, we have very fewer observations in the respondents experiencing increased manpower in ten-year.

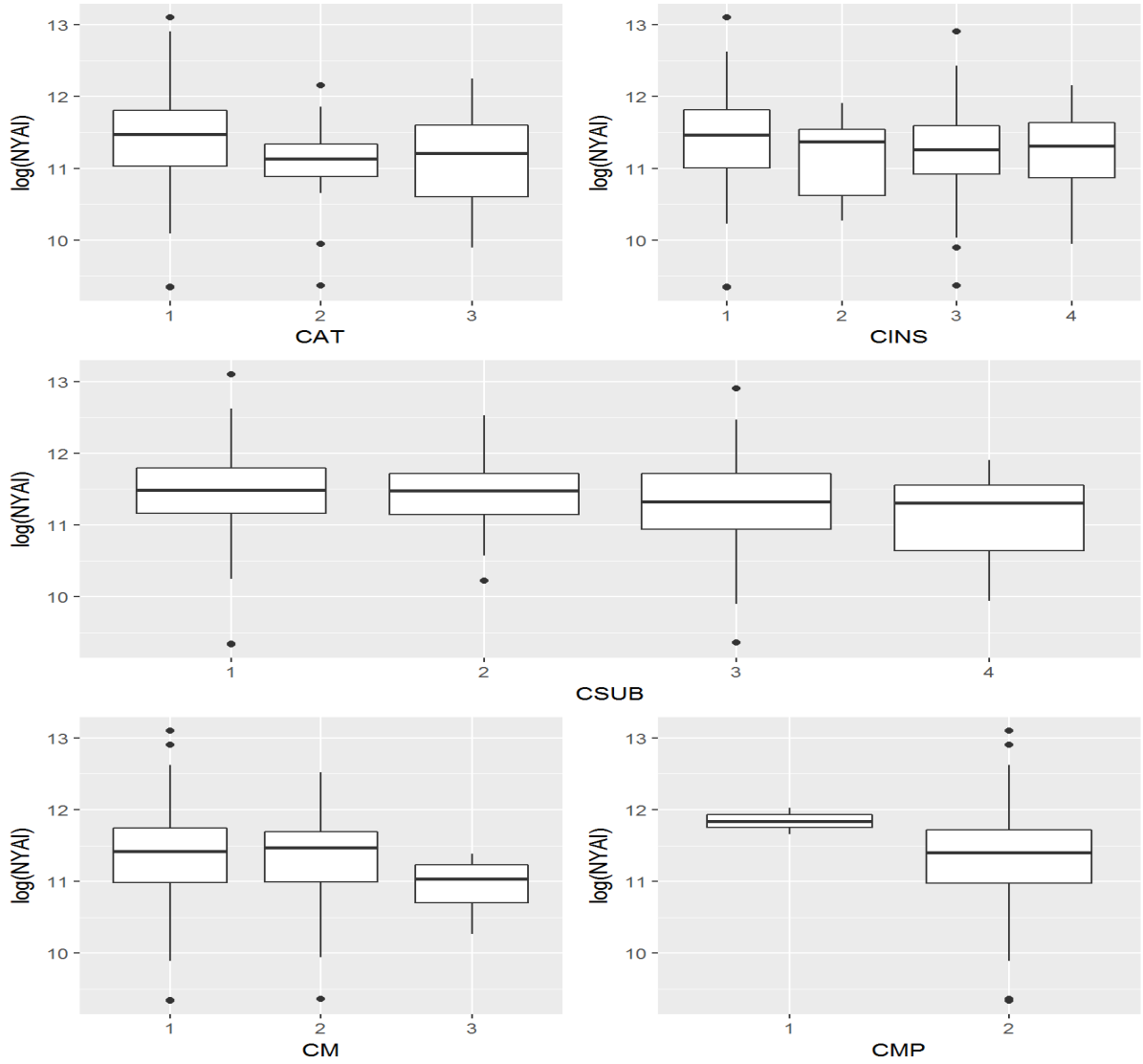


Figure 14: CAT representing the trend of change in the status of agricultural technologies, CINS representing the change in the status of infrastructures, CSUB representing the trend of change in the status of agricultural subsidies, CM representing the trend of change in the status of local markets and CMP representing the trend of change in the status of manpower in ten-year time thereby comparing with log of net yearly agricultural income

Effect of Land Degradation, Soil Erosion, Chemical Fertilizer and Farm Yard Manure use on NYAI

It is important to understand the status of soil quality of the farms because it is a major determinant of agricultural production. Soil quality is specifically defined by the inherent characteristic of soil and its health condition (Karlen et al. 1997). Since the status of soil erosion and land degradation is likely to define the health condition of the soil, it is thus important to examine how changing soil conditions impact the benefits of intensification among the farmers in the watershed. While examining CSE and NYAI in figure 15, it can be observed that there are no big differences in NYAI among the farmers which suggests that there is no significant relationship in between the changing status of soil erosion and NYAI. Nonetheless, farmers who responded the unchanged status of soil erosion had considerable lower NYAI than other farmers. Similarly, linking the relationship in between CLD and NYAI, the result suggests that farmers who have reported increased and unchanged land degradation status in ten-year time have slightly higher NYAI than farmers with the decreased land degradation status. However, substantial variations of the NYAI among the farmers suggests that there exists no significant relationship in between CLD and NYAI among the farmers.

It is also important to find how the changing use of chemical fertilizers and farmyard manure is affecting the NYAI of the farmers. While looking the relationship in between HCF and NYAI, the result suggests that farmers who have increased their use of chemical fertilizer in ten-year have slightly higher NYAI than farmers who have reduced and unchanged status of the use. However, there are larger variations of the income among all the farmers which suggest that there is no significant relationship in between chemical fertilizer use and annual agricultural income among the farmers. With respect to farmyard manure use (HFY) and NYAI, the result shows that farmers who have decreased their use of farm manure have lower NYAI than other farmers. However, there are larger variations of the income among the farmers which suggest that there is no significant relationship in between farmyard manure and NYAI of the farmers.

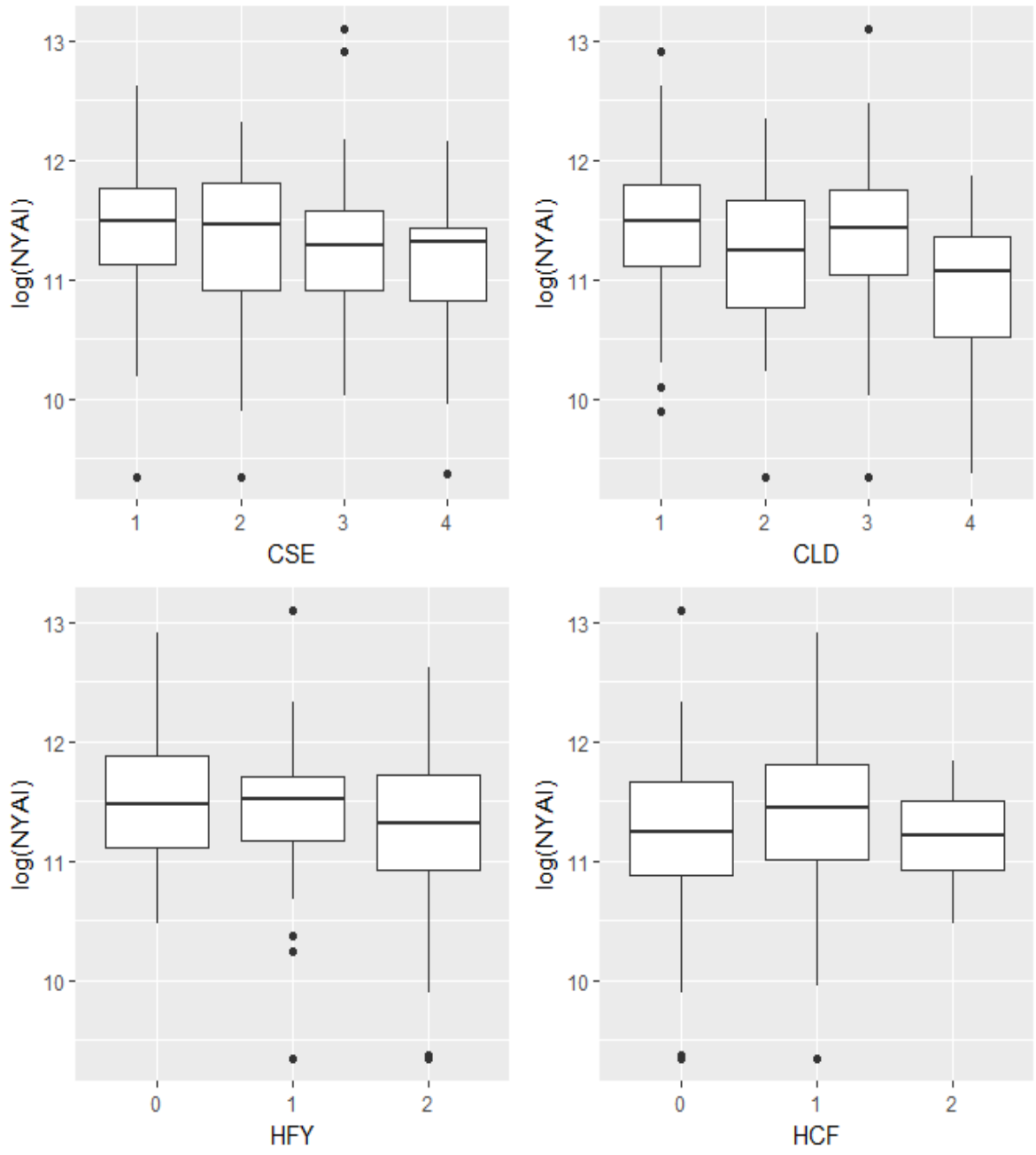


Figure 15: change in soil erosion (CSE) and change in land degradation (CLD) assigned with value 1 for the increase, 2 for the decrease, 3 for unchanged status and 4 for don't know responses and households' farmyard manure use (HFY) and households' chemical fertilizer use trend (HCF) in which 0 has been assigned to unchanged status, 1 for the increase and 2 for decreased status.

Statistical Analysis

Analysis of Variance (ANOVA) test was conducted to understand the effect of major variables on NYAI of the farmers. From table 3, it can be observed that at 5% significance level,

variables (Gender and Crop Types) has a significant effect (with P value less than 0.05) on NYAI. Similarly, at 10% significance level, HCF, HFY, and CAT have significant effect (P value less than 0.1) on NYAI of the farmers. The result implies that Gender and Crop Types has the major impact on NYAI of the farmers.

Through linear model, it is assessed whether the variations in NYAI is explained by this model or not. The R^2 value of 0.17 reveals that 17 percent of the variations in NYAI of the farmers is explained by this model.

Table 4: showing different variables affecting NYAI along with the degrees of freedom (DF), P value and R square

Variables	Degree of Freedom	Sum Squares	Mean Squares	F value	P value
Gender	1	1.63	1.63	5.25	0.0227
Crop Types	4	7.96	1.99	6.38	0.00006
HCF	2	1.53	0.76	2.46	0.0872
HFY	2	1.62	0.81	2.60	0.0758
CAT	2	1.72	0.86	2.76	0.0650
CWP	2	1.26	0.63	2.02	0.1339
Residuals	246	76.68	0.311		

R^2 – 0.17, adjusted R^2 - 0.127

In summary, the study has shown that intensification indicators kept on changing in the watershed thereby influencing the NYAI of the farmers. Among the selected intensification indicators, changes in the crop types and Gender have the most significant effect upon the benefits of intensification in the watershed. This study has also indicated that among the crop types, crop 9 has higher NYAI than other farmers of the watershed. Similarly, male-headed households of the watershed have significantly higher NYAI than the female-headed households of the watershed. It implies that male-headed households who cultivate paddy with two vegetables are taking higher benefits of intensification in the watershed. However, the substantial decline of A category households in the watershed implies that major benefitters are the C category households who engage in wage labors and invest less in agricultural activities. So, apart from cultivating two vegetable crops, male-headed households who worked on others' farms thereby gaining daily wages and invested less in intensification by the minimum use of inputs (mainly CF) are mostly benefitted. Moreover, study from Dahal et al.

(2009) showed that there have been increased preferences to work for daily wages in the watershed as it has become an important source of income of the farmers.

Summary on Farmers Perceptions on Intensification Indicators

This section deals with the major perceptions of farmers on the status of intensification indicators identified from group discussion session. Farmers have mixed responses to ongoing changes in intensification indicators in the study area. On one hand, farmers perceived substantial improvement in agricultural technologies, infrastructures, access to markets, subsidies and women's decision-making status. In addition, women participants in group discussion perceived that decision-making power in the households and community affairs has substantially increased. For example, vegetable cultivation has brought changes on decision making to the members of the households mainly on the selection of varieties, use of technologies and farm inputs as well (Tiwari et al. 2008). On the other hand, farmers perceived that they are experiencing decreased manpower, unfair urban market conditions, increased chemical fertilizers reliance, increased agricultural costs, soil quality declination, water scarcity and increased overall agricultural problems. Moreover, farmers are using less farm yard manure because of the decreased livestock numbers in the watershed.

Farmers also reported that use of chemical fertilizers has been maximized due to increased intensification practices in the watershed. They stated that their soil is demanding more and more agrochemicals and soil is gradually losing its productivity. Study from Raut et al. (2011a) also showed that intensification in the watershed has relied on extensive use of chemical fertilizers. Cultivation of potatoes has made the farmers to use more agrochemicals on their farms. Raut et al. (2011a) argue that urea and DAP (Diammonium phosphate) are the major agrochemicals used along with the start of intensification specifically for the cultivation of potato and rice in the watershed. Additionally, farmers reported that farm expenses have soared due to excessive costs of inputs and wages of labor thereby decreasing NYAI of the farmers. Further, farmers are not getting the fair prices for their agricultural products in the urban markets due to the influence of middlemen.

Farmers also reported that manpower crisis in agriculture has emerged as a major challenge of the watershed. If this trend continues, there were worried that there would be difficulty in continuing their agriculture in near future and their land would remain barren. This situation is likely to stop the existing intensification practices in the watershed. Conelly (1994) also pointed out that the shortage of labor force caused dis-intensification in Rosinga island of Kenya.

Farmers perceived that manpower shortage has thus shifted the responsibility of the farming from young men to women. However, women's increased involvement in agricultural activities might be reducing their access to education and other off-farm job opportunities in future. The implication of the changed labor division in the watershed is that women's farm responsibility, decision-making ability and income has been increasing. Tiwari et al. (2008) argue that intensification with the vegetable farming has empowered women and have improved their decision making both at households and community levels.

Farmers in the group discussion revealed that increased water scarcity has reduced the potential benefits of intensification due to decreased agricultural production in the watershed. Despite the earthquake, farmers perceived that increased rainfall uncertainties and changing patterns of rainfall has caused water scarcity. Malla (2009) argues, there have been inconsistencies in rainfall patterns both with higher rain intensities and lesser rainy days in Nepal. This trend is likely to affect farmers' regular agricultural activity thereby diminishing their agricultural production. For example, rainfall shortage in 2005 and 2006 because of the early rainy season had reduced the crop harvests by 12.5 percent in the plain lands of Nepal (Raut et al. 2011b). Hence, decreased farmyard manure use, excessive use of chemical fertilizers and pesticides and increased agricultural problems are likely to be shifting the future course of intensification towards the unsustainable direction.

Another interesting trend noted in the group discussion was farmers from highlands reported that they have less motivation in the intensification activities as it basically demanded higher inputs and labor costs whereas farmers from lowland areas stated that they have relatively more motivation to intensification practices. This might be because farmers in lowlands are well off than upland farmers and have increased access to technologies, infrastructures such as roads, markets, irrigation facilities, training opportunities. This difference in the highlanders and lowlanders might initiate some social differentiation in the long-term in the watershed. For example, intensification is likely to lead to the systematic differentiation when there is non-uniformity in credits, technical inputs and market opportunities (Carswell 1997).

Farmers perceived that infrastructures have played an influential role in the promotion of agricultural intensification in the watershed. For example, the road that joins the watershed and nearby markets have enhanced the intensification activity in the area (Raut et al. 2011c). Though infrastructures have improved with the increased road and market networks in ten-year time in the whole watershed, highlanders have relatively less exposure to intensification.

Hence, there is no uniformity in the benefits and exposure of intensification among the farmers of the watershed. Although farmers reported that they have relatively improved infrastructures and facilities in ten-year time, it might not be enough for them to exploit the benefits of intensification. For optimizing the benefits of intensification, supportive agricultural policies, extension services, improved institutions, access to technologies, modern farm machinery, and fairer markets are needed. As an example, extension services are considered important for promoting the benefits of intensification as it provides necessary supervision and suggestions to the farmers regarding their existing agricultural problems. Further, extension services tend to inform the farmers about new technological developments (Raut et al. 2011a).

Communication with the district agricultural offices is also important for farmers to utilize the benefits of intensification and for the welfare of the farming communities. However, the qualitative group discussion reveals that there is a clear gap of communication of the farmers with these offices. This has made them uninformed about the government's welfare programs, subsidies and insurances schemes to the farmers. Nonetheless, this miscommunication was from both farmers' and government's side. Farmers reported that they are being supported by the government subsidies in chemical fertilizers. However, it has increased motivation in using more chemicals on their farms (Raut et al. 2011c). Moreover, farmers perceived that increased intensification practices have also demanded higher inputs and labor forces thereby increased their agricultural expenditures. In addition, they perceived that less manpower availability and unfair market conditions influenced by middlemen has also reduced net agricultural profits of the farmers in the watershed. For instance, study from Tiwari et al. (2008) showed that monopoly existed in the markets for vegetable products and middleman were more benefitted than the local farmers.

Limitations of the Study

The major limitation of this study is that it relies completely on farmers' responses. It would have been more appropriate if I would have been able to do some laboratory tests for examining the soil fertility, soil acidification, and erosion status. While interviewing, I realized that it was difficult for the farmers to remember the status of agricultural inputs uses before 10 years. For instance, their practices of chemical fertilizer and farmyard manure use before 10 years was a hard question for them to answer. Another limitation of the study is that Cat_b10 households are based on broad socio-economic indicators unlike Cat_AI, which was derived only through NYAI. Nonetheless, Cat_OF has captured the major essence of the changes in socio-economic

indicators of the watershed. Apart from that, since I am from farming background, my own biases regarding farming activity, might have some influence.

In methodology part, apart from using the univariate statistics, it would be more appropriate if I had used multivariate statistical methods. This would help to analyze the effect of changing intensification indicators to more than one dependent variable. Similarly, limitations exist in using these finding to other similar watersheds because of the sensitivity of the socio-economic, geographical and cultural context of different areas. Since agricultural intensification has not been fostered widely in Nepal and there is only limited number of studies done on these topics. It is thus important to show carefulness in applying the findings from this study.

Conclusion

Ansikhola watershed is one of the popular mid hill semi-urban agricultural zone with increased roads and markets connectivity which has been actively engaged in intensification in recent decades. The study has shown that socio-economic conditions of the farmers remain largely changed in ten-year time with the substantial increase of medium income households. Further, intensification indicators were also largely changed in the watershed thereby influencing the benefits of intensification in the watershed.

The study recognizes that male-headed households who cultivated paddy and two vegetables had been able to gain higher agricultural income in the watershed. Further, with increased employment opportunities from intensification, the income of C category households has substantially improved their annual agricultural income despite their non-intensification status. Though, category A households have higher viability to intensification than B and C households, their net profits of agriculture are found to have been decreased because of the increased inputs use and subsequent costs, unfair urban markets conditions and increased labor use and costs specifically in intensified farms.

It is quite important for farmers to increase the benefits of intensification to continue with the intensification practices in the watershed. For this, increased agricultural issues of the watershed should be settled through both policy and institutional reforms. It would be crucial for farmers to move in the path of sustainable production and farm income. Pretty (1998) argues, farmers supportive agricultural policies with the integration of local resources and knowledge tend to promote sustainable agricultural development. Further, supportive agricultural policies are likely to enable farmers' access and availability of extension services,

technologies, training, infrastructures, subsidies, insurances, and markets. Lele and Stone (1989) argue that agricultural policy adopted by a country for promoting agricultural development is facilitated through the better status of extension services, technologies, subsidies, credits, and markets. Further, policy interventions are required for the regulation of unfair markets and to provide fair prices of farmers' products and discourage monopoly of middlemen.

Institution reforms is considered vital for promoting the benefits of intensification in developing countries like Nepal. Tiwari et al. (2008) argue that local institutions should be strengthened in making farmers cautious about the effective use of resources and limiting their use of agrochemicals. Further, farmers should be given necessary knowledge and guidance on sustainable farming through the extension services and farmers field schools. Hence, both policy and institutional reform collectively function in creating ecologically sustainable and economically productive agriculture system.

List of References

Adugna, T. (1997). Factors influencing the adoption and intensity of use of fertilizer: The case of Lume District, central Ethiopia. *Quarterly Journal of international agriculture*, 36: 173-98.

Alauddin, M. & Quiggin, J. (2008). Agricultural intensification, irrigation and the environment in South Asia: Issues and policy options. *Ecological Economics*, 65 (1): 111-124.

Bajracharya, R. M. & Sherchan, D. P. (2009). Fertility status and dynamics of soils in the Nepal Himalaya: a review and analysis. *Soil Fertility*: 111-135.

Baumol, W. J. & Oates, W. E. (1988). *The theory of environmental policy*: Cambridge university press.

Berg, B. & Lune, H. (2004). Qualitative Research Methods for the Social Sciences Pearson Boston.

Bhandari, B. & Grant, M. (2007). Analysis of livelihood security: A case study in the Kali-Khola watershed of Nepal. *Journal of environmental Management*, 85 (1): 17-26.

Brookfield, H. C. (1984). Intensification revisited. *Pacific viewpoint*, 25 (1): 15-44.

Brown, S., Schreier, H., Shah, P. & Lavkulich, L. (1999). Modelling of soil nutrient budgets: an assessment of agricultural sustainability in Nepal. *Soil use and management*, 15 (2): 101-108.

Brown, S. & Shrestha, B. (2000). Market-driven land-use dynamics in the middle mountains of Nepal. *Journal of Environmental Management*, 59 (3): 217-225.

Brown, S. & Kennedy, G. (2005). A case study of cash cropping in Nepal: Poverty alleviation or inequity? *Agriculture and Human Values*, 22 (1): 105-116.

Carswell, G. (1997). Agricultural intensification and rural sustainable livelihoods: a'think piece'.

Carswell, G. (2000). *Agricultural intensification in Ethiopia and Mali*.

Christaller, W. (1933). *Die Zentralen Orte in Süddeutschland. Gustav Fischer, Jena. English translation (1966): Central Places in Southern Germany*: Prentice—Hall, Englewood Cliffs, NJ.

Conelly, W. T. (1994). Population pressure, labor availability, and agricultural disintensification: The decline of farming on Rusinga Island, Kenya. *Human Ecology*, 22 (2): 145-170.

Conway, G. R. (1985). Agroecosystem analysis. *Agricultural administration*, 20 (1): 31-55.

Creswell, J. W. & Clark, V. L. P. (2007). Designing and conducting mixed methods research.

Dahal, B. M., Sitaula, B. K. & Bajracharya, R. M. (2008). Sustainable agricultural intensification for livelihood and food security in Nepal. *Asian Journal of Water, Environment and Pollution*, 5 (2): 1-12.

Dahal, B. M., Nyborg, I., Sitaula, B. K. & Bajracharya, R. M. (2009). Agricultural intensification: food insecurity to income security in a mid-hill watershed of Nepal. *International Journal of Agricultural Sustainability*, 7 (4): 249-260.

Dahal, N. (1997). A Review of Nepal's first conference on agriculture. *Water Nepal*, 5 (2): 149-164.

Dixon, J., Gulliver, A., Gibbon, D., Carloni, A., de Grandi, J., Spehar, C., Majella, G., Tanic, S., Dauphin, F. & Ivory, D. (2001). Global farming systems study: challenges and priorities to 2030.(v. 1): Synthesis and global overview.-(v. 2): Regional analysis. Sub-Saharan Africa.-(v. 3): Regional analysis. Middle East and North Africa.-(v. 4): Regional analysis. Latin America and the Caribbean.-(v. 5): Regional analysis. Eastern Europe and Central Asia.-(v. 6): Regional analysis. East Asia and Pacific.-(v. 7): South Asia.

Dougill, A., Soussan, J., Kiff, E., Springate- Baginski, O., Yadav, N., Dev, O. & Hurford, A. (2001). Impacts of community forestry on farming system sustainability in the Middle Hills of Nepal. *Land Degradation & Development*, 12 (3): 261-276.

Dutcher, J. D. (2007). A review of resurgence and replacement causing pest outbreaks in IPM. In *General concepts in integrated pest and disease management*, pp. 27-43: Springer.

Field, A. (2009). *Discovering statistics using SPSS*: Sage publications.

Grabowski, R. (1985). Technical efficiency in Nepalese agriculture. *The Journal of Developing Areas*, 19 (4): 515-526.

Karkee, K. (2004). Land degradation in Nepal: A menace to economy and ecosystems. *Sweden: Lund University*.

Karlen, D., Mausbach, M., Doran, J., Cline, R., Harris, R. & Schuman, G. (1997). Soil quality: a concept, definition, and framework for evaluation (a guest editorial). *Soil Science Society of America Journal*, 61 (1): 4-10.

Katwal, B. & Sah, L. (1992). *Transformation of mountain agriculture: case study*: International Centre for Integrated Mountain Development.

Koirala, G. P., Thapa, G. B. & Joshi, G. R. (1995). Can Nepalese farmers compete in the domestic market?

Lele, U. & Stone, S. W. (1989). Population pressure the environment and agricultural intensification. Variations on the Boserup hypothesis.

Malla, G. (2009). Climate change and its impact on Nepalese agriculture. *Journal of agriculture and environment*, 9: 62-71.

Merz, J., Nakarmi, G., Shrestha, S. K., Dahal, B. M., Dangol, P. M., Dhakal, M. P., Dongol, B. S., Sharma, S., Shah, P. B. & Weingartner, R. (2003). Water: A scarce resource in rural watersheds of Nepal's Middle Mountains. *Mountain Research and Development*, 23 (1): 41-49.

Neupane, F. P. (2003). *Integrated pest management in Nepal*. Proceedings of a National Seminar, Himalayan Resource Institute.

Partap, T. (1999). Sustainable land management in marginal mountain areas of the Himalayan region. *Mountain Research and Development*: 251-260.

Pingali, P. L. & Rosegrant, M. W. (2001). Intensive food systems in Asia: Can the degradation problems be reversed. *Tradeoffs or synergies*: 383-397.

Pokhrel, D. M. & Thapa, G. B. (2007). Are marketing intermediaries exploiting mountain farmers in Nepal? A study based on market price, marketing margin and income distribution analyses. *Agricultural Systems*, 94 (2): 151-164.

Pokhrel, D. M. (2010). Comparison of farm production and marketing cost and benefit among selected vegetable pockets in Nepal. *Journal of Agriculture and Environment*, 11: 10-25.

Pretty, J. (2008). Agricultural sustainability: concepts, principles and evidence. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 363 (1491): 447-465.

Pretty, J. N. (1998). Supportive policies and practice for scaling up sustainable agriculture. *Facilitating sustainable agriculture: participatory learning and adaptive management in times of environmental uncertainty*: 23-45.

Rasul, G. & Thapa, G. B. (2003). Shifting cultivation in the mountains of South and Southeast Asia: regional patterns and factors influencing the change. *Land Degradation & Development*, 14 (5): 495-508.

Raut, N., Sitaula, B. K. & Bajracharya, R. M. (2010). Agricultural intensification: linking with livelihood improvement and environmental degradation in mid-hills of Nepal. *Journal of Agriculture and Environment*, 11: 83-94.

Raut, N., Sitaula, B. K., Aune, J. B. & Bajracharya, R. M. (2011a). Evolution and future direction of intensified agriculture in the central mid-hills of Nepal. *International Journal of Agricultural Sustainability*, 9 (4): 537-550.

Raut, N., Sitaula, B. K. & Bajracharya, R. M. (2011b). A Discourse on Agricultural Intensification in the Mid-Hills of Nepal. *Asian Journal of Agriculture and Development*, 8 (1): 79.

Raut, N., Sitaula, B. K., Vatn, A. & Paudel, G. S. (2011c). Determinants of adoption and extent of agricultural intensification in the central mid-hills of Nepal. *Journal of Sustainable Development*, 4 (4): 47.

Raut, N. (2012). *Agricultural Intensification Processes and Greenhouse Gas Emissions from Soils: A Study from Nepal and India*: Department of International Environment and Development Studies, Noragric, Norwegian University of Life Sciences.

Raya, B. (2013). *Role of gender on agricultural intensification and its implication for soil fertility management*: Norwegian University of Life Sciences, Ås.

Redclift, M. (1987). 1987: Sustainable development: exploring the contradictions. London: Methuen.

Schroeder, R. F. (1985). Himalayan subsistence systems: Indigenous agriculture in rural Nepal. *Mountain Research and Development*: 31-44.

Shrestha, B. & Brown, S. (1995). People, community dynamics and perceptions in the watershed. *Challenges in mountain resource managment in Nepal: Processes, trends, and dynamics in middle mountain watershed. ICIMOD, Kathmandu and International Development Research Centre, Singapore*.

Shrestha, P. L. & Neupane, F. P. (2002). *Socio-economic contexts on pesticide use in Nepal*. Proceedings of the International Workshop on Environmental Risk Assessment of Pesticides and Integrated Pest Management in Developing Countries.

Silverman, D. (2006). *Interpreting qualitative data: Methods for analyzing talk, text and interaction*: Sage.

Smith, J., Barau, A. D., Goldman, A. & Mareck, J. H. (1994). The role of technology in agricultural intensification: The evolution of maize production in the Northern Guinea Savanna of Nigeria. *Economic development and cultural change*, 42 (3): 537-554.

Thapa, G. B. & Niroula, G. S. (2008). Alternative options of land consolidation in the mountains of Nepal: An analysis based on stakeholders' opinions. *Land use policy*, 25 (3): 338-350.

Thapa, G. B. & Rattanasuteerakul, K. (2011). Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand. *Applied Geography*, 31 (1): 201-209.

Tiwari, K. (2009). Runoff and soil loss responses to rainfall, land use, terracing and management practices in the Middle Mountains of Nepal. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, 59 (3): 197-207.

Tiwari, K. R., Nyborg, I. L., Sitaula, B. K. & Paudel, G. S. (2008). Analysis of the sustainability of upland farming systems in the Middle Mountains region of Nepal. *International Journal of Agricultural Sustainability*, 6 (4): 289-306.

Tiwari, K. R., Sitaula, B. K., Bajracharya, R. M. & B∅ rresen, T. (2009). Runoff and soil loss responses to rainfall, land use, terracing and management practices in the Middle Mountains of Nepal. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, 59 (3): 197-207.

APPENDIX

Structured Survey Questionnaires

Name of researcher ……. Interviewer…… Date……

1. **Household family Information**

a. Total family members……

Male……

Female …….

b. Household Head male ……. Female…….

c. Employment outside home yes….. No…

If yes, how many Male…. Female….

d. House made up of

Concrete…. Stone and Mud……. Brick……Wooden…… Other….

e. Roof made up of

Tin…. Stone…… Tile…… Hay…… Other…….

f. Household assets status

Household assets	Number	Market value
House		
Agricultural equipment		
Ploughing tool		
Thresher		
Tractor		
Radio and TV		
Sprayer		

g. Fuel use for cooking

Wood…… Electricity……Bio gas……Kerosene**.....**dry-dung……. Other….

2. **Livestock and off farm income sources**

Type of Livestock	Number	Production	Market price per unit	Total income	Buying of livestock	Buying price	Selling of livestock	Selling Price
Cow								
Ox								
Buffalo								
Goat								
Chicken								
Pigs								
Other								

3. Off-farm income status

Source of income	Yes	No	Total income per year
Business			
Wage labor			
Job			
Pensions			
Abroad job			
Urban Job			
Other			

4. Livestock fodder availability status in ten-year time

   Increase……. Decrease…… Unchanged status…….

5. Livestock treatment status in ten-year time

   Increase……. Decrease…… Unchanged status…….

6. Landholding status in ten-year time

Present landholding	landholding before ten-year	landholding before twenty - year

7. Cropping change

Major crops in 1 year	Major crops cultivated in 10-year	New crops in 1 year	New crop in 10-year

8. Crop left away

Names of crops left	Reasons behind leaving

9. Reasons behind start of new crop in 10-year

Higher production	High market price	Disease and pests	Less wage labor	Less water need	Copying others	Less fertilizer need	Lack of seeds

10. Number and name of crop cultivated in one plot last year

Number	Name of crops

11. Reasons behind cultivating three and more crops

Increase income	Food insufficiency	Availability of CF	Increase of irrigation	Availability of manpower	Availability of improved seeds	technologies	markets	infrastructures

12. Short term crops cultivated in 10-year time

Soybean	Millet	Potato	Tomato	Other

13. Income from these short-term crops

Very high	Medium	Very low

14. Details of crops cultivated

Land type	Crop type	Area used	Production before 10year	Production last year	Input and other agricultural expenses	NYAI
	Summer paddy					
	Winter paddy					
	Maize					
	Wheat					
	Potato					
	Tomato					
	Millet Green vegetables					

15. Change in soil fertility status in 10-year time

Increase	Decrease	Unchanged	Don’t know

16. Reasons behind changes in soil fertility

Extensive CF use	Cultivation of more crops	Balance use of CF and FYM	Pests and water shortage	NA

17. Land degradation status in ten-year time

Increase	Decrease	Unchanged	Don’t know

18. Reasons behind changes in land degradation

More tillage and more crops	Natural disasters such as earthquake and flood	Massive rainfall	Better drainage and crops cultivation	NA

19. Change in soil erosion status in 10-year time

Increase	Decrease	Unchanged	Don't know

20. Reasons behind the changes in soil erosion

Sloppiness	More crops and more tillage	less rainfall	Rainfall uncertainties	NA

21. Status of FYM use in 10-year time

Crops	Summer paddy	Winter paddy	Maize	Wheat	Potato	Tomato	Green veg	Millet	Other
Now									
Before 10-year									

22. Reasons behind the change in FYM use in ten- year time

Decrease livestock and CF dependency	Higher availability and lower price	Awareness that manure good for soil	High price of CF	NA

23. Status of CF (Urea, DAP and Potash) use in ten-year time

Crops	Summer paddy	Winter paddy	Maize	Wheat	Potato	Tomato	Green veg	Millet	Other
Now									
Before 10-year									

24. Reasons behind the change in CF use in ten- year time

Increase production	Soil demand	Aware about side effects and high CF costs	Everywhere practice	NA

25. Agricultural activities and labors used

Type of crops	Land preparation	Sowing	hoeing, pesticides, irrigation	Harvesting	Manpower used	Hired wage labors	Home labors	Men involvement	Women involvement
Summer paddy									
Winter paddy									
Maize									
Wheat									
Millet									
Potato									
Tomato									
Green veg									
other									

26. Agricultural production status

Does your agricultural production meet your yearly family's food needs?

Yes…… No…….

If no, for how many months?

…….

27. How do you fix the food shortage?

Buy from local markets	Buy from local neighbors	Other

28. Change in status of agricultural production in ten-year time?

Increase	decrease	unchanged

29. Reasons behind the change in agricultural production in ten-year time?

Improved seeds	Pesticides and CF use	FYM use	Technology and irrigation	Hard work

30. What type of crops you mainly cultivate? Specify reasons

Food crops	Reasons	Cash crops	Reasons

31. Buying and Selling of seeds

Crops	Summer paddy	Winter paddy	maize	millet	wheat	potatoes	tomatoes	Green veg	others	Price buy &sell
Buying in Kgs										
Selling in Kgs										

32. Institutions, infrastructures and training status

Institutions	Roads	dairy	Local market	Agriculture office	Veg collection center	Bank & co-operatives	Dist. HQ
Time needed and distance							

33. Status of agricultural training

Training	Member who participated	In which year	Duration of course	institution	What did you learn
IPM					
Bee keeping					
Dairy development					
Veg production					
Land management					
Seed storage					
other					

34. Availability of support from other institutions

Yes…… No…...

If yes, what type of help,

Training……. Credits…. Equipment ……. money……. others…….

35. What type of support you would need in future?

To make water drains	Soil test	Land management	other

36. What type of agricultural policy would you need in future?

Better infrastructures	Extension services	Improved seeds	Fairer markets	Agricultural loan	training	others

37. Change in farm productivity in ten-year time

Increase	Decrease	Unchanged	Don’t know

38. Change in agricultural technologies in ten-year time

Increase	Decrease	Unchanged	Don’t know

39. Status of urban markets in ten-year time

Good	Bad	unchanged

40. Changing status of manpower in ten-year time

Increase	Decrease

41. Changing status of subsidies in ten-year time

Increase	Decrease	Unchanged	Don’t know

42. Changing status of agricultural infrastructures in ten-year time

Increase	Decrease	Unchanged	Don’t know

43. Changing status of women’s position in ten-year time?

Increase	Decrease	Unchanged	Don’t know

44. Changing status of agricultural problems in ten-year time?

Increase	Decrease	Unchanged	Don’t know

45. What are the co-operative groups in your village?

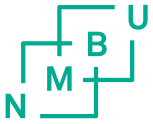
Women co-operatives	Men co-operatives	mixed

46. How well women are prioritized in agricultural training?

Very much	medium	Very less	Don't know

Qualitative Group Discussion Questionnaires

1. In what ways the socio-economic conditions of the farmers are being changed in the watershed? Explain through the existing status of socio-economic indicators such as job, education, landholding, cattle holding, assets, farm and off-farm income and agricultural production and seed buying and selling status.
2. What are your perceptions regarding the existing status of social capital, natural capital, human capital, financial capital and physical capital in the watershed?
3. In what ways the intensification indicators are being changed in the watershed?
4. What are your perceptions regarding the changes of agricultural practices in the watershed?
5. What are the major benefits and risks of the existing farming practices in the watershed?
6. What are the major changes in crops types, cropping patterns and explain the reasons behind the changes in cropping types and patterns?
7. What are your recommendations for sustainable farming practices in the watershed?



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