CONSERVATION AND COMMERCIALIZATION PROSPECT OF RICE BEAN LANDRACES IN RAMECHHAP DISTRICT OF NEPAL

INDRA HARI PAUDEL

JULY, 2008

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THESIS

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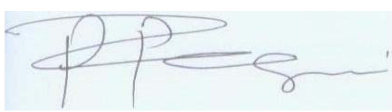
JULY, 2008

CERTIFICATE

This is to certify that the thesis entitled **"CONSERVATION AND COMMERCIALIZATION PROSPECT OF RICE BEAN LANDRACES IN RAMECHHAP DISTRICT OF NEPAL"** submitted in partial fulfillment of the requirements for the degree of Master of Science in Agriculture with major in Agricultural Economics of the Postgraduate Program, Institute of Agriculture and Animal Science, Rampur, is a record of original research carried out by **Mr. INDRA HARI PAUDEL Id. No. R-2006-AEC-03-M,** under my supervision, and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been acknowledged.



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The thesis attached hereto, entitled **"CONSERVATION AND COMMERCIALIZATION PROSPECT OF RICE BEAN LANDRACES IN RAMECHHAP DISTRICT OF NEPAL"** prepared and submitted by **Mr. INDRA HARI PAUDEL** in partial fulfillment of the requirement for the degree of Master of Science in Agriculture (Agricultural Economics), is here by accepted.

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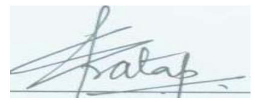

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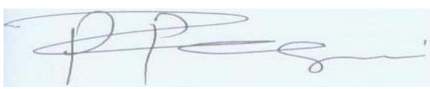

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TO

MY PARENTS

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Indra Hari Paudel

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ACRONYMS

ABPSD	Agribusiness Promotion and Statistics Division
AEC	Agro Enterprise Center
AGDP	Agricultural Gross Domestic Product
APP	Agriculture Perspective Plan
BLUE	Best Linear Unbiased Estimator
CAZSNR	Center for Arid Zone Study Natural Resources
CBD	Convention on Biological Diversity
CBS	Central Bureau of Statistics
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro International de Mejoraniento de Maiz Y Trigo
DADO	District Agriculture Development Office
DDC	District Development Committee
DLSO	District Livestock Service Office
FAO	Food and Agricultural Organization
FOSRIN	Food Security through Rice Bean Research in India and Nepal
FYM	Farm Yard Manure
GDP	Gross Domestic Product
GMO	Genetically Modified Organism
HH	Household
IAAS	Institute of Agriculture and animal Science
IFPRI	International Food Policy Research Institute
INGO	International Non Governmental Organization

IPGRI	International Plant Genetic Resource Institute
IRRI	International Rice Research Institute
JT	Junior Technician
JTA	Junior Technical Assistant
KBS	Knowledge Based System
LI- BIRD	Local Initiatives for Biodiversity Research and Development
LSU	Livestock Standard Unit
MOAC	Ministry of Agriculture and Cooperatives
NARC	Nepal Agriculture Research Council
NGLIP	National Grain Legume Improvement Program
NGO	Non Governmental Organization
NPC	National Planning Commission
OLS	Ordinary Least Square
PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
PRA	Participatory Rural Appraisal
SPSS	Statististical Package for Social Science
SSMP	Sustainable Soil Management Program
TRIPS	Trade Related Aspects of Intellectual Property Rights
TU	Tribhuvan University
VDC	Village Development Committee
WFP	World Food Programme
WTO	World Trade Organization

EQUIVALENTS

Months

Nepali Calendar	Gregorian Calendar
Baisakh	Mid April – Mid May
Jestha	Mid May – Mid June
Ashad	Mid June – Mid July
Shrawan	Mid July – Mid August
Bhadra	Mid August - Mid September
Aswin	Mid September – Mid October
Kartik	Mid October – Mid November
Mangsir	Mid November – Mid December
Poush	Mid December – Mid January
Magh	Mid January – Mid February
Falgun	Mid February – Mid March
Chaitra	Mid March – Mid April

Area

1 Kattha = 20 Dhur

1 Bigha = 20 Kattha = 13.31 Ropani = 0.68 Hectares

1 Hectare = 30 Kattha = 19.66 Ropani

Weight

1 Ton = 10 Quintals = 1000 kg

Currency

US $ 1 = NRs. 67.00 (4th January, 2008)

ABSTRACT

Name: Indra Hari Paudel Id.No.: R-2006-AEC-03-M
Semester and year of admission: First, 2006 Degree: Master of Science in Agriculture
Major Subject: Agricultural Economics Department: Agricultural Economics
Major Advisor: Dr. Punya Prasad Regmi

Rice bean (*Vigna umbellata* T.) is an underutilized leguminous crop that possesses tremendous landraces diversity in Nepal. Farmers have been maintaining rice bean landraces for time immemorial due to social, cultural, geographical and economic reason. The main objective of this study was to assess the conservation and commercialization prospect of rice bean landraces in Ramechhap District of Nepal. Household survey was conducted during September, 2007, to collect information from rice bean growers by taking a representative sample size of 102, comprising 34 each from Ramechhap, Bhaluwajor and Pakarbas Village Development Committees (VDCs) of Ramechhap District. Producers were selected randomly from each VDC by applying simple random sampling technique. Selected respondents were interviewed using the pre-tested interview schedule. Similarly, 23 rice bean traders and 10 rice bean consumers were interviewed purposively and collected data about rice bean marketing. Local knowledge associated with rice bean was documented from 18 well experienced rice bean producers. Average area of rice bean landraces was 0.56 ha with 0.67 mt ha^{-1} productivity. The contribution of rice bean enterprise to the total annual household cash income was 11 percent. *Sano seto, ghorle, kalo, rato* and *pahelo* were the common rice bean landraces. *Sano seto* was most preferred landrace by consumers. Average area under rice bean landraces and their productivity were decreasing significantly over last 6 years. Multiple regression analysis using OLS technique was used to determine the important factors affecting *in situ* conservation of rice bean landraces diversity. Socioeconomic factors like number of

parcels of land, area under *bari* land, number of family members who work regularly on farm, access to market facility and sex of household decision maker have shown significant effect. The opportunity costs or benefit forgone from growing rice bean landraces was very low in marginal and risk prone environment. The role, responsibility and decision making of women farmers in rice bean production, seed selection, management and use were dominant. The marketing system was poorly organized and at rudimentary stage. Lack of farmer's networks, access to market information and poor institutional capacities were some of the key problems that exclude farmers to receive direct economic benefits from the existing technologies and biodiversity. Most of the rice bean produced at Ramechhap District was supplied to the Kathmandu valley through the involvement of marketing intermediaries. Producers in rural areas of Ramechhap District and consumers in urban area of Kathmandu valley would be mutually benefited if an effective marketing system of these local products could be established. Therefore, commercialization and diversification of rice bean products and linking these products to market not only gives an economic return to farming communities but also contribute to conserve biodiversity for future.

Dr. Punya Prasad Regmi

Major Advisor

Indra Hari Paudel

Author

शोध-सार

नामः इन्द्र हरि पौडेल
परिचय पत्र नंः आर- २००६- ए. इ. सी.-०३-एम.
सत्रान्त र भर्ना बर्षः प्रथम, सन् २००६
उपाधिः स्नातकोत्तर (कृषि)
मुख्य बिषयः कृषि अर्थशास्त्र
बिभागः कृषि अर्थशास्त्र
मुख्य सल्लाहकारः डा. पुण्य प्रसाद रेग्मी

मस्याङ्ग कम प्रयोगमा ल्याईएको एक कोसेबाली हो, जसका धेरै रैथाने जातहरु नेपालमा पाइन्छन् । सामाजिक, आर्थिक तथा भौगोलिक महत्वको कारणहरुले गर्दा कृषकहरुले बर्षौंदेखि विभिन्न जातका मस्याङ्गको खेती गर्दै आएको पाइन्छ । मस्याङ्गका रैथाने जातहरुको संरक्षण तथा व्यवसायिकरणको सम्भावना अध्ययन गर्नको लागि वि.सं. २०६४ साल भाद्र-आश्विन महिनामा रामेछाप जिल्लाका रामेछाप, भलुवाजोर र पकरवास गा. वि. स. हरुमा यो अनुसन्धान संचालन गरिएको थियो । यस अनुसन्धानको लागि प्रत्येक गा. वि. स. हरुबाट ३४ जनाका दरले कुल १०२ जना मस्याङ्ग उत्पादक कृषकहरुलाई समानुपातिक प्रतिनिधित्व हुने गरी साधारण दैहिक नमूना छनौट प्रकृयाबाट छनौट गरिएको थियो । छनौट गरिएका कृषकहरुबाट पूर्व परिक्षण गरिएको प्रश्नावली प्रयोग गरी प्रत्यक्ष अन्तवार्ताको माध्यमद्वारा तथ्याकं संकलन गरिएको थियो । बजार अवस्थाको तथ्याकं संकलन गर्न जम्मा २३ जना व्यापारी र १० जना उपभोक्ताहरुलाई उद्धेश्यात्मक रुपले छनौट गरिएको थियो । त्यसैगरी मस्याङ्ग बालीसँग सम्बन्धित कृषकहरुको परम्परागत ज्ञानको अभिलेखिकरण गर्नको लागि १८ जना जानिफकार कृषकहरुलाई उद्धेश्यात्मक रुपले छनौट गरिएको थियो । समग्रमा प्रति घर-परिवार मस्याङ्गका रैथाने जातहरुले ओगटेको क्षेत्रफल ०.५६ हे. र उत्पादकत्व ०.६७ मे.टन प्रति हे. रहेको पाइयो । अनुसन्धान क्षेत्रका कृषकहरुको कुल वार्षिक आम्दानीको करिब ११ प्रतिशत हिस्सा मस्याङ्ग बालीको रहेको पाइयो । मस्याङ्गका जातहरुमा सानो सेतो, घोर्ले, कालो, रातो र पहेंलो जस्ता रैथाने जातहरु प्रमुख रुपमा लगाइएको पाइयो । मस्याङ्गका रैथाने जातहरुमध्ये उपभोक्ताहरुले सानो सेतो जातलाई बढी मन पराएको पाइयो । मस्याङ्गका रैथाने जातहरुले ओगटेको क्षेत्रफल र तिनीहरुको उत्पादकत्व गत ६ बर्षको अवधिमा तात्विक रुपमा घट्दै आएको पाइयो । सिमान्तकृत जग्गा तथा जोखिमपूर्ण वातावरणमा मस्याङ्ग खेतीको अवसर लागत अत्यन्त

न्यून रहेको पाइयो । एउटै घर-परिवारको स्वामित्वमा रहेको तर विभिन्न सूक्ष्म जलवायूमा अवस्थित जग्गाका टुक्राहरु, खेतीयोग्य बारीको क्षेत्रफल, खाद्यान्न सम्पन्नताको स्तर, कृषक समुहको सदस्यता, बजारको पहुँच, नियमित रुपमा खेतीपातीको काममा सलंग्न हुने परिवारका सदस्य संख्या र घर-परिवारमा निर्णय गर्ने व्यक्तिको लिङ्ग जस्ता तत्वहरुले मस्याङ्गको रैथाने जातको यथास्थान संरक्षणमा दूरगामी प्रभाव पारेको देखियो । मस्याङ्ग लगाउने जग्गाको छनौट, बीउको छनौट, जातको छनौट तथा व्यवस्थापनमा पुरुषको तुलनामा महिलाहरुको मुख्य भूमिका रहेको पाइयो । यस अध्ययन अनुसार मस्याङ्गको वर्तमान बजार प्रणाली अविकसित र लगभग सुषुप्त अवस्थामा रहेको पाइयो । बजार संरचना तथा संजालमा कृषकहरुको न्यून पहुँच साथै कमजोर संस्थागत क्षमताको कारणहरुले गर्दा कृषकहरुले स्थानीय कृषि जैविक विविधता तथा प्रविधिहरुको अधिकतम उपयोग गर्न नसकेको पाइयो । रामेछाप जिल्लामा उत्पादन भएको अधिकांश मस्याङ्ग व्यापारीहरुको सकृयतामा काठमाण्डौ उपत्यकामा आपूर्ति हुँदै आएको पाइयो । रामेछाप जिल्लाको ग्रामीण भेगमा उत्पादन भएको मस्याङ्गलाई प्रभावशाली बजार प्रणालीद्वारा काठमाण्डौ उपत्यकासँग जोड्न सकेमा उत्पादक तथा उपभोक्ताहरु दुवै पारस्परिक रुपमा लाभान्वित हुने तथ्य यस अनुसन्धानले प्रष्ट रुपमा देखाएको छ । तसर्थ, मस्याङ्ग बालीको विविधिकरण तथा व्यवसायिकरण गरी शहरी बजारको संजालसँग जोड्न सकेमा कृषकहरुले प्रति इकाई जग्गाबाट अधिकतम मुनाफा आर्जन गर्नुका साथै लोपोन्मुख रैथाने जातहरुको दिर्घकालीन संरक्षणमा समेत महत्वपूर्ण योगदान पुऱ्याउने सम्भावना यस अनुसन्धानले देखाएको छ ।

डा. पुण्य प्रसाद रेग्मी — इन्द्र हरि पौडेल

मुख्य सल्लाहकार — लेखक

1 INTRODUCTION

1.1 Background

Being one of the signatories of Convention on Biological Diversity (CBD) in 1992, Nepal has put high priority for the conservation and sustainable utilization of agro-biodiversity. Agro-ecological variations even within a small geographical area of the nation favor specification of flora and fauna that provides ample opportunities for diversifying agriculture to enhance productivity and alleviate poverty by generating off-season employment and income for resource poor farmers (Gauchan *et al.,* 1999). Crop diversity in Nepalese farming system is basically influenced by the natural and human managed environment, by the population structure, management of this structure by farmers, and by the selection of agro-morphological traits of the cultivar (Jarvis *et al.,* 1998). A farmer's decision of whether to select or reject or maintain a particular landrace at any given time is influenced by environmental, biological, cultural and socio-economic factors (Bajrachrya *et al.,* 1999). Farmers, all over the world, maintain agrobiodiversity for their use, but due to deforestation, increase in human population, poverty, commercialization, change in environment and degradation and development of the modern varieties, these diversities are threatened (Brush, 1995). Therefore, conservation of agrobiodiversity *in situ* is felt important world wide.

The Hindustani Subcontinent region is a very important centre of diversity of crop plants (Zeven and Zhukovsky, 1975). Nepal lies within this region of diversity for crop landraces of global importance (Paudel, *et al.,* 1999). Among these crops, rice bean has tremendous landraces diversity in Nepal. About 156 accessions of rice bean have been reported in the country (Khanal and Paudel, 2008). It is an underutilized leguminous crop, most widely grown as an intercrop, particularly with maize, throughout Indo-China and extending into southern China in the east and into north east India, Bangladesh and Nepal in the west (Fery, 1991). It is a rainy season crop, extensively grown as an intercrop with maize in *bari* land, on the edges of the upland terraces with millet, and on rice bunds in *khet* land, in sloppy-marginal to sub marginal lands with little or no fertilizers under rain fed condition, in tropical to warm temperate region (i.e. up to 2000 masl) of mid hills of Nepal (Lohani, 1980). Therefore, rice bean has become an important component of the dry land farming system in Nepal. At national level official statistics on area coverage, production and productivity of the crop is not readily available and in most cases the figures for pulses as a whole is combined. Rice bean landraces are nurtured and maintained by farmers for their immediate food needs and survival for generations due to inherent diversity in farmer's resource endowments, rice bean production systems and socioeconomics settings. The diversity of rice bean genetic resource retained for use within modern agriculture will be one very important input for future improvement and sustainability of rice bean based production system. In the marginal environments diverse rice bean landraces are highly valued because of their various production, consumption and cultural values. These values, which are important to farmers, are also of major national and global significance as they are introduced in to many modern varieties. Since farmers are the producers and main beneficiaries of crop genetic resources, the use value of genetic resources should be assessed directly in their local farming systems including their costs of maintenance (Gauchan, 1999). The research priority should therefore, be put on assessing correctly the direct use value of the stock of genetic resources of such underutilized crops in traditional agriculture and the costs of its on-farm maintenance (Goeschl and Swanson, 1998).

The convention on Biological Diversity (CBD), Agenda 21 and Global Plan of Action (GPA) have emphasized the need to conserve and sustainable use of the biodiversity with special reference to *in situ* conservation of crop plants (Upadhyay and Subedi, 1999). Understanding of socio-economic, cultural and environmental factors that influence farmers' management practices and decision making on agrobiodiversity on-farm is prerequisite for better understanding and devising strategy for *in situ* conservation (Jarvis and Hodgkin, 1997).

Though Nepal is rich in agro-biodiversity, the recent studies have revealed that the genetic resources are gradually disappearing over time and space (Manandhar, 2007). Local crop species and varieties are gradually being replaced by a small number of high yielding food and cash crops (Jarvis and Hodgkin, 1997). The agrobiowealth potential of the country has not been properly harnessed and realised by the policy makers, planners and development workers alike (Gauchan *et al.,* 1999). In an agro-based country like Nepal, where agrobiodiversity is the backbone for the sustainable development of agriculture, food security, and poverty alleviation, it is the national responsibility to conserve, maintain and sustainable use of the available diversity. This necessitates effective institutional environments and programs to meet the needs and aspirations of the future generations.

Since, agriculture plays a central role in securing livelihoods and providing services related to medicine, clothes, religious and cultural needs; conservation of agricultural biodiversity on-farm can be assured if they hold specific use values either in socio-cultural, economic, ecological terms or preference characteristics (Jarvis *et al.,* 2000). Of the direct and indirect benefits as described by Brush (1999), market method provides incentive for maintaining agrobiodiversity on-farm. There are several case studies that demonstrate that specific local crop diversity can be conserved through market incentives (Rijal *et al.,* 2001). Promotion of landraces based on food recipes can, therefore, be one of the potential options. Of the many ways of creating incentives it is hypothesized that market promotion of certain food recipes improves use values thereby help enhance on-farm conservation (Rijal *et al.,* 2001). Traditionally farmers have identified diverse types of crop and varieties suitable for specific local food culture. Like farmers, different stakeholders including traders, processors and consumers value landraces on their own ways. Attempts to improve access of local food products and local recipes have yet to be popularized among the consumers in an economic scale for the sustainable conservation of these crops.

Lack of farmer's networks, access to market information, and poor institutional capacities are some of the key problems that exclude farmers to receive direct economic benefits from the existing technologies and biodiversity (Sapkota *et al.,* 2005). Farmers are having a hard time not only with the problems inherent to their production activities, but also with the challenges in the marketing of these farm products. On the other hand, urban people are still in need of these local products. These products are not readily available in urban markets, and urban people don't have access to the countryside to buy these products. This situation reveals that both producers in rural areas and consumers in urban cities would be benefited if an effective marketing system of these local products could be established. Experiences suggest that it is also possible to increase farm income of many rural farmers through targeted commercialization of the rich bio-wealth, and it is important to link these local products to the market (Sapkota *et al.,* 2005). Therefore, diversifying farm products and linking these products to the market not only give an economic return to farming communities but also contribute to conserve biodiversity for future.

1.2 Statement of problems

Genetic resources are gradually disappearing over time and space from Nepal (Manandhar, 2007). Farmers from different parts of the country are not benefited form cultivating rice bean landraces due to low productivity, long maturity period, high cost of production and insect pest problems. Similarly, lack of organized market, shortage of improved seeds, lack of technical know-how, weak extension services, and insufficient research works on rice bean are the important causes for being underutilized. Lack of farmer's networks, access to market information and poor institutional capacities are some of the key problems that exclude farmers to receive direct economic benefits from the existing technologies and biodiversity. Efficient marketing system and processing opportunities are still lacking; therefore, potentialities for commercialization have not been exploited for rice bean in Nepal. Similarly, farmer's experience derived from their life long attachment on farming has not yet been well documented which would be of great value for the development and recommendation of proper crop management strategies in future. Consequently, these valuable and diverse rice bean landraces prevalent in different parts of the country are disappearing from farmer's field at alarming rate. So, it has become an important threat to the country for conservation and sustainable use of valuable indigenous genetic material. Considering this in mind, this study was designed to address the following research questions:

- What is the status of rice bean enterprise to the household food security?
- What is the local knowledge associated with rice bean?
- How do different factors affect the rice bean landraces diversity?
- What are the costs and benefits of *in situ* conservation of farmer-valued landraces?
- How is the value chain structure of rice bean?

1.3 Research rationale

Nepal is rich in agro-biodiversity as a result of its diverse farming systems, extreme variation in micro-agro-ecological niches and varied socio-cultural settings. Rice bean landraces are the valuable crop genetic resources of Nepal. Nepal has immense potential for improving farmer's food security and livelihood through sustainable utilization, value addition and conservation of its rich agro-bioresources (Gauchan *et al.,* 1999). Underutilized crop species have a hidden potentiality that needs to be harnessed. These crops including rice bean are rich in protein and amino acid content, make diets more balanced; and hence, play an important role in combating silent hunger (Swaminathan, 1999). Scientific research on underutilized crops plays significant role to attain sustainability, profitability and diversification in agriculture and to restore the balance of trade. Further it reduces the import of the foods items and promotes export potentiality of the country. Three Year-Interim Plan has target of bringing down the number of people below poverty line from 31% to 24% by the end of 2010 (NPC, 2007). Similarly, Agriculture Perspective Plan (APP-1994/95-2014/15) has targeted to reduce poverty from 49% to 14% and increase Agricultural Gross Domestic Product (AGDP) growth from 2.96 to 4.76 (NPC, 1995). So this crop could also help in poverty alleviation by providing income generating opportunities to farmers by linking the development of these crops to market opportunities. The diversity of landraces, co-adapted to various biotic and abiotic stresses, is used as the primary breeding material for modern varieties (Sthapit, 2007). The continuing use of landraces by farmers significantly contributes to stable food production and income, especially in marginal environments where, impacts of modern varieties have been limits (Sthapit, 2007). Therefore, the Convention Biological Diversity (CBD) has recognized the continued maintenance of traditional varieties on-farm as an essential component of sustainable agricultural development.

The vision of National Agro-biodiversity Policy, 2004 is to conserve and sustainable use of agricultural genetic resources/materials and associated traditional knowledge with the participation of concerned stakeholders for present and future generations (Manandhar, 2007). In an agro-based country like Nepal, where agrobiodiversity is the backbone for the sustainable development of agriculture, food security and poverty alleviation, it is the national responsibility to conserve, maintain and sustainable use of the available diversity.

Hence, realizing the significance of agrobiodiversity and the national commitment in the Convention on Biological Diversity (CBD), 1992, International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA), National Agricultural Policy, 2004, National Agro-biodiversity policy and other international treaties and agreements, there has been a immediate need of a scientific research in the conservation and commercialization prospects of underutilized crops like rice bean in Nepal.

1.4 Objectives

The broad objective of the study was to assess the conservation and commercialization prospect of rice bean landraces in Ramechhap District of Nepal. The specific objectives of the study were:

1. To assess the contribution of rice bean enterprise to the household food security.
2. To analyze the local knowledge associated with rice bean landraces.
3. To analyze the factors affecting rice bean landraces diversity.
4. To estimate the cost and benefit of *in situ* conservation of farmer valued landraces.
5. To analyze the value chain structure of rice bean enterprise.

1.5 Hypotheses

This study stated the following hypotheses:

1. There is no change in area allocation of rice bean over time.
2. There is no change in productivity of rice bean over time.
3. All factors equally affect the rice bean landraces diversity.
4. Per unit gross margin of all rice bean landraces are same.

1.6 Scope and limitation of the study

There is great scope of studying different aspects of under utilized crops like rice bean in Nepal and findings of this study will be helpful for making policies related to the *in situ* conservation of agro-biodiversity, food security, and commercialization on Nepalese agriculture.

Different rice bean landraces with different name and categories have been mentioned merely based on farmers response due to lack of researchers access for cross validation of the name and categories of landraces with respect to their genetic and physical make up. Most of information presented in this study are based on the response of farmers and hence, memory recall bias is inevitable. This study has more focused toward the study of production system and limited market information has been analyzed due to lack of extensive market study and impracticability in deriving market information during short time with limited budget. Time and budgetary constraints were the limiting factors to increase the area and sample size. Therefore, narrow range of research coverage may not generalize wide array of the country.

2 REVIEW OF LITERATURE

2.1 Research on grain legumes in Nepal

In Nepal, legume research works were initiated as early as 1972 at the agronomy division, Khumaltar and Parwanipur agriculture station. However, the research works were limited to few grain legume crops such as chickpea, lentil, soybean, black gram, and mungbean. Parwarnipur agriculture station was selected as a coordinating site for chickpea & lentil improvement while agronomy division, Khumaltar coordinated for soybean, black gram and mungbean. The major research sector was to identify and develop high yielding varieties of different legume corps. Besides, consideration had also paid for agronomic entomological and pathological aspects of crop management. Viewing an urgent need to strengthen the program with an integrated team approach for overall improvement National Grain Legume Improvement Program (NGLIP) was initiated in 1985 with its headquarter at Rampur, Chitwan (Rajbhandari, 1988). Now NGLIP is under the umbrella of Nepal Agricultural Research Council (NARC) since 1990 with its name National Grain Legume Research Program. The major activity of this program is the development of improved varieties of different grain legumes suitable to different agroclimatic conditions of Nepal.

2.1.1 Grain legume diversity in Nepal

The major and minor legumes generally cultivated as food crops in different ecological region of Nepal are presented in the Chart 1.

Chart 1. Grain legume diversity in Nepal

Ecological Region	Major Legumes	Minor Legumes
Terai and inner-terai (Dry and Humid tropics)	Lentil (*Lens esculenta* M.)	Mung bean (*Vigna radiata* L.)
	Chick Pea (*Cier arietinum* L.)	Pea (*Pisum sativum*)
	Pigeon Pea (*Cajanus cajan* L.)	Horse gram (*Dolicus spp*.)
	Lathyrus (*Lathyrus sativus)*	Bean (*Phaseolus spp.)*
	Black gram (*Vigna mungo* L.)	Rice bean (*Vigna umbellata* T.)
Hill and valley (Humid-Subtropics and temperate)	Soybean (*Glycine max* L.)	Faba bean (*Vicia faba)*
	Black Gram (*Vigna mungo* L)	Pea (*Pisum sativum*)
	Cow Pea (*Vigna sinensis* L.)	Rice bean (*Vigna umbellate* T.)
	Ground Nut (*Arachis hypogea*)	Bean (*Phaseolus spp.)*

(Source: Rajbhandari, 1988).

2.1.2 Research on rice bean in Nepal

Rice bean along with other pulses like field pea, cow pea, broad bean, *Phaseolus*, and mungi occupies 319557 ha area with production 274375 mt and productivity 859 kg ha^{-1} in Nepal (ABPSD, 2007). National Grain Legume Research Program is the sole governmental organization responsible for research in grain legume in Nepal. But almost all the activities of the research institution have concentrated on the major leguminous crop along with few minor leguminous except rice bean. Because of these reasons, major priority has not been given to the research on rice bean in Nepal. So, there were no any improved varieties and even scientific production technology has been recommended yet. However, a package of simple production technology along with two types of local varieties (*determinate* and *indeterminate type*) on rice bean has recommended by the Sustainable Soil Management Program (SSMP) Nepal (Subedi *et al.*, 2001). No systematic research has been carried out yet on the improvement of these underutilized legume crops (i.e. rice bean) in Nepal therefore; no standard statistics is available about this crop. Currently (April, 2006), a new research project "Food Security through Rice bean Research in India and Nepal" (FOSRIN) has been lunched in India and Nepal. FOSRIN is a three year project funded under the EC's INCO programme to popularize the under-utilized crop rice bean. The project involves eight partners: universities, research organizations and NGOs in Europe and Asia, and has adopted a client-oriented approach, working closely with farmers and other stakeholders. The partner organizations of FOSRIN are:

- Local Initiatives for Biodiversity Research and Development (LI-BIRD), Pokhara, Kaski, Nepal
- Nepal Agricultural Research Council (NARC), Kathmandu, Nepal
- CAZS Natural Resources, University of Wales Bangor, UK (CAZS-NR)
- Department of Agricultural Economics, Christian Albrechts University, Kiel, Germany (CAU)
- Department of Geography, University of Bergen, Norway (UB)
- Crop Research Component, Gramin Vikas Trust, Dahod, Gujarat, India (GVT)
- Ch. Sarwan Kumar Krishi Vishwa Vidyalaya, Palampur, Himachal Pradesh, India (CSK HPKV)
- Assam Agricultural University, Jorhat, Assam, India (AAU)

The overall objective of FOSRIN project is to make the under-utilized crop rice bean more than locally popular by identifying and measuring the diversity within the range of germplasm available in India and Nepal and characterizing it for suitability to the cropping systems of the region, matching farmer-preferred varieties to diverse seasons, environments and markets, using a combination of genetic, agronomic, and socio-economic approaches firmly based on client-orientated principles to identify genotypes and parents for breeding programmes suitable for integrating rice bean into rice- and maize-based cropping systems as well as into the diets of consumers in WNE India and Nepal.

Taxonomy and origin of rice bean

Like other Asiatic *Vigna* species, rice bean belongs to the subgenus *Ceratotropis* (Maréchal *et al.*, 1978; cited in Fernandes, 2003). Within the various cultivated species in this subgenus there are three more-or-less isolated secondary gene pools: *radiata* (mungbean, green gram)-*mungo* (black gram, urd bean), domesticated in India; *umbellata* (rice bean)-*angularis* (adzuki bean), domesticated in South East Asia and North East Asia , respectively; and *aconitifolia* (moth bean, mat bean)-*tribolata* (pillipesara bean, jungle bean), domesticated in South Asia (Rath *et al.,* 1996; Fernandes, 2003). *Vigna glabrens* is thought to be a cross between *V. radiata* and *V. umbellata*, domesticated in South East Asia. The centre of diversity and presumably of origin of rice bean in Indo-China – it is thought to be derived from the wild species *V. umbellata* var. *gracilis*, found naturally from southern China through the north of Vietnam, Laos and Thailand into Burma and India, and which is thought to be cross-fertile (Tomooka *et al*, 1991; cited in Fernandes, 2003). The species is thought to have become domesticated progressively through accumulating agronomically desirable traits. The wild form is typically fine-stemmed, freely branching and small leaved, with a twining habit, photoperiod sensitivity, indeterminate growth, sporadic and asynchronous flowering, strongly dihescent pods and small, hard seeds (Choubey, *et al.,* 1997; Fernandes, 2003).

Rice bean is most widely grown as an intercrop, particularly with maize, throughout Indo-China and extending into southern China in the east and into North East India, Bangladesh and Nepal in the west. It is grown mainly as a dried pulse, but also used as a fodder crop and a source of green pods. In the past, it was widely grown as a lowland crop on residual soil water after the harvest of traditional long-season rice varieties. Despite their long history, only mungbean has received in-depth research interest. Only three mungbean, black gram and adzuki bean are used in mechanized agriculture due to their more upright habit and relatively synchronous flowering (Fernandes, 2003).

Varietal diversity on rice bean

Rice bean is described as an annual crop with erect to semi-erect or a vine (Fery, 1991). It is profusely branched and its vines sometimes attain a height of three meters (Chandel *et al.,* 1988). Leaves are tri-foliate, leaflets being comparatively broader, hairy and usually trilobed. Flowers are conspicuously bright yellow and borne in clusters (Fernandes, 2003). Wild varieties of rice beans are perennial, very viny, and thin stemmed with a tuberous root system. Seedlings grow vigorously, establish themselves early, and smother weeds (National Academy of Science, 1979; cited in Fernandes, 2003). This crop is largely a self-pollinated diploid (2n = 22) but there is some evidence of natural cross-pollination (Fery, 1991). Its pods are medium long, slightly curved and beaked, while seeds of variable size and color elongated with a long linear, raised and furrowed hilum are predominant (Fernandes, 2003). There are four taxonomically distinct botanical varieties of rice beans and these are:

1. Variety *rumbaiya*, cultivated in Khasia Hills of Myanmar with short erect or spreading stems.
2. Variety *gracilis*, a wild form with slender smooth stems and narrow leaflets.
3. Variety *glaber* with smooth stems and leaves.
4. *Phaseolus torosus* Roxb, cultivated in Nepal has reddish pods, short and sub cylindrical, pale cream colored seeds (Chandel *et.al*., 1988)

Rice bean ecology

Rice bean can be grown on a wide range of soil types, including heavy paddy soils, although maximum yields require fertile loam (Arya *et al.,* 1995; Fernandes, 2003). Although traditionally planted after rice, it cannot withstand waterlogged conditions (National Academy of Science, 1979; Fernandes, 2003). The cultivars of rice beans are well adapted to practically the same areas as cowpeas. As a tropical crop, it is susceptible to frost, but tolerates high temperatures. It is best grown where temperature averages 18-30 degrees Celsius and where rainfall as 1,000-1,500 mm per annum (Duke, 1981; cited in Fernandes, 2003). Rice beans are known to thrive at altitudes as high as 2,000 meters in the Western Himalayas (Arya *et al.,* 1994; Fernandes, 2003). As a short day legume, its flowering is only initiated when days are short. The day -length threshold is less than 12 hours (Kay, 1979; cited in Fernandes, 2003)

Rice bean use diversity

Rice bean is a multipurpose crop, which can be used as food, fodder, green manure, and as a cover crop (Chatterjee, 1977; cited in Fernandes, 2003). The rice bean has a potential as a protein-rich pulse for human consumption, soil improvement and conservation, as a fodder for livestock and as a deterrent against soil erosion if used as a cover crop (Mal & Joshi, 1991). It has good cooking quality. The seeds, the primary products, are usually eaten in soups, or as a pulse boiled with or without rice. The young pods and leaves are used as vegetable (Purseglove, 1974; cited in Fernandes, 2003). After picking the mature pods, the plant is utilized as fodder. If grown primarily for fodder, it should be harvested when the pods are half developed, since the leaves drop easily as the plant reaches maturity (Mohapatra, 1996; Fernandes, 2003). The foliage, green pods, immature seeds, and flowers are all easily eaten by animals.

2.2 Agricultural biodiversity

The component of biodiversity that is directly relevant to agriculture in the form of crop plants and livestock along with their gene providing wild relatives and landraces, bio-control agents and those offering vital ecosystem services such as pollinators, decomposers and which recycle nutrients, is known as agrobiodiversity (Thapa, 2006). The diversity of crops and livestock is the outcome of thousand of years of deliberate selection and field level cross breeding which farmers have tried out. However, the agricultural system is changing drastically in recent years with monoculture plantations and replacement of traditional varieties by high yielding varieties.

Landraces (traditional cultivars) and their wild relatives are the key element of agricultural biodiversity and constitute a key resource maintained and used by farmers in different production environments. Diversity of agro ecosystems has helped Nepalese farming communities in maintaining diverse crop resources in the form of local cultivars i.e. landraces (Bajracharya *et al.*, 1999). Different landraces have been grown to the farmer's field since long time, which have been adapted to specific local human needs and environmental niches. Bardsley and Thomas (2005) stated that landraces are the genetically distinct local crop population which came to existence as a result of combined forces of natural and artificial selection in a farmer's field. Crop diversity, in addition to being affected by population structure and natural selection from the surrounding environment is affected by farmer selection of agro-morphological traits and management (Jarvis *et al.,* 1998). Landraces are passed from generation to generation of farmers and are normally distinguished by farmers by agro-morphological characteristics (Louette *et al.,* 1997; Teshome, 1997). Farmer's decision of whether to select or reject or maintain a particular landrace at any given time is influenced by environmental, biological, cultural and socio-economic factors (Bajracharya *et al.*, 1999).

2.2.1 On-farm conservation of agricultural biodiversity

On-farm conservation of plant genetic resources has been defined as the continued cultivation and management of a diverse set of crop populations with intra and inter-population variation in the agro-ecosystems where a crop has evolved (Bellon, 1996). On-farm conservation of landraces refers to plants or its wild relatives that are conserved in the place where they developed their present-day characteristics (Altieri and Merrick, 1987; Brush, 1995; Jarvis and Hodgkin, 2000). On-farm conservation, which is a dynamic form of PGR management, allows the process of natural and human selection to continue. Therefore, on-farm conservation is generally used to describe as a management process by which farmers maintain the traditional crop varieties which was developed in their local conditions and which they continues to manage and improve (Sthapit, 2006). Thus, the conservation of specific genotypes is secondary to the continuation of the processes that allow the material to evolve and change over time (Altieri, and Merrick, 1987; Jarvis and Hodgkin, 2000).

Farmers' practice on-farm conservation that have maintained and managed the diversity at different levels depending upon their traditional needs, resources and the production environments available over space and generations. However, there is a concern emerging worldwide on the loss of genetically variable landraces and substitution with genetically uniform modern crop varieties (Harlan, 1992). The Convention on Biological Diversity (CBD) is the first multilateral international agreement that has recognized the conservation and sustainable use of biological diversities an international concern and has given prominence to the approach of in situ conservation of biological diversity globally and nationally for sustainable use and welfare of human beings especially of local farmers and communities. Landraces constitute one of the most important sources of crop plant variation valuable for plant breeding and a significant component of sustainable food production system. Despite the importance of landraces and increasing interest in on-farm conservation, there is limited knowledge and understanding on on-farm conservation as only a few studies have been undertaken to understand crop diversity at farm and community level. In 1994, the Bioversity International took the initiative and began working together with eight partner countries for he development of a global project "Strengthening the Scientific Basis of *In Situ* Conservation of Agricultural Biodiversity on-farm" and was implemented in these countries (Jarvis and Hodgkin, 1998). Nepal was one of them and has completed it in early 2006. Substantial studies on scientific, socio-economic, community participatory aspects in relation to project foci: extent and distribution of genetic diversity on-farm; processes used to maintain genetic diversity on-farm; custodians of genetic diversity within farming community and factors influencing farmers decision on maintaining traditional varieties we carried in three major agro-ecosystems (high-hill, 2200-3000 m; mid-hill, 600-1400m; and Terai-the low land,80-100 m) of the country in eight mandatory agricultural crops during the project period. The project sites representing the different agro-ecosystems were Jumla, Kaski and Bara and the crops were rice, barley, buckwheat, finger millet, pigeon pea, sponge gourd, cucumber and taro. Except rice, all mandatory crops were the under utilized crops in Nepal. The project has contributed considerable amount of knowledge base and has established some good methods and practices on these aspects for the conservation of agro-biodiversity on-farm with examples of the project mandatory crops (Bajracharya, *et al.,* 2006).

2.2.2 Factors influencing farmers' decision on on-farm conservation of landraces

Farmer's decision regarding deployment of varieties to specific agro-ecological domains was determined by the farmers' traditional knowledge on the suitability of varieties to specific domains (Subedi *et al.,* 2003). Farmer's decision to maintain, incorporate or discard a variety is determined by set of variables. These variables could be of economic, socio-cultural and environmental (physical) factors which satisfy farmers for undertaking on-farm conservation of diversity. It is the combination of these variable that determines on-farm crop diversity (Cromwell & Oosterhout, 2000; Rana *et al.,* 2005).The wealth status, composition of farm family (male/female/farm-kids), education status, landholding, number of parcels, land types, on-farm and off-farm sharing, agricultural practices like application of farm yard manure (FYM), chemical fertilizer, irrigation, planting, harvesting etc. and site location and its environment are the key factors that influence the farmers' decision and shapes the diversity of a crop (Gauchan *et al.,* 2005). The various socio-economic, technical and land resources related factors influencing farers decision on management of diversity of these three crops are outlined in the Chart 2.

Chart 2. Factors influencing farmers' decisions to manage crop diversity in the ecosite

Socio-economic	Technical	Resources and land
Wealth category of farmers	Cultivation practices	Type of land
Type of community	Seed quality and viability	Soil types and structure
Education level of farmers	Varietal types and their traits	Number of land parcels
Involvement of gender	Seed selection and exchange	Moisture availability
Household size and composition	Knowledge about cultivars	Livestock types and number
Farmers' occupation	Status of research and development in a given crop	Access to seed source
Market access and price		Awareness abut biodiversity
Culture of the society		

Religious regions

(Source: Baniya *et al*., 2006).

2.3 National policies for agrobiodiversity conservation

Nepal has immense potential for improving farmer's food security and livelihood through sustainable utilization, value addition and conservation of its rich agrobio-resources. However, this agrobio-wealth potential of the country has not been properly harnessed and realized by the policy makers, planners and development workers alike (Gauchan *et al.,* 1999). Enabling policy environment especially the incentives (both market and non market based) it generates through price, credit, technology, institutions (research, extension and formal education), and regulatory framework play pivotal role in sustainable harnessing, value addition, and conservation of agro-bioresources (Gauchan *et al.,* 1999).

Presently there are few policies for the sustainable utilization and conservation of agrobiodiversity on-farm. Although there are few national policies on agrobiodiversity management and farmers' right, yet the country lacks programs to provide incentives to the farming communities for their knowledge and innovations. Increasing globalization, liberalization and commercialization in agriculture have posed a potential threat in the loss of genetic resources. Nepal's entry to World Trade Organization (WTO) and enforcement of Trade Related Aspects of Intellectual Property Rights (TRIPS) in WTO have brought new policy challenges and issues that need increasing concern for equitable sharing of benefits arising from the use of agrobiodiversity (Gauchan *et al*., 1999). The present policy on genetic diversity is more focused on forest resources including wildlife than on the overall genetic diversity of the agricultural crops, which are important source of livelihood for Nepalese people. Nepal as a signatory of Convention on Biological Diversity (CBD (in

1992, no significant progress has been made in this respect. Present government polices on infrastructure, market, irrigation development and input supply and subsidies are geared towards improved varieties and practices. In addition, there are gaps in policy perceptions (interpretation) and implementation among different groups of stakeholders (e.g. farmers, traders, development workers, researchers and planners and policy makers). Policies to multiply, certify, quality control and seed distribution of minor crops and landraces are lacking. In addition, informal seed supply system do not receive any form of policy and institutional support from the government, despite its large coverage (80-90% of the area) and contribution in overall crop production and food security of small-scale farmers. The existing regulatory framework also provides disincentives to the rapid promotion and utilization of rich land races diversity found in the farmers fields (Sthapit *et al.,* 1996).

Economic and agricultural policies often play a major role in farmer's decisions whether or not replace traditional landraces with modern varieties. Such policies can either revolve around agricultural practices directly, or they can shape the macroeconomic conditions, which determine the marketability of particular varieties. Until 2002, biodiversity conservation programmes in Nepal were mainly focused on forestry and wild life resources without considering the importance of conserving crop genetic diversity for local food security and livelihoods (Upadhyay *et al.,* 2006). Present agricultural policies of government of Nepal are guided by the 20 years (194/95-2014/15) Agriculture Perspective Plan (APP), national agricultural policies (2004), and three year interim plan (2007-2010). These policies have fundamentally focused on production of a few major crops and well researched uniform modern varieties of crops in favorable pockets with intensive input use and package approach. The 'pocket package approach' of APP seems to be implemented without analyzing their consequence on on-farm genetic diversity.

2.3.1 Agriculture perspective plan (1994/95-2014/15)

Nepalese official agricultural policies such as Agriculture Perspective Plan (APP) emphasize crop diversification; they lack policy guidelines on on-farm conservation and utilization of minor crop genetic diversity of the country for future food security and sustainability of agricultural production. These policies commonly emphasize high external input and high- yield agricultural production in favorable environments with access to irrigation, roads, electricity, markets and availability of other support services without analyzing their consequences on on-farm genetic diversity. At the local level, farmers may replace their landraces by high yielding varieties (HYVs) in a high yield system, enticed by the apparent financial gains, which such approach promises, these types of policies are commonly referred to as negative incentives because although they do not detract from traditional crop diversity directly, they act to promote HYVs and practices, which cause genetic erosion.

2.3.2 National agricultural policy, 2004

There are possibilities of achieving a sustainable economic growth and ensuring food security through the proper utilization of the opportunities provided by the country's geography, farmer's experience, and modern farming technologies. The 1991 policy outlines of Agricultural Development and the Agricultural Perspective Plan, which have been brought into force with the objective of ensuring an overall development of the agricultural sector, have provided, to some extent, a sense of direction to the process of development of this sector. Even then, against the background of economic liberalization, the commitments made by the country at the World Trade Organization and regional organizations, the sustainable development agenda set for the country, and its goals of millennium development, the need has been field for formulation and implementing a new National Agricultural policy that retains the basic aspects of the Agricultural Perspective Plan (MOAC, 2004). The long-term vision of the national agricultural policy, 2004 is improvement in the standard of living of people through a sustainable agricultural development that will be achieved by transforming the current subsistence oriented farming system into a commercial and competitive farming system (MOAC, 2004).

Policy highlights

Increase in agricultural production and productivity

- Agricultural production and productivity will be increased by utilizing the local potentialities, comparative advantages and special opportunities, and ensuring the development, extension and utilization of appropriate agricultural technologies. Besides, additional opportunities of income and employment will be created by laying emphasis on the commercialization and diversification of agriculture.
- The extent of involvement and participation of women in all possible fields of the operation of agricultural programs will be raised to 50 %. With respect to women farmers training, arrangements will be made as far as possible, to conduct mobile training programs and take such training programs closer to villages and household. The flow of information and data relating to the involvement of women in the programs will be ensured.

Development of commercial and competitive farming system

- Large production pockets will be developed to produce agricultural products in quantities and of qualities that match the demands of the market. In such pockets, priority will be given to the production of such agricultural products as have comparative advantages. Besides, technologies and technical services, as well as such facilities as agricultural roads, rural electrification, irrigation, agricultural credit and marketing arrangement, will be mobilized in an interacted manner in such pockets.

- In areas adjoining food-deficit hilly regions where the food supply program is to be operated, the local production of food grains will be encouraged by purchasing locally produced food grains at market prices under the food supply program.
- The production and use of high-breed seeds and improved seeds will be encouraged, and the use of genetically-modified organism will be regulated.
- Traditional, local, original agricultural products and the related technologies will be registered and promoted. Special products and production technologies of the local origin will be identified and the related rights secured.
- Priority will be given to the promotion of cooperative-based agricultural industries and enterprises. The processes of commercializing the agricultural sector will be provided with necessary support by effectively mobilizing the agricultural industry and enterprise promotion board to analyze and provide outlets to the complaints and suggestions of agricultural entrepreneurs, industrialists, progressive farmers and related organizations and associations.
- The task of developing and extending a market information system and disseminating such information will be carried out in partnership with the private and cooperative sectors and the local bodies.
- For the purpose of guaranteeing opportunities for marketing the commercial production of agricultural products, the establishment of collection centers near the potential production centers will be encouraged, and, for the purpose of guaranteeing organized markets near large numbers of potential consumers, the process of developing and expanding well-equipped wholesale and seasonal markets under the cost-participation and management of the private and cooperative sectors will be encouraged.

Conservation, promotion and proper utilization of natural resources and the environment

- The negative impact of the use of agricultural chemicals on the condition of soil and reservoirs, and their environmental problems resulting there from, will be minimized
- The production, use and promotion of organic fertilizers will be encouraged.
- Arrangements will be made for gene banks and in-situ conservation will be encouraged in order to conserve bio-diversity. Participatory biodiversity parks will be established in feasible areas.
- Bio-diversity will be conserved, promoted and properly utilized and the agro-forestry system will be developed in such a way as to improve the condition of degraded forests and natural reservoirs.
- A conservation-oriented farming system will be gradually developed by managing watersheds and controlling erosion of soil by rivers on the basis of local participation.

2.3.3 National agrobiodiversity policy, 2007

Agrobiodiversity has a significant role for the food security and livelihood of human beings. Since time immemorial, our ancestors have been conserving, maintaining and developing this diversity (Manandhar, 2007). Though Nepal is rich in agro-biodiversity, the recent studies have revealed that the genetic resources are gradually disappearing over time and space. In an agro-based country like Nepal, where agrobiodiversity is the backbone for the sustainable development of agriculture, food security and poverty alleviation, it is the national responsibility to conserve, maintain and sustainable use of the available diversity (Manandhar, 2007). This necessitates effective institutional environments and programs to meet the needs and aspirations of the future generations. Realizing the significance of agrobiodiversity and the national commitment in the Convention on Biological Diversity (CBD), 1992 and recognizing also that the International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA) came into force on June 29, 2004, and other international treaties and agreements, this National

Agro-biodiversity policy has been formulated (Manandhar, 2007). The vision of National Agro-biodiversity Policy is to conserve and sustainable use of agricultural genetic resources/materials and associated traditional knowledge with the participation of concerned stakeholders for present and future generations. In national and international level, effort has been made to conserve biological diversity. The policy intends to recognize agrobiodiversity as an integral component of biodiversity based on the spirit of international treaties / agreements and national initiatives in order to ensure social, economic and environmental benefits to the Nepalese people (Manandhar, 2007).

Policy highlights

- Prioritize and implement programs on scientific studies, research, extension and other programs for conservation, maintenance and sustainable use of agrobiodiversity.
- Rights to authorize ownership of the agricultural genetic resources of Nepal shall remain with the Government of Nepal, Ministry of Agriculture and Cooperative.
- The ownership of local agricultural genetic resources shall remain with farmers, farming communities and the Government of Nepal for their roles in conservation, maintenance and sustainable use of genetic resources.
- The ownership of traditional knowledge, skills and techniques shall remain with farming communities.
- Agrobiodiversity registration shall be initiated to prepare a document for which the ownership shall remain with the farming communities.
- Rights to grant prior informed consent (PIC) for accessing local agricultural genetic resources and traditional knowledge, skills and techniques for foreign institutions shall remain with the National Agro- biodiversity Conservation Committee of the Ministry of Agriculture and Cooperative, Government, Nepal.

- Prior informed consent (PIC) shall not be required for the scientific studies and research at the national level.
- Institutions with prior informed consent for access to genetic resources and traditional knowledge shall undergo in the process of agreement for developing technology and commercialization of accessed genetic resources and knowledge. However, agreements shall not be allowed if it has an adverse effect on environment and biodiversity.
- IPR for innovation on genetic resources and knowledge shall not be claimed inside or outside Nepal without prior approval of the NABC.
- Traditional knowledge, skill and techniques on genetic resources / materials shall be protected as per the national IPR protection legislations.
- Benefits arising from use, commercialization and IP rights of agricultural genetic resources and IKT shall be based on the agreements made with the NABC.
- One window policy shall be adopted for the registration, ownership, access, use, commercialization and IPR etc of the genetic resources/ materials.
- Traditional seed exchange system shall be strengthened to protect farmers to farmers' seed exchanges and their access to a wide diversity material for inclusion in their innovation/production systems.
- The NABC shall approve and monitor scientific studies and research for import and innovation of GMO, LMOs and infectious organisms.

2.3.4 Three year interim plan (2007–2010)

The vision is to modernize and commercialize the agriculture sector, by acknowledging the Agriculture Perspective Plan and the National Agricultural Policy, 2004 as the central policy for the development of agriculture (NPC, 2007).

Agricultural and working policy highlights

Conservation, promotion and sustainable use of agriculture biodiversity

- Study, research and extension programs will be launched for conservation, promotion and sustainable use of agricultural biodiversity.
- Farmer to farmer seed exchange and traditional seed distribution system will be encouraged.
- Production increment, employment and income generating programs based on agricultural biodiversity and operation of the market and related business will be encouraged.

Traditional knowledge, skills, research and use of technology

- Farmers' traditional knowledge, skills, research, use of technology and practices on traditional and local food and agriculture genetic resource management will be protected. Arrangements will be made to place the rights to protect, promote and develop the ownership of such resources on with the farmers and the Government of Nepal.
- Detailed scientific profile of collection, classification and evaluation of agriculture bio-resources will be prepared.
- Agricultural biodiversity will be registered and arrangements will be made to keep their ownership with farmers.
- Arrangements will be made to keep the rights related to the ownership of farmers" traditional knowledge, skills, research, use of technology and practices with the concerned farmers.

Equitable and justified distribution of access and benefits of agriculture genetic resources and materials

- Study at the institutional level will be facilitated in subjects related to traditional local food and agriculture genetic resources with the prior permission of the Government of Nepal under pre-defined conditions. Permission will not be granted at a personal level.

- ❖ Arrangements will be made for the equitable sharing of benefits accruing from business or intellectual property with the utilization of traditional and local food and agriculture genetic resources and/or knowledge of the local community.
- ❖ Issues of record and ownership of food and agriculture genetic resources, access and benefits sharing will be dealt with, under the 'one window system'.

Regulatory system for environmental balance and protection of agriculture biodiversity

- ❖ Conservation of agriculture bio-diversity will be focused while conducting EIA for development projects.
- ❖ Arrangements will be made to follow the provision of not to conduct study strictly, research and import of infectious, genetically modified organisms, living modified organisms without the prior consent of the concerned agency.
- ❖ Arrangements will be made to control and or prohibit the production of GMOs that carry the risks of negative impacts on biodiversity, environment and human health.
- ❖ Conservation programs will be implemented by undertaking study, research and monitoring of pollination and other organisms providing environmental services for the sustainable mobilization of agriculture ecological services.

2.4 Marketing

Marketing is a major function after production. Acharya and Agarwal (1999) state that production is the door to economic development but it is marketing, that opens the lock. Thus, marketing plays an important role in agricultural production. Moreover, marketing is the creation of time, place ad possession utilities through which human wants are satisfied by the exchange of goods and services. According to Acharya and Agarwal (1999), agricultural marketing is a process, which includes farmer's decision to produce a saleable farm commodity and various aspects of marketing structures, both functional and institutional with technical and economic consideration including products assembling, preparation of market distribution and use by final consumer. Thus, marketing starts with the decision to plant unlike to the conventional way of thinking.

High value and fine rice bean landraces have better market opportunity to improve the economic status of the farmer and to fulfill the consumer needs. In Nepal, most of the research is production oriented and less emphasis is given for market linked production that would be the important means to meet the changing needs of the people (Gauchan *et al.*, 1996).

2.4.1 Marketing system

Marketing system includes producer farmers, traders, transporter, wholesalers, retailers and consumer as the main actors to carrying out different activities. Marketing system also consists of subsystems affected by physical, climatic, socio-cultural, technological, economic, legal and political factors (Sidhu, 1986). Marketing system consisted the understanding of three aspects which are market channel to understand product flow and outlet of cultivars, marketing margin to understand margin and profit signals and market price to understand market price signals (Gauchan *et al.,* 2005). This concept of marketing system was also used to identify incentives for cultivation rice landraces. According to Joshi (2004), an efficient marketing system is essential for timely delivery at reduced marketing costs and the efficiency of market is influenced by a number of external factors such as policy, regulatory framework and infrastructures.

Rijal *et al.,* (2003c) have stated that unlike modern varieties, there is hardly any formal market channel for rice bean landraces and landrace based products, but a number of informal channels do exist. Market, which provides incentives for maintaining agrobiodiversity on-farm is now lacking. As a result, conservation, use and maintenance of these local varieties and associated knowledge are eroding in the local communities though cultural institutions that are supported through indigenous food cultures.

2.4.2 Marketing incentives

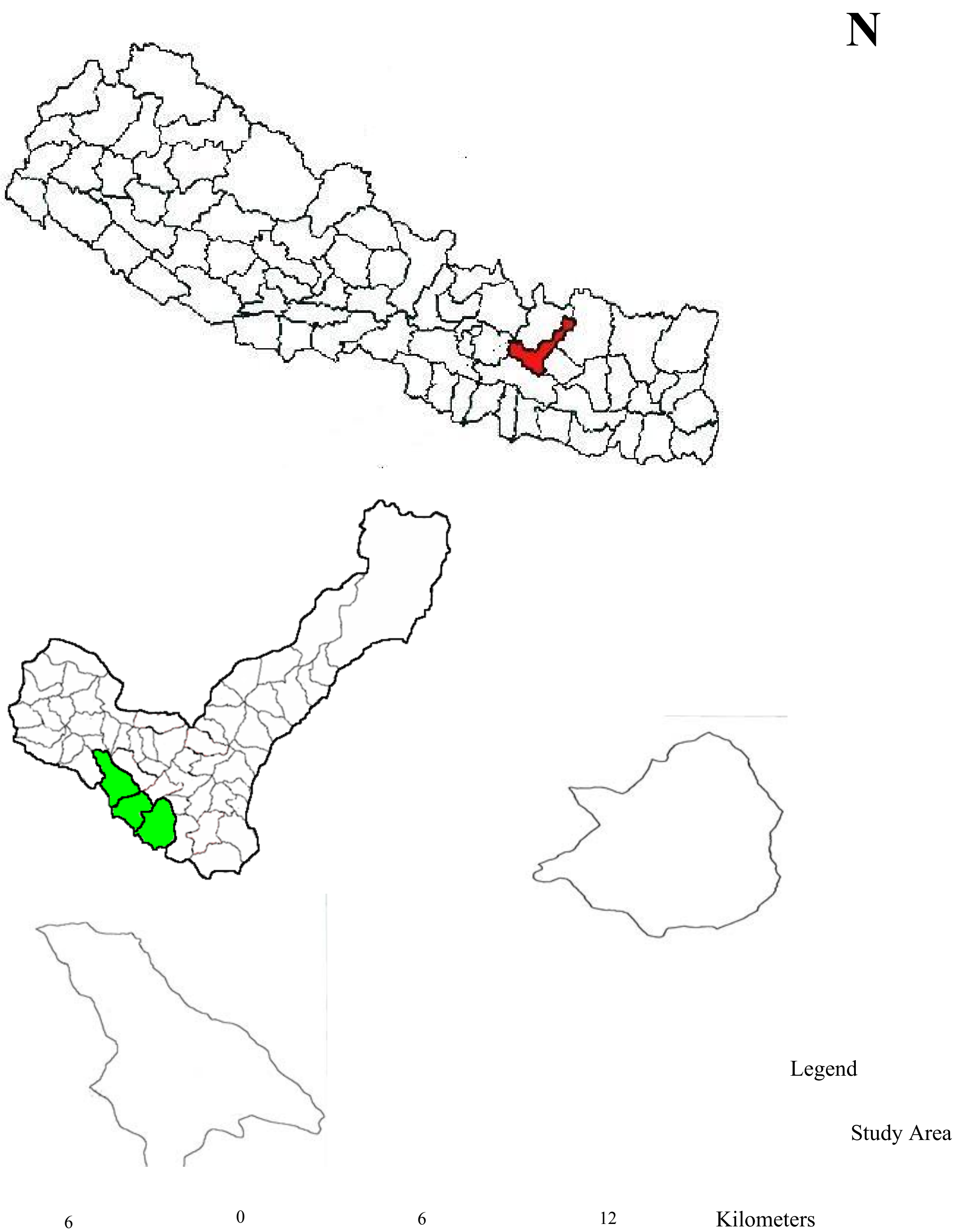
Incentives are the positive or negative outcomes that people expect from actins they take within the working rules of their physical and social setting. Such rules reflect their individual and cultural values and are embedded in institutions (Ostrom, 1997, cited in Gauchan *et al.,* 2005). Jarvis and Hodkin (1997) suggested that there are two main ways of adding benefit to crop genetic resources. First, the local landraces *per se* may be improved by adding use value through breeding means and second, the demand of the farmers cultivars or some derived products may be increased by providing market incentives, policy relief and consumer awareness.

Rijal *et al.,* (2000) demonstrated that adding benefits on some local landraces would be the simple way to enhance on-farm conservation of rice bean landraces. These benefits can be added through identifying niche market e.g. Local shops, restaurants, hotel, target consumer etc. and understanding incentives structure for production and marketing in terms of quality, cultural value, market pricing etc. In Nepal, lack of promotional activities to enhance the use value and benefits of landraces is one of the main factors to lower the community participation to conserve the diversity. At present Nepal still lacks clear policies on value addition and marketing support e.g. Market facilities for conserving local crops and landraces (Sapkota *et al.,* 2003). According to Gauchan *et al.,* (2005), market-based incentives are the least expensive instruments for supporting conservation because there is no need for public interventions when they function well. No matter would be interested to conserve any plant genetic resources just for the stake conservation (Joshi *et al.,* 2003). Some sort of benefit would motivate farmers to maintain landraces. Thus, the idea is to add value or provide market incentives to the existing landraces so that they become competitive with modern varieties and hence, likely to be conserved.

3 METHODOLOGY

3.1 Selection of study area

This study was conducted in the Mid-hills of Central Development Region of Nepal, which is one of the most potential regions for rice bean both in terms of area and production of the country. From this region, Ramechhap District was selected for the purpose of the study based on the relatively higher area coverage by rice bean. Similarly, the pocket areas within the district were selected purposively based on area coverage and production of rice bean. Based on these criteria, three Village Development Committees (VDCs) namely, Ramechhap, Bhaluwajor and Pakarbas were selected from Ramechhap District. In addition to this the study area was selected in such a way that these three VDCs represent the whole agro-ecological domain of the Ramechhap District producing rice bean landraces. The map of Nepal showing the study district and map of Ramechhap District showing the study sites are presented in Figure 1.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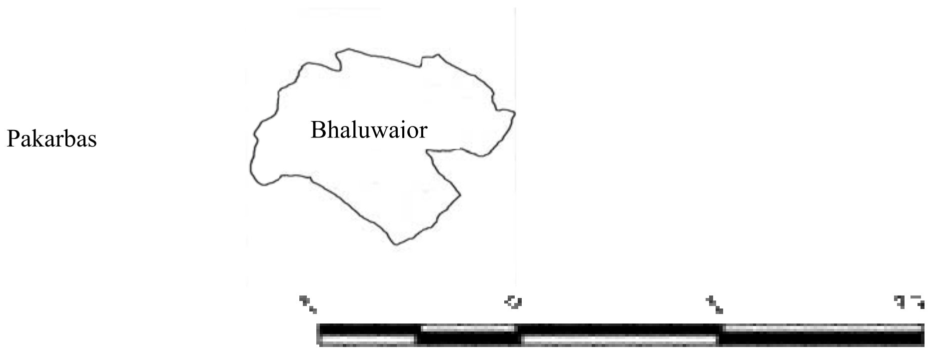


3.2 Sample size and sampling procedure

Sampling plays an important role in research. Without a sound sampling plan and a suitable sample size, the data will be collected from neither proper respondents nor the appropriate number of them (Tull and Hawkins, 2000). The sample size determination and sampling procedure used in this study are discussed hereunder.

3.2.1 Selection of rice bean producers

Rice bean growers of the selected VDCs were the targeted population for his study. Most of the farmers (95%) of these VDCs grow rice bean and almost all rice bean varieties grown in these sites are the landraces form the respective sites (DADO, 2006). However, in order to facilitate measurement of interest variables, the farmers who grow at least one rice bean landrace were considered as survey population and were thus, included in the sampling frame. The list of rice bean growers in the district was not recorded formally by DADO but informal list rice bean grower across the study sites were prepared with the help of JT, JTA, and local key informants of respective sites. Care full attention was paid to make the list more inclusive (i.e. inclusion of producers from different wealth categories, different ethnic groups and different agro-ecological domains) within the VDC as far as possible because farmer's decision of whether to select or reject or maintain a particular landrace at any given time is influenced by environmental, biological, cultural and socio-economic factors (Bajrachrya *et al.,* 1999). Altogether 34 producer's form each VDCs, meeting the criteria of sampling unit were selected by applying simple random sampling method. Altogether 102 respondents were randomly selected for this study.

Table 1. Sample size distribution by VDC in the study area

Name of VDC	Sample Size (No.)
Ramechhap	34
Bhaluwajor	34
Pakarbas	34
Total	102

3.2.2 Selection of rice bean traders and consumers

For this study three types of rice bean traders, village level collectors/commission agents, wholesalers, and retailers were identified and selected for the interview. Village level collectors and commission agents were identified during the visit of study sites and at local *hat*. Therefore, 6 village level collectors, 6 local retailers, 4 commission agents and 5 consumers were selected purposively and interviewed from the Ramechhap District. Similarly 3 wholesalers, 5 retailers and 5 consumers were selected purposely and interviewed from the Kathmandu valley, since more than 70% of the total production of rice bean at Ramechhap District flows to Kathmandu valley (DADO, 2006).

3.2.3 Selection of key informants for local knowledge documentation

Altogether, 18 knowledgeable farmers (6 from each VDC) belonging to different economic status, ethnicity, and gender were selected for the documentation of local knowledge associated with rice bean.

Table 2. Selection of key informants for local knowledge documentation

Socio-economic categories	No of interviews in each VDC			
Wealth category	Ramechhap	Bhaluwajor	Pakarbas	Total
Rich	2	1	3	6
Medium	3	3	1	7
Poor	1	2	2	5
Ethnicity				
Brahmin/Chhetri	1	2	3	7
Newar/Tamang	3	2	2	6
Dalit	2	2	1	5
Gender				
Male	4	3	3	10
Female	2	3	3	8
Total	6	6	6	18

3.3 Methods of data collection

Both the primary and secondary data were used. The pre-tested interview schedule was administered to the selected farmers and traders to collect primary data. These data were supplemented by the information obtained through observation and key informant interview for understanding marketing system, marketing channels, marketing margins and location specific characteristics of the study site.

The secondary information were obtained through reviewing different publication mainly produced by Local Initiatives for Biodiversity Research and Development (LI-BIRD), Nepal Agricultural Research Council (NARC), Market Development, Division (MDD), Ministry of Agriculture and Co-operatives (MOAC), Central Bureau of Statistics (CBS), Agro-enterprise Center (AEC), International Plant Genetic Resource Institute (IPGRI), International Rice Research Institute (IRRI), District Agricultural Development Office (DADO).

3.3.1 Techniques of primary data collection

3.3.1.1 Interview

Primary data were collected through interview schedule. The information on existing production system and various problems of production and marketing of rice bean landraces were collected. Information about household and farm-physical characteristics and market participation were also collected from the farmers. Traders were interviewed to collect the information on marketing system, market price and marketing problems. Similarly consumers were interviewed to collect the information on consumer preference on food items prepared from rice bean, satisfaction with existing price, consumer demand of rice bean and their attitude to wards product etc.

3.3.1.2 Observation

A number of visits were made by the researcher in different area to understand marketing systems, marketing channels, marketing margins and location specific characteristics of the study site. Researcher participated in the national level rice bean field trial monitoring team from Food Security through Rice bean research in India and Nepal (FOSRIN) project, coordinated by CAZS Natural Resources, University of Wales Bangor, UK and observed the multi-location trials conducted on the research stations of Nepal Agriculture Research Council such as National Grain Legume Research Programme, Rampur, Chitwan, Hill Crop Research Programme, Kabre, Dolkha and the rice bean, grown on farmer's field in Ramechhap District which was the study site of researcher.

3.3.1.3 Local knowledge documentation

Knowledge-Based System (KBS) approach was used as methodological framework for documentation of local knowledge on rice bean. For this a total of about 18 farmers (belonging to different ethnicity, economic status, age and gender) from different physiographic and agro-ecological domains of selected VDCs had been selected for the face to face interview with the help of key informants. The interview was taken with the help of mentally prepared check list and their voice was recorded in the Dictaphone. The recorded information was translated in to the writing form every day/night regularly. The repeated interaction with the farmers was done to overcome the short comings and unclear section of the indigenous/ local knowledge associated with rice bean.

3.4 Survey design and data collection procedure

3.4.1 Interview schedule design

Three set of data collection instruments were prepared for the collection of primary data. First set includes interview schedule, which was prepared to collect information from producer and second set was prepared for intermediaries to collect information from traders. The third set was for key informants for local knowledge documentation about rice bean. A co-ordination schema was prepared to identify variables and the interview schedule was prepared accordingly. The major variables included interview schedule were household socio-economic characteristics, farm characteristics and production and marketing environment, major livelihood systems, landraces diversity and use, use of external inputs, farmers' perceptions about variety traits, and farmer access to information and support services.

3.4.2 Pre-testing

The pre-testing of the interview schedule was carried out to 8 growers 3 traders and 2 consumers located at Ramechhap District and then correction of interview schedules was done accordingly.

3.4.3 Field survey

The field survey was conducted starting from 26 September, 2007 to 30 October, 2007. The respondents were interviewed by visiting their homes. The interview timing was fixed as per the farmer's convenience. Regular checking and validation of the information was done immediately after filling the interview schedule. The traders, key informants and consumers' were interviewed in the same manner.

3.5 Methods and techniques of data analysis

The information collected from the field was coded first ad entered into the computer. Descriptive statistics like mean, standard deviation, percent and frequency were used to describe socioeconomic and farm characteristics. For the test of hypothesis t-test and f-test were used. Multiple Regression model was used to analyze the factor influencing the rice bean landraces diversity and factors determining household income. Data entry and analysis was done by using computer software package, which are Statistical Package for Social Science (SPSS) and Microsoft Excel.

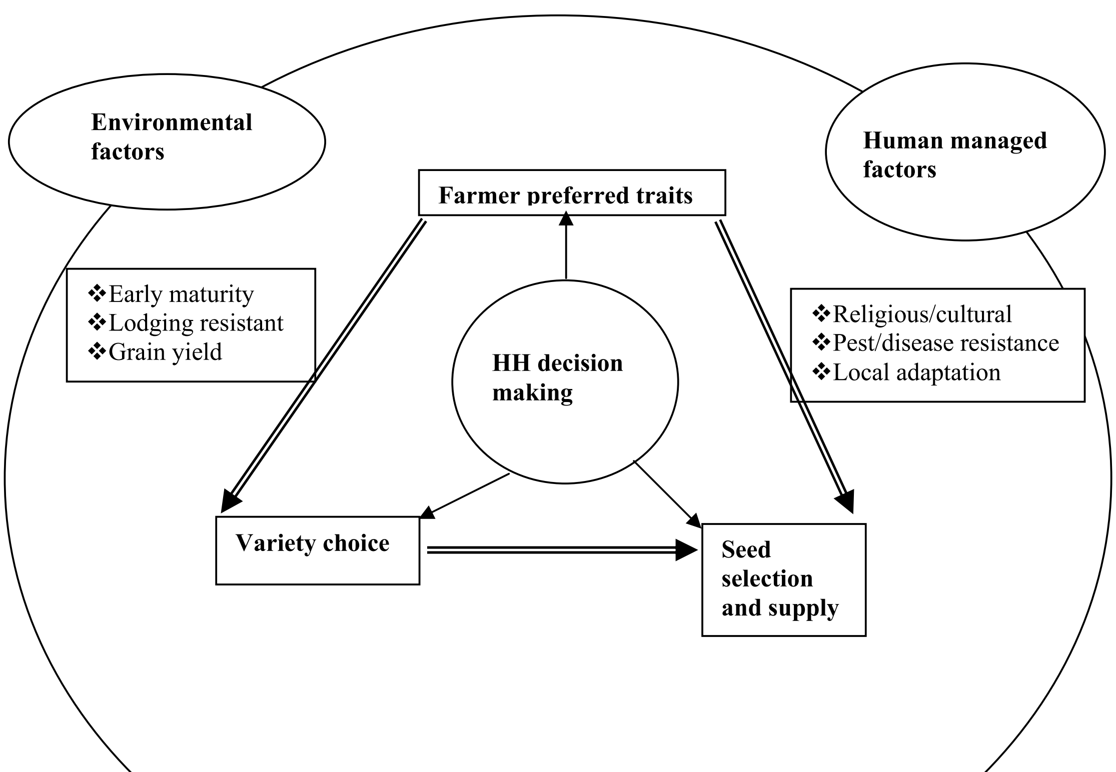
3.6 Conceptual framework for data analysis

3.6.1 Factors affecting rice bean landraces diversity

The study sites represent the subsistence production system and in such system production decision is indispensable to the consumption decision because farmers of subsistence nature are both producer and consumer. In addition, farmers in subsistence condition maximize utility rather than the profit. In this study, concept of socio-economic factors influencing landraces diversity has derived as used by Rana *et al*., (2006) to analyze the socio-economic factors influencing varietal diversity on-farm.

Farmer's decisions on management of agricultural biodiversity (landraces and modern varieties) on-farm are influenced by both biophysical and socio-economic factors. Kamppinen and Walls (1999) believe the existence and future course of biodiversity is very much dependent up on both biological and socio-cultural processes that directly influence biodiversity. Thus, a complex range of factors influences the conservation or erosion of genetic resources in farmers' field over time (Jarvis *et al.,* 2000). At operational level, factors influencing farmer's decision on management of varietal diversity on-farm are broadly classified under five major headings: environmental; human-managed environmental; socio-economic; cultural and government policies (Figure 2). These factors influence farmer's decisions whether to select, maintain or discard a particular crop variety (landrace or MV) at any given point of time (Jarvis *et al.,* 1998).

Conceptual framework



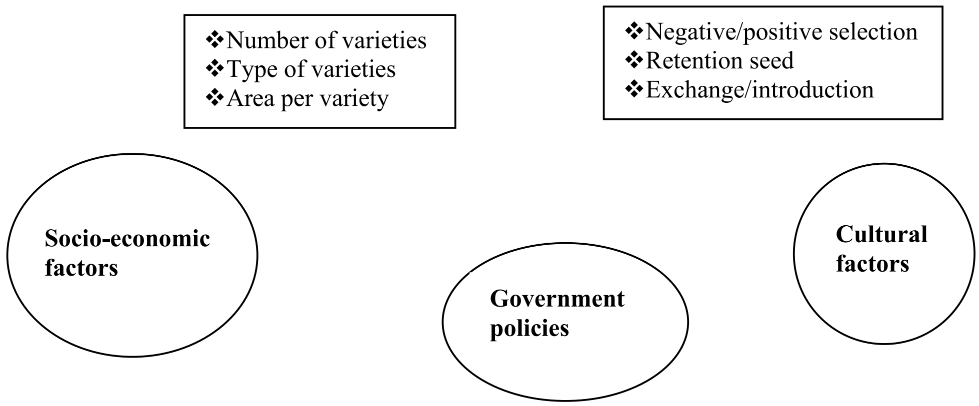


Figure 2. Conceptual framework of farmers' on-farm management of agro-biodiversity (Source: Adapted from Jarvis *et al.,* 1998 and Bellon *et al*., 1997).

The main thrust of the study is detailed understanding of socio-economic, cultural and human managed environmental factors influencing conservation. In other words, it is clearly geared towards creating a better understanding using social, economic and cultural perspectives of the nature of genetic diversity and its management at household and community level. Within socio-economic and cultural factors the study explores the relationship between resource-endowment of households and varietal diversity on-farm expressed as number of varieties per household, area under landraces and modern varieties, and growing of specific landraces. Gender of decision maker is an important parameter considered while disaggregating data on agricultural biodiversity management including upholding indigenous knowledge on use vale of landraces and agro-ecological knowledge base. Access to market and level of intervention from formal research and extension agencies is other important variables considered in the study. Cultural factors deals with the food culture and explores how specific food culture and religious ceremonies help in survival of landraces on-farm. The study on socio-economic and environmental context of agricultural biodiversity management is expected to revel relationships that underlie pattern in genetic diversity distribution at household and community levels.

Farmers' management of agricultural biodiversity on-farm can be distinctly arranged into three components (Bellon *et al.,* 1997). First, farmers make section on plant population using farmer-preferred traits (maturity, yield, disease resistance, post-harvest traits etc.) thus, deciding on survival of certain population over others. This aspect of farmer's management of biodiversity on-farm is outside the remit of the study. Thus, the study concentrates on farmer's management of variety choice. Within variety choice efforts are made to understand types of varieties (landraces and modern varieties) maintained along with the reasons for doing so. Similarly, number of landraces and area covered by different landraces both at household and community levels are analyzed to monitor diversity shift at different levels over time. The role of socio-economic and gender categories in management of landraces diversity is also established. Multiple regression has been run to see the effects of no of parcel, land size, availability of irrigation facility, no of food sufficiency months, income status, gender of decision maker in agriculture, education status of decision maker in agriculture, age of decision maker in agriculture, access to market facility, no of family member who work regularly on farm, group membership, ethnicity, cultural significance of particular rice bean landraces and intervention from formal research and development as independent variables over the number of rice bean landraces maintained by household as dependent variable. The model derived for the multiple regression analysis is:

Number of rice bean landraces maintained by household = f (no of parcels of land, area under *bari* land, HH food sufficiency, gender of decision maker in agriculture, HH access to market facility, no of family member who work regularly on farm, group membership).

Proposed equation of the multiple regression model

$R_n = \alpha + \beta_p X_p + \beta_a X_a + \beta_f X_f + \beta_s X_s + \beta_m X_m + \beta_l X_l + \beta_g X_g + \mu$ …………………..(i)

Where,

R_n = Number of rice bean landraces maintained

α = Intercept made of regression plane.

Where, X_p, X_a, X_f, X_s, X_m, X_l and X_g represents the no of parcels of land, area under *bari* land, Household food sufficiency, sex of decision maker in agriculture, Household access to market facility, no of family member who work regularly on farm and group membership , respectively.

Similarly β_p, β_a, β_f, β_s, β_m, β_l and β_g represents the coefficients of the no of parcels of land, area under *bari* land, HH food sufficiency, gender of decision maker in agriculture, HH access to market facility, no of family member who work regularly on farm, group membership , respectively. μ is the error term of proposed model.

Where, parcels of land in number, area in hectare, family labor in no, food sufficiency months in number; gender of decision maker in agriculture, access to market facility and group membership as dummy variable.

Chart 3. Description of independent variables and hypothesized effects on number of rice bean landraces maintained

Variables	Definition	Hypothesized effect
NOPL	No of parcels of land	(+)
AUBL	Area under *bari* land	(+)
HHFS	HH food sufficiency	(+)
SDMA	Sex of decision maker in agriculture	(+, -)
HHMF	HH access to market facility	(-)

NFMWRK	No of family member who work regularly on farm	(+)
GRPM	Group membership	(-)

3.6.2 Conceptual framework for local knowledge documentation

The framework for acquisition and analysis of farmers local knowledge on different aspects of rice bean landraces, used in the present research is based on a knowledge-based systems (KBS) approach developed originally for agro-forestry research and extension (walker *et al.,* 1995). The approach has been successfully used in Nepal, especially in the collection and analysis of farmers ecological knowledge about tree fodders (Thapa *et al.,* 1995) and its subsequent use in the planning of agro-forestry research and development (Joshi, 1997; Walkar *et al.,* 1997), and is increasingly being used in a number of countries worldwide in a variety of disciplines (Sinclair and Walker, 1999; SAFS, 2001). This is however, the first attempt to use the KBS approach in the field of local knowledge documentation of rice bean landraces in Nepal. The theoretical model of the KBS model is as follows (Figure 3). The scoping, definition and compilation stages, together lead to knowledge acquisition and development of a knowledge base. The generalization stage, designed to validate the representativeness of recorded knowledge and to explore its distribution amongst people within farming community.

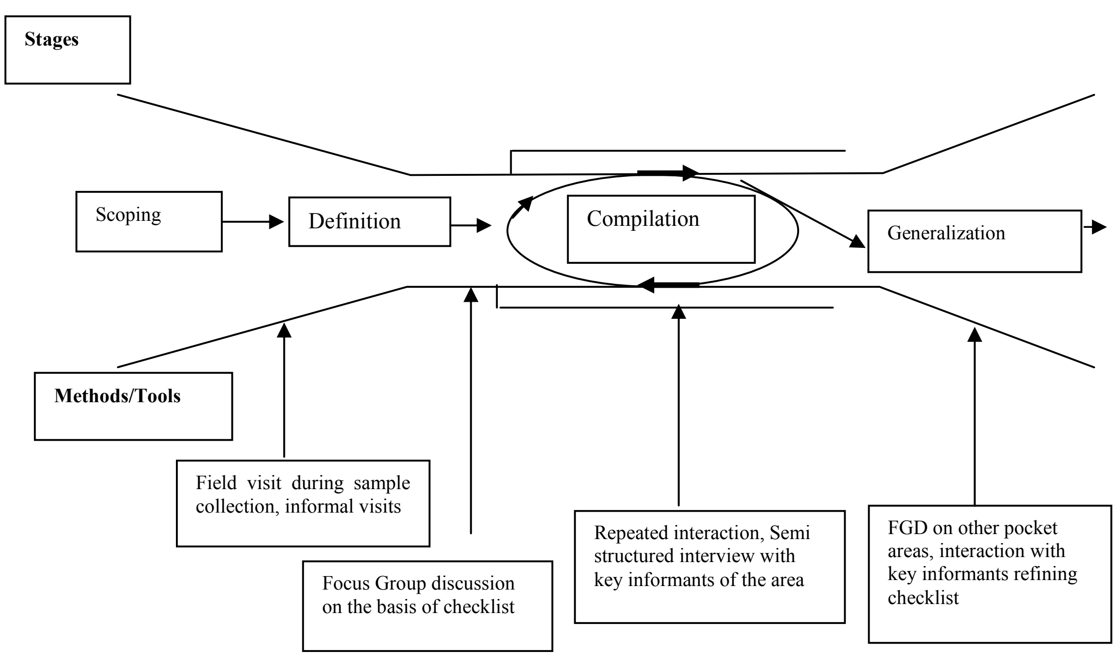


Figure 3. Overview of the four stages in the knowledge elicitation process
(Source: Adapted from Walker and Sinclair, 1998; cited in Shrestha, 2003).

A broad range of activities such as informal visits, interaction with existing farmers' group, accidental survey with rice bean growers during sample collection were done in order to familiarize with the source community and get the broader understanding of the knowledge held. Then, focus group discussion was done with rice bean growers of the community on the basis of checklist. Through focus group discussion, knowledgeable farmers representing the different altitude range of the area were selected for interview. Focus group discussions also helped in refining the research question, finding key informants and guide the knowledge acquisition strategy. With key informants, team interacted repeatedly through semi structured interview. Gathered knowledge and information were validated through Focus Group Discussion (FGD) with randomly selected farmers in the area.

3.6.3 Landraces diversity analysis

Farmer knowledge is documented to distinguish the farmer-named varieties based on their own morphology, growing environment and utility. The large numbers of parameters used by the farmers to describe their landraces such as plant height, grain size, grain color, pod length , growth habits, yield , eating quality, and resistant to adverse environmental conditions etc. are called "Farmer Descriptors". The landraces diversity is analyzed with the help of such farmer descriptors. Though the crop varieties are morphologically similar, farmer varieties/landraces are genetically different and therefore, farmers are consistent in naming and describing the landraces or Varietal diversity (Rijal *et al*, 2003).

3.6.4 Framework for economic valuation

Appropriate framework for economic valuation are required to identify, quantify, and monetize value of crop genetic resources in the local farming systems using farmers own perspectives, criteria and use values. The valuation methodologies need to be based on local knowledge, uses, and values of wild resources, therefore, must involve local people-men and women-in the valuation process (Perrings , 1995). However, assigning monetary values for landrace diversity is complicated in the traditional subsistence rice production systems, as many of the values are not reflected in market price. In this case, therefore, economic value of landraces diversity is estimated by the summation of individual preferences (Hanley and Splash, 1993). This present framework has employed local farmers (different resource category) in two different systems (subsistence and semi commercialized) in the valuation process based on local knowledge, use, and values of rice bean genetic resources. This framework was designed for the theoretical insights obtained from Perrings (1995), Smale and Mc Bride (1996), Bellon and Smale (1998), and Goeschl and Swanson, (1998). The highlight of the framework is outlined below.

Economic valuation through opportunity costs approach

This approach is based on the concept of "opportunity cost" or potential income lost by not planting modern varieties. When the farmers cost surpasses the local portfolio value, there is an incentive to convert to modern agriculture (Swanson, 1994) This approach will be employed here to identify and assign monetary value for the cost of landraces conservation in situ both at individual household and community level. Valuation ant the local level will be done using direct use value of landraces at two levels:

i. Subsistence marginal risk prone environments

ii. Semi-commercial system with favorable environments.

3.6.5 Benefit cost ratio analysis of rice bean landraces production

Benefit cost ratio simply gives an idea about recovery of cost incurred during the production by return from products. This analysis was done after calculating the total cost and gross return from rice bean production. Total variable cost was considered total cost of production as almost no fixed cost was observed to be incurred during rice bean landraces production except lad revenue. The benefit-cost analysis was carried out by using following formula.

$$\text{B/C ratio} = \frac{Gross.return}{Total.\cos t}$$

3.6.6 Value chain analysis

The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky & Morris,2000). Considered in its general form, it takes the shape as described in Figure 4. Moreover, there are ranges of activities within each link of the chain. Although often depicted as a vertical chain, intra-chain linkages are most often of a two-way nature – for example, specialized design agencies not only influence the nature of the production process and marketing, but are in turn influenced by the constraints in these downstream links in the chain. Value chain analyses include the study of marketing system, marketing channels, marketing margin, producer’s shares and marketing efficiency (Kaplinsky & Morris, 2000). Therefore, value chain analysis approach is used here to study the marketing system, marketing channels, marketing margin, producer’s shares and marketing efficiency of rice bean enterprise at Ramechhap District.

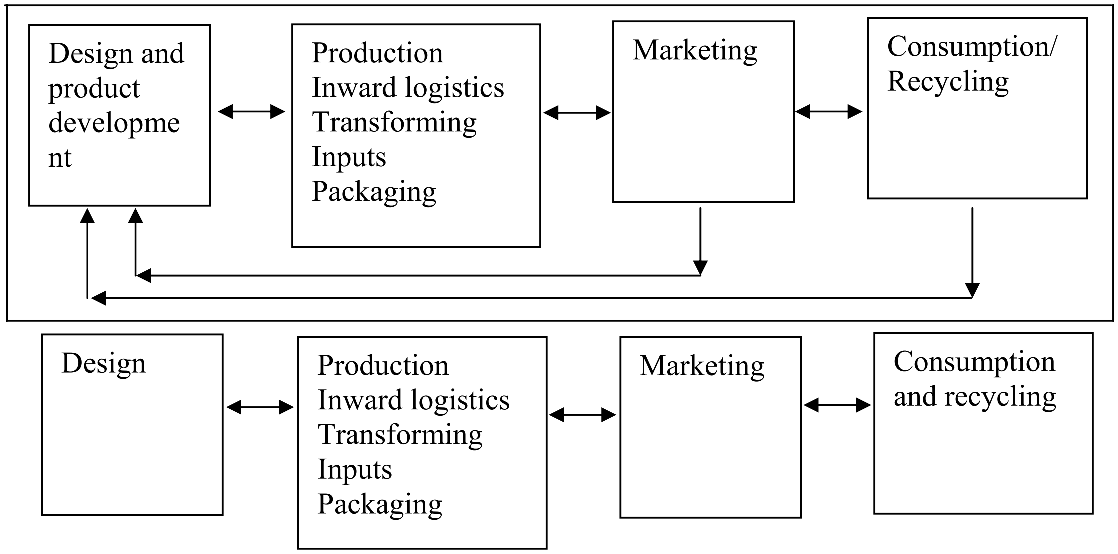


Figure 4. Four links in a simple value chain
(Source: Kaplinsky & Morris, 2000).

Marketing system analysis

As the marketing system involves wide range of activities, firms and mechanisms of delivering goods from one hand to other hand, an understanding of the system is essentially important for the identification of bottlenecks in the system with a view to providing efficient services in the continuum of production-consumption chain. It is because; an efficient marketing system minimizes costs, and benefits all the section of the society (Acharya and Agarwal, 1999). Marketing system creates time, space and form utilities of the farm produce for the consumers. Marketing system operates to transport produce to where consumers wish to take delivery of it, at times they find more convenient and in the forms desirable. These functions add values of the farm produce for the consumers and reflected in marketing margin. If these marketing functions are performed in an efficient way, there is low marketing costs' resulting in to lower marketing margin and higher producers share on consumer's rupee. Thus, the prices farmers receive and the quantities they can sell are very much dependent upon the performance of functionaries in the value chain. As marketing margin provides an indication of the efficiency of existing marketing system consideration of it in economic analysis of marketing system of particular crop enterprises is sensible. The marketing margin, also known as retail-farm-gate margin, is the difference between the retail price of a product and the price received by farmers for its agricultural product (Colman and Young, 1995). The retail price of the commodity (Pr) is determined by the intersection of derived supply (or retail level supply) and primary demand (or retail level demand). Likewise, farm-gate price (Pf) of the commodity is determined by the intersection of primary supply (or farm level supply) and derived demand (or farm level demand). This is clearly explained in Figure 5. Marketing margins reflect the economies of supply and demand for marketing services, at it is important to acknowledge that such margins reflect to provision of 'marketing utilities' to consumers and that they are not excess profits to 'middlemen' in the value chain.

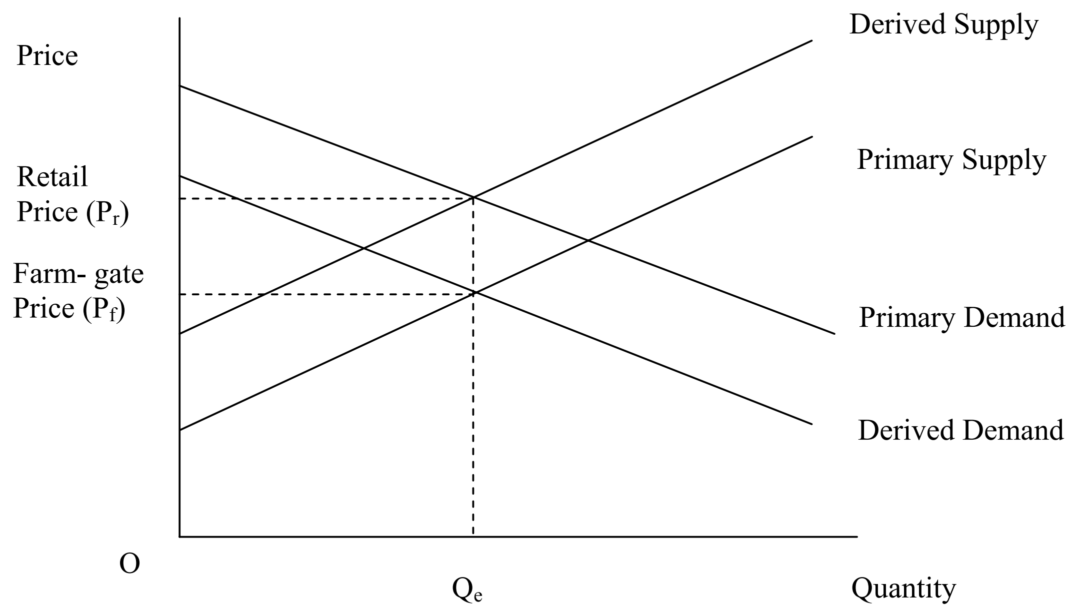


Figure 5. Primary and derived functions and marketing margins
(Source: Colman and Young, 1995).

Marketing system analysis comprises the study of:

(a) Marketing channel, to explain product flow and marketing efficiency

(b) Marketing price analysis, as the study of market price signals and

(c) Market margin analysis, from which market profit signals can be understood

Marketing margin and producers share analysis

Marketing Margin (MM) is used synonymously with the term "Price Spread" and is the difference between the price paid by the consumers and the price received by the farmers. This was calculated by subtracting farm-gate price from retailer price.

$$Marketing \quad margin \quad = \quad Retailer \quad price \quad - \quad Farm-gate \quad price$$

$$\mathbf{MM = P_r - P_f}$$

Similarly, producers share is the price received by the farmer expressed as a percentage of the retail price, which is the price paid by the consumer. Considering P_r is the retail price and P_f is the producer's price (farm gate price), the producers share (P_s) is calculated as:

$$P_s = \frac{P_f}{P_r} \times 100$$

Gross margin analysis

For any enterprises gross margin is the difference between total value product of the enterprise and variable cost attributed to it. Gross margin is also termed as gross profit or "returns over variable costs" in the economic literature (Sankhyan, 1983). For the analysis of gross margin, only the variable costs were considered. The variable cost must be specific to single enterprise and vary approximately in proportion to the size of the enterprise.

Gross margin is the value of output produced by the producer, which is evaluated at the farm gate price minus the total variable cost.

Gross margin = Gross return – Total variable cost

Where, Gross return = Price of rice bean * Total quantity marketed

Total variable cost = Summation of cost incurred in all the variable items

Gross margin of different rice bean landraces may differ each other. So, the average gross margin of different rice bean landraces at current market price was compared through univariate analysis of variance.

3.6.7 Marketing efficiency

Marketing efficiency is essentially the degree of market performance. The movement of goods from producer to consumers at the lowest possible cost, consistent with the provision of the services desired by the consumer, may be termed as efficient marketing (Acharya and Agarwal, 1999). A change that reduces the costs of accomplishing a particular function without reducing consumer satisfaction indicates an improvement in the efficiency. But a change that reduces costs but also reduces consumer satisfaction need not indicate increase in marketing efficiency. A higher level of consumer satisfaction even at a higher marketing cost may mean increased marketing efficiency if the additional satisfaction derived by the consumer outweighs the additional cost incurred on the marketing process. An efficient marketing system is an effective agent of change and an important means for raising the income levels of satisfaction of the consumers.

An ideal measure of marketing efficiency, particularly for comparing the efficiency of alternate markets/channels, should be such which takes into account all of the following:

a. Total marketing costs (MC)

b. Net marketing margins (MM)

c. Prices received by the farmer (FP)

d. Prices paid by the consumer (RP)

The marketing efficiency was measured empirically with the help of Acharya's Modified Approach for Marketing Efficiency (Acharya and Agarwal, 1999).

MME = FP/ (MC+MM)

Where,

MME = the modified measure of marketing efficiency

FP = Price received by the farmer

MC = Marketing cost

MM = Marketing margin

3.6.8 Indexing

Production and market related problems were ranked with the use of index. Scaling techniques, which provides the direction and extremity attitude of the respondent towards any proposition (Miah, 1993) was used to construct index. The intensity of production and marketing problems being faced by the aromatic rice producers and traders, respectively were identified by using five point scaling technique comparing most serious, serious, moderate, a little bit and no problem at all using scores of 1.00, 0.75, 0.50, 0.25, and 0.00, respectively. The formula given below was used to find the index for intensity of production and marketing problems faced by producers and traders, respectively.

$$I_{prob}=\sum \frac{S_i f_i}{N}$$

Where,

I_{prob} = Index value for intensity of problem

$\sum$ = Summation

S_i = Scale value of i^{th} intensity

f_i = Frequency of i^{th} response

N = Total number of respondents

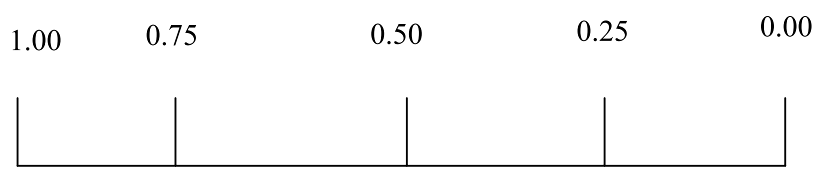


Figure 6. Scale value for intensity of production and marketing problems

4 RESULTS AND DISCUSSION

4.1 Study area

Ramechhap District is one of the mid-hill districts of central development region, which is popularly known as "Botanical Garden" of Nepal as it is one of the richest district in terms of botanical and ecosystem diversity due to wide range of climatic variation (DDC, 2004). The overview of Ramechhap District is discussed hereunder.

4.1.1 Geographical settings

The geographical position of the district is between $27^0 28'$ to $27^0 50'$N latitude and $85^0 50'$E to $86^0 35'$E longitude. It occupies a total area of about 1564.32 square kilometers. Dolakha District to the north, Okhaldhunga and Solukhumbu to the east, Sindhuli to the south and Kavrepalanchwok and Sindhupalchwok to the west surround the district. The altitudinal range of the district is from 439 m (Kolonjorghat) to 6958 m (Numbur Himal) above mean sea level (DDC, 2004). The average temperature of this district ranges from 11.90 degree celsius to 21.30 degree celsius. The average annual rainfall is 2055 mms. The climatic condition of the district varies from tropical to tundra depending upon the topography of the district (DDC, 2004).

Table 3. Climatic overview of the Ramechhap District

Type of climate	Altitude (m) above mean sea level	Average annual temperature (^{0}C)	Average Annual rainfall (mm)
Tropical	379 – 1200	26	2000
Subtropical	1200 – 2100	13.75	2000
Temperate	2100 – 3300	10	1500
Alpine	3300 – 5000	2.5	1700
Tundra	>5000	-5	Snow fall

(Source: DDC, 2004).

From the geographical point of view the district consists of three major topographical divisions; High Himalayan region (i.e. 11.95 %), High Mountain region (i.e. 16.03 %) and Mahabharat hill region (i.e. 72.02 %). Administratively, the district is divided into 55 VDCs and 459 wards. Manthali is district headquarter and is located at the central part of the district. The economy of the district mostly depends upon the agriculture, and about 84.54 % of the work forces derive their income from this activity (DDC, 2004).

4.1.2 Natural resource and environment

The total arable land in Ramechhap District is 50908 ha, of which 46715 ha of land are cultivated. There are 54102 ha of forest land, 24734 ha of shrubs, 9272 ha of grass land, and 670 ha of land are covered by rivers and glaciers. Among cultivated land only 6830 ha is irrigated throughout the year while rest of the cultivated land is irrigated only partially. *Tama koshi, sun koshi, likhu koshi, khimti khola, chauri khola, milti khola* and *bhatauli khola* are the main watersheds of the district. The district is dominated with *Lithic* Sub Groups, *Usforthents, Typic, Rhodic, Udic, Ustochere* soil and *Anthropices* Sub Groups of soil, which is equally favorable for agricultural products. Since the district has more capacity to grow leguminous crops, it exports pulses to Kathmandu and other parts of Nepal. Being a hilly region *bari* dominated farming system with maize-rice bean intercropping system is the major cropping pattern of the district. The district is the pocket area of sweet orange (*Citrius sinencis*) locally known as *junar*. Major crops grown in the district are maize, paddy, millet, wheat, barley, grain legumes, potato and oil seeds. Beside these, buck wheat, seasonal vegetables, local fruits like mango, litchi, peach, plumb, pear, custard apple, apple, walnut, etc are also grown commonly in Ramechhap. Farmers in the district mainly use compost manure i.e. mostly animal dung. This encourages them to raise dairy animals, which is the main source of manure. Livestock farming is also an important component of farming system in the district. Cattle, buffaloes, goats and sheep are the major livestock and they are raised mainly milk and meat and draft purpose.

Table 4. Land use information

Particulars	Area	
	ha	%
Total area of district	156432	-
Cultivable land	50908	*32.54*
Cultivated land	46715	*29.86*
Barren land	14395	*9.21*
Irrigable land	32276	*63.40*
Irrigated land	6830	*21.10*
Forest	54102	*34.58*
Bushes	24734	*15.82*
Grass land	9272	*5.92*
Snow &Glaciers	670	*0.42*
Sandy land	1824	*1.16*
Watershed	523	*0.34*
Others	4	*0.01*

(Source: DDC, 2004).

Table 5. Area production and productivity under different crops

Crops	Area (ha)	Production (mt)	Productivity (mt ha^{-1})

Paddy	8542.00	33741.00	3.95
Wheat	4795.00	10069.50	2.10
Maize	23015.00	67664.00	2.94
Millet	5052.00	5961.30	1.18
Barley	2002.00	761.50	0.76
Pulse crops	600.00	660.00	1.10
Rape seed	300.00	240.00	0.80
Potato	3032.00	25772.00	8.80
Fruit	887.40	7521.50	8.47

(Source: DDC, 2004).

4.1.3 Socio-demographic setting

Brahmin, Chhettri, Gurung, Magar, Tamang, Tharu, Newar, Kami, Damai, Sarki, Chamar, Bote, and Hayou are the major ethnic groups and Hinduism (i.e. 67.80 %), Buddhism (i.e. 28.30 %), Kirat (i.e. 2.00 %) and Christen (i.e. 0.40 %), are the major religion of Ramechhap District. The total population of the district is 211824, economically active population is 115717 and Crude Activity Rate (CAR) is 54.50%.

4.1.4 Transportation network and market centers

Compared to other parts of the hilly region, Ramechhap District is relatively less accessible to transportation network and market centers. Markets, hospitals, and educational centers are not within assessable distance and the transportation facilities are not easily available. Manthali, Ramechhap Danda, Saghutar, Khimti, Salupati, Dhobi, Sirise, Those, and Bamti Bhandar are the main market centers of the district. It has one airport and one graveled road connected to Kathmandu from district headquarter Manthali.

4.2 Household and farm characteristics

The household and farm characteristics include total population, gender distribution, family size, occupation, education, ethnicity, land holding, land utilization and cropping pattern. These characteristics are discussed briefly here after.

4.2.1 Population distribution

The total population of the 102 sampled households was found 764, specifically, 34.68 percent were from Ramechhap, 28.40 percent were from Bhaluwajor and 36.91 percent were form Pakarbas (Table 6). In terms of gender, 52.07 percent were male and 47.92 percent were female in Ramechhap. About 52.99 percent were male and 47.00 percent were female in Bhaluwajor. Likewise, 46.80 percent were male and 53.19 percent were female in Pakarbas.

Table 6. Distribution of population of sampled HHs by gender and VDC

VDC	Male		Female		Total	
	F	%	F	%	F	%
Ramechhap	138	*52.07*	127	*47.92*	265	*34.68*
Bhaluwajor	115	*52.99*	102	*47.00*	217	*28.40*
Pakarbas	132	*46.80*	150	*53.19*	282	*36.91*
Total	385	*50.39*	379	*49.60*	764	*100.00*

F = Frequency and % = Percentage.

4.2.2 Sex of respondents

During field study it was observed that most of the respondents (household decision maker) were male (i.e. 71.6 %) across the study sites (Figure 7). On comparison, 58.8 percent in Ramechhap, 85.3 percent in Bhaluwajor and 70.6 percent respondents in Pakarbas were male (Appendix 1).

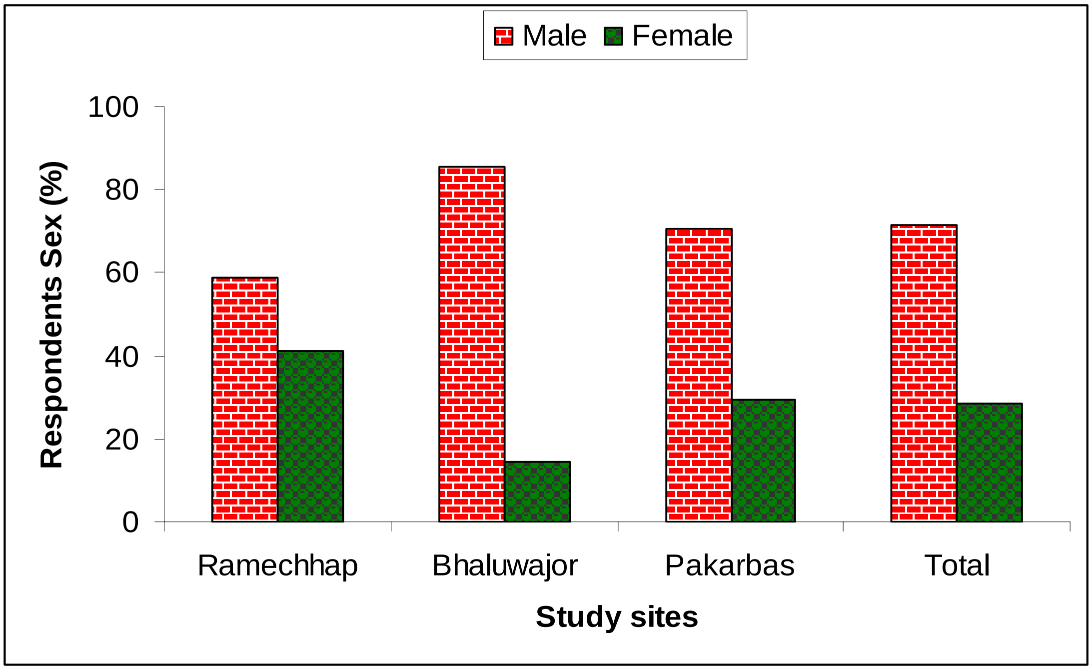


Figure 7. Distribution of respondents by gender and VDC

4.2.3 Education status of respondents

Respondents (decision-maker in agricultural related matters) were asked to specify their formal educational attainment in the questionnaire. Five major categories were devised such as illiterate (who cannot read and write), literate only (basic reading and writing skill acquired through non-formal and in-formal education), primary level (formal education up to 5 class), secondary level (formal education up to 10 class) and above secondary level (formal education more than 10 class). The factor (i.e. education) is so important that it is one of the three indicators to be used in Human Development Index (HDI) calculation. On an average about 67.6 percent of the respondent were literate across the study site but on comparison this figure is greater than district average (i.e. 39.05 %) and national average (i.e. 54.1%) of population census 2001 (CBS, 2004). The number literate respondents were highest at Ramechhap (i.e. 82.4 %) and those of illiterate were highest at Bhaluwajor (i.e. 41.2 %), respectively. The numbers of respondents attaining formal education above than secondary level were only found at Ramechhap as presented in the Table 7.

Table 7. Educational attainment of respondents by VDC

Education Level	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%
Illiterate	6	*17.6*	14	*41.2*	13	*38.2*	33	*32.4*
Literate	28	*82.4*	20	*58.8*	21	*61.8*	69	*67.6*
Literate only	6	*17.6*	5	*14.7*	3	*8.8*	14	*13.7*
Primary	10	*29.4*	10	*29.4*	14	*41.2*	34	*33.3*
Secondary	5	*14.7*	5	*14.7*	4	*11.8*	14	*13.7*
Above secondary	7	*20.6*	0	*0.0*	0	*0.0*	7	*6.9*
Total	34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*

F = Frequency and % = Percentage.

4.2.4 Ethnicity

The ethnicity of the respondents was of various types. Majority of the respondents were Brahmin/Chhetry, followed by Newar, Tamang and Dalit in Ramechhap and Pakarbas while the case was just reverse in Bhaluwajor where, majority of the respondents were Newar followed by Dalit and Brahmin/Chhetry. In the total, 48.0 percent of the respondents were Brahnin/Chhetry, followed by Newar (i.e. 26.5 %), Dalit (i.e. 15.7 %) and Tamang (i.e. 11.8%). The distribution of ethnicity of the respondents was different with the location of the study area as presented in the Table 8.

Table 8. Ethnicity of the respondents by VDC

Ethnicity	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%

Brahminn/Chhetry	13	*38.2*	7	*20.6*	29	*85.3*	49	*48.0*
Newar	9	*26.5*	14	*41.2*	4	*11.8*	27	*26.5*
Tamang	7	*20.6*	2	*5.9*	3	*8.8*	12	*11.8*
Dalit	5	*14.7*	11	*32.4*	0	*0.0*	16	*15.7*
Total	34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*

F = Frequency and % = Percentage.
Note:

- Brahmin/chhetry includes the casts Paudel, Ghimire, Koirala, Bhandari, Budhathoki, Karki, Khadka, Thapa, Khatri.
- Dalit include the cast Nepali, Bika and Kasai.

4.2.5 Family labour force for agricultural and non-agricultural activities

Family size is an important variable that determine the supply of labor to the farm operations. The average family size of the surveyed sample was found to be 8.94±0.37, which was higher than district average of 5.26 in 2001 (CBS, 2006) and national average of 5.6 in 2001 (CBS, 2006) (Table 9). The average family size of Ramechhap was slightly greater than of Bhaluwajor and Pakarbas but the standard error was observed highest for Pakarbas (i.e. 0.72) than Ramechhap (i.e. 0.60) and Bhaluwajor (i.e. 0.61). This indicates wider range of variation in family size in Pakarbas as compared to other VDCs.

As livelihood strategy household members form different wealth categories were engaged on-farm as well as off-farm activities. Primary source of agricultural labour to work on-farm was female and male members of the family. In addition, hired labour during peak agricultural seasons for specific activates (crop planting, weeding, harvesting, threshing etc) met the labour requirement for agriculture enterprise. Agriculture also depended to certain extent on labour force contributed by school going children. Availability of family labour force to work on-farm determined the level of management provided for a landrace/variety. Availability of labour force has been regarded as one of the key variables to be monitored at household level for change in management practices and shift of variety (from intensive management requirement to less management demanding one or vie versa) in response to changed management. Agriculture was the major occupation for almost all sampled household (n = 102), which was apparent from the contribution the agriculture made on household livelihood security (sources of income). Average family members engaged on agricultural activities was highest in Ramechhap (i.e. 8.55 ± 0.50) and that was lowest in Bhaluwajor (i.e. 7.17 ± 0.51). But the standard error of average family members engaged on agricultural activities was observed highest in Pakarbas (i.e. 0.67) and lowest in Ramechhap (i.e. 0.50), that indicates wider variation of family labor force in Pakarbas than other study sites. Like wise average family members engaged on off-farm activities was highest in Bhaluwajor (i.e. 1.00 ± 0.15) and that was lowest in Pakarbas (i.e. 0.73 ± 0.17) but the case was just opposite in case of standard error (Table 9).

Table 9. Availability of family labor for on-farm and off-farm activities by VDC

Variables	VDC			
	Ramechhap	Bhaluwajor	Pakarbas	Total
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Average family size	9.41 ± 0.60	8.17 ± 0.61	9.23 ± 0.72	8.94 ± 0.37
Average family members in agricultural activities	8.55 ± 0.50	7.17 ± 0.51	8.50 ± 0.67	8.07 ± 0.33
Average family members in non-agricultural activities	0.85 ± 0.19	1.00 ± 0.15	0.73 ± 0.17	0.86 ± 0.10

SE = Standard Error.

4.2.6 Food sufficiency

Numerous field exercises on wealth ranking with terai and mountain communities in Nepal have indicated that food sufficiency months of households based on production from own (shared-in and rent-in) land was the true reflection of well being in marginal and agrarian society (Rana *et al*., 1999). In fact, in very marginal and agrarian society this could be the single most important indicator explaining the majority of the variation in social community. Because of its importance in discriminating households information on food sufficiency level was collected in household survey of this study as well (Table 10). The food sufficiency criteria used here is adopted from Sah and Khan (2002).

Table 10. Economic status wise food sufficiency of the sampled HHs by VDC

Food sufficient for	Economic Status	VDC							
		Ramechhap		Bhaluwajor		Pakarbas		Total	
		F	%	F	%	F	%	F	%
0	Destitute	0	*0.0*	0	*0.0*	0	*0.0*	0	*0.0*
>0-3	Very poor	7	*20.6*	12	*35.3*	7	*20.6*	26	*25.5*
>3-6	Poor	12	*35.3*	15	*44.1*	17	*50.0*	44	*43.1*
>6-9	Capable poor	4	*11.8*	3	*8.8*	1	*2.9*	8	*7.8*
>9-12	Better-off	5	*14.7*	1	*2.9*	7	*20.6*	13	*12.7*
>12	Well-off	6	*17.6*	3	*8.8*	2	*5.9*	11	*10.8*
Total		34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*

F = Frequency and % = Percentage.

Only 10.8 percent of the sampled households were food self sufficient (i.e. 12 month and above) and economically well-off. Around 21 percent of households were capable poor and better-off and they had food for 6 to 12 months only. Majority of households (i.e. 68.6 %) were very poor and poor and they had food just for 3 to 6 months. On comparison across the study sites the economically well-off households were highest in Ramechhap where 17.6 percent household had surplus food for more than 12 months. Like wise 50.0 percent households in Pakarbas and 35.3 percent households in Bhaluwajor were having poor and very poor economic status. The information indicated that majority of households' form poor and medium categories have to resort to alternative sources of income to tide over the food deficit months, which became evident when analyzing sources of income at household level across wealth categories.

4.2.7 Land holding and distribution

Broadly land was categorized into five groups namely *irrigated khet, unirrigated khet, tari khet, bari* and *kharbart. Irrigated khet* is low laying land where year round irrigation is available and is mostly suitable for rice is cultivation. *Unirrigated khet* is upland where irrigation is partially or seasonally available and upland rice is main crop of this category of land. *Trari khet* is the ancient river terrace, where rainfed rice is cultivated as main crop. *Bari* is upland where different drought crops like millet, maize, rice bean and seasonal vegetables are cultivated. *Kharbari* is marginal sloping land where thatch grasses are grown with sparse fodder/ fuel wood tree species in agroforestry system.

Table 11. Land distribution pattern of sampled HHs (in ha)

Type of land	VDC			
	Ramechhap	Bhaluwajor	Pakarbas	Total
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Irrigated *khet*	0.25 ± 0.10	0.13 ± 0.05	0.19 ± 0.06	0.19 ± 0.04
Unirrigated *khet*	0.06 ± 0.05	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.01
Tari khet	0.29 ± 0.09	0.07 ± 0.04	0.05 ± 0.03	0.14 ± 0.03
Total *khet*	0.60 ± 0.23	0.20 ± 0.10	0.24 ± 0.10	0.35 ± 0.09

Bari land	1.04 ± 0.13	1.05 ± 0.15	0.52 ± 0.13	0.87 ± 0.08
Kharbari	0.42 ± 0.11	0.18 ± 0.07	0.24 ± 0.08	0.28 ± 0.05
Total own land	2.06 ± 0.40	1.44 ± 0.31	1.01 ± 0.31	1.50 ± 0.20
Shared in land	0.04 ± 0.02	0.06 ± 0.02	0.01 ± 0.01	0.04 ± 0.01
Shared out land	0.20 ± 0.11	0.12 ± 0.06	0.10 ± 0.04	0.14 ± 0.04
Total operation al land	1.91 ± 0.30	1.38 ± 0.26	0.95 ± 0.28	1.41 ± 0.16

SE = Standard Error.

The study revealed that, the average size of total own land holding was 1.50 ± 0.20 ha, which is greater than the national average size of land holding 0.83 ha (ABPSD, 2007). Besides cultivation their own land, farmers were found to be involved in share cropping. The average operational land holding (i.e. 1.41 ± 0.16) was observed higher than the national average holding size. The contribution of shared in land was more than that of shared out land. The pattern of land distribution in Ramechhap was observed different than that of Bhaluwajor and Pakarbas. The average size of own land holding was higher in Ramechhap (i.e. 2.06 ± 0.40 ha) than Bhaluwajor (i.e. 1.44 ± 0.31 ha) and Pakarbas (i.e. 1.01 ± 0.31 ha) (Table 11). The standard error of own land distribution pattern in Ramechhap was observed more (i.e. 0.40) than that of Bhaluwajor (i.e. 0.31) and Pakarbas (i.e. 0.31). This indicates that variability of land distribution in Ramechhap is wider than that of Bhaluwajor and Pakarbas.

4.2.8 Land tenancy pattern

Land tenure-ship of the sampled households was categorized in three major groups namely own land, shared-in land and shared-out land. The won land category was considered as the family having land in which the household has the sovereignty to use and sell. Shared in land is such land where household cultivate crops with output sharing to land owner and it has no authority to sell it. In case of shared out land, household gives its land to other and share the output of cultivated crops but it has authority to sell it. Those household having shared in land besides having their own land were categorized into shared in category and those having shared out land were categorized in to share out category.

Table 12. Land tenure pattern of sampled HHs by VDC

Households with land tenancy	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%
Own land	34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*
Shared in	4	*11.8*	5	*14.7*	3	*8.8*	12	*11.8*
Shared out	9	*26.5*	5	*14.7*	5	*14.7*	19	*18.6*

F = Frequency and % = Percentage.

Almost all households across the study side have their own land but some of them used to share in and share out land for cultivation. About 11.8 percent of household had taken land from other households for cultivation across the study sites (Table 12). Likewise about 18.6 percent of household had given their own land to other (tenants) and they were sharing out from tenants.

4.2.9 Livestock holding

Livestock is one of the integral components of Nepalese farming system. Livestock holding depicts the picture about farmers' economic condition and it also gives the idea about the total farm yard manure availability in the households. Selected household were observed to raise various kind of livestock species in different number. For the study of total livestock holding by common unit Livestock Unit (LSU) was used converting all the livestock species in a single unit. The aggregated LSU was calculated as explained by Adhikari (2000).

LSU = 1.5 (number of buffalo) + 1 (number of cow/bull) + 0.6 (number of swine/pig) + 0.4 (number of sheep/goat) + 0.2 (number of poultry).

Table 13. Livestock holding of sampled HHs by VDC (in LSU)

VDC	Livestock holding		Livestock holding in LSU		
	F	%	Average	Minimum	Maximum
			Mean ± SE		
Ramechhap	34	*100.0*	12.55 ± 1.84	3.2	44.1
Bhaluwajor	34	*100.0*	12.32 ± 1.96	2.4	63.6
Pakarbas	34	*100.0*	14.05 ± 5.04	2.2	149.5
Total	102	*100.0*	12.97 ± 1.88	2.2	149.5

F = Frequency, % = Percentage and SE = Stand Error.

Almost all sampled households across the study sites used to rare at least one farm animal. The average size of herd (in LSU) was 12.97 ± 1.88. On comparison the size of herd was largest in Pakarbas (i.e. 14.05 ± 5.04) and lowest in Bhaluwajor (i.e. 12.32 ± 1.96) (Table 13). The standard error associated with average livestock holding was observed highest in Pakarbas (i.e. 5.04) that indicates the wider variability in number of livestock holding in Pakarbas as compare to other VDCs.

4.2.10 Cropping patterns

Maize intercrop with rice bean was the dominant cropping system on *bari* land across the study sites. Rice-wheat cropping system was major cropping system of *khet land* across all study sites. Most of households used to grow rice bean on rice bund in *khet* land. *kharbari* was used to grow fruits, fodder and fuel woods in agro-forestry system. Besides these potato, horse gram, black gram, soybean, local bean, pea, rapeseed, barley, millet, seasonal vegetables, fruits like sweet orange (*junar*), mandarin orange, pear, apple, peach, plumb, mango, litchi, guava, Jackfruit, pomegranate etc were also grown across the study sites. Conclusively, maize, rice bean and rice were the dominating components of the cropping system of the study sites (Chart 4).

Chart 4. Existing cropping patterns in the study site

Khet land	*Bari land*
Rice – Wheat – Maize	Maize + Rice bean – Fallow
Rice – Wheat – Fallow	Maize + Millet – Fallow
Rice – Fallow- Fallow	Maize – Seasonal vegetables
Rice – Maize – Maize	
Rice – Maize – Fallow	
Rice – Buck wheat – Fallow	
Rice – Mustard – Fallow	
Rice – Pulse crop - Fallow	
Rice – Fallow- Rice	

4.2.11 Household income analysis

Households members in the study sites were observed to support their household needs by engaging in different kind of farm and off farm activities. The study indicated that the share of total farm cash income to the annual household cash income was large (i.e. 79.69 %) as compare to total annual off farm cash income (i.e. 20.30 %) (Table 14). Among all farm enterprises cereal crops is a vital component farming system, which lone contribute 48.05 percent to the total household economy throughout the study sites.

Table 14. Source of HHs annual cash income (thousand)

Source of cash income	Ramechhap	Bhaluwajor	Pakarbas	Total	*Share %*
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	
Cereal crops	91.53 ± 28.48	75.15 ± 23.20	84.70 ± 26.10	83.79 ± 14.88	*48.05*
Rice bean	23.46 ± 2.87	20.76 ± 3.52	12.64± 3.66	18.95 ± 1.98	*10.86*
Other legumes	3.68 ± 0.92	3.10 ± 0.48	4.63 ± 1.01	3.81 ± 0.48	*2.18*
Fruit & vegetables	20.53 ± 3.58	11.78 ± 2.62	8.43 ± 2.42	13.58 ± 1.74	*7.78*
Oil seeds	3.20 ± 1.40	3.93 ± 1.48	1.98 ± 1.23	3.03 ± 0.79	*1.73*
Total crops	142.43±35.77	114.74±29.17	112.40±32.94	123.19±18.76	*70.64*
Kharbari	3.03 ± 0.68	0.61 ± 0.19	1.88 ± 1.32	1.84 ± 0.50	*1.05*

Livestock	17.25 ± 1.74	13.55 ± 1.44	11.01± 3.00	13.94 ± 1.26	*7.99*
Total farm	162.72±36.48	128.92±29.47	125.29±37.02	138.98±19.79	*79.69*
Total off farm	33.65 ± 6.43	43.90 ± 8.71	28.64 ± 9.67	35.40 ± 4.83	*20.30*
Total income	196.37±41.57	172.82±36.38	153.94±46.18	174.38±23.82	*100.00*

SE = Standard Error.

Note: Share is the average contribution to the total cash income of households in percent.

It was noteworthy that off-farm activities contributed 20.30 percent share to the total annual cash income of the household. The household of Ramechhap were generating higher average farm cash income of 162.72 ± 36.48 thousands as compared to Bhaluwajor (i.e. 128.92 ± 29.47 thousands) and Pakarbas (i.e. 125.29 ± 37.02 thousands) (Table 14). The contribution of crops to the total annual cash income was observed higher in Ramechhap (i.e. 142.43 ± 35.77 thousands) followed by Bhaluwajor (i.e. 114.74 ± 29.17 thousands) and Pakarbas (i.e. 112.40 ± 32.94 thousands). On comparison, average annual household cash income was observed highest in Ramechhap (i.e. 196.37 ± 41.57 thousands) as compared to Bhaluwajor (i.e. 172.82 ± 36.38 thousands) and Pakarbas (153.94 ± 46.18 thousands), but the standard error was observed highest in Pakarbas. This indicates wide range of variation on income distribution at Pakarbas as compared to other sites.

4.2.12 Contribution of rice bean landraces to household food security

Food security of household member is the prime concern for any households. The issue of food security can be seen at various levels depending on whose perspective one takes. For instance, the subject could be dealt at national, regional, community, household and intra-household levels. However, for the purpose the food security issue at household level only would be discussed. Furthermore, food security issue at micro-level is dealt with either increasing the purchasing capacity of household or by directly producing the required commodities in the farm itself (Rana *et al.,* 1999). The former approach works fine when households are fully integrated with market. But later option would be proffered when the market access and distribution mechanism is less than dependable. The role of landraces in food security at household (resource poor) level could be one of the strongest justifications for their consideration in conservation programmes (Rana *et al.,* 1999). Food security is understood with tow interrelated concepts, food utilization and food access (WFP, 2006). Food utilization means the ability of household to properly absorb food in order to benefit from its nutrient and energy content where as food access means the ability of households to be able to produce or purchase a sufficient amount of diversity of food items.

As stated earlier, only about 10.8 percent of households across the study sites were of self food sufficient and remaining others were of self food in sufficient category. In this study, the contribution of rice bean landraces to the household food security was taken in to analysis. Households in the study sites especially which are self food insufficient were observed to sell rice bean to the market as cash crop mainly because of their compulsion to purchase other food grains especially rice. If they did not sell, the amount of food grain (ready to consume) produced on their own land would sufficient for few months only. If they sell rice bean in the market, they can get premium price almost more than double the price of other food grain. Then they purchase other food grains (especially, milled rice) from the cash returned from selling of rice bean as the household accessibility (in terms of purchasing capacity) increased. Then the balance of total food grain increased as compared to the condition of before marketing of rice bean, and household would be food sufficient for months. The result on the Table 14 showed that the cash income obtained from selling rice bean contributed significantly to increase household food availability. Out of total farm income rice bean alone had contributed about 10.86 percent to the total household economy, which underscore the importance of rice bean enterprises in the rural farming economy. On comparison, the contribution of rice bean to the total household income was observed highest in Ramechhap (i.e. 23.46 ± 2.87 thousands) as compared to Bhaluwajor (i.e. 20.76 ± 3.52 thousands) and Pakarbas (i.e. 12.64 ± 3.66 thousands) , respectively (Table 14). The critical analysis on standard error value indicates that distribution of income from rice bean varied widely in Pakarbas as compared to other sites.

4.3 Local knowledge on rice bean

4.3.1 Farmers' local knowledge

Local knowledge refers the knowledge held by local people, irrespective of its original source (Shrestha, 2003). Farmers' knowledge has been most commonly and widely discussed using the term 'indigenous knowledge' or local knowledge (Brokensha, *et al.,* 1980). Local knowledge is the 'outcome, independently of the interpreter, of the interpretation of data that can be articulated and communicated', and it is the 'locally derived understanding which is based on experiences and real world observation' (Fairhead and Leach, 1994). Adaptation of the approach as methodological framework in incorporating local knowledge in participatory development of soil and water management interventions (Shrestha, 2003) and in documentation of indigenous knowledge of farmers' in the shifting cultivation areas of western Nepal (LI-BIRD/ HARP study report) shows that the approach is well suited for local knowledge documentation. Therefore, KBS approach (Walker *et al.,* 1995) has been used here on knowledge elicitation technique to document local knowledge associated with rice bean crop.

4.3.2 Historical perspectives

Rice bean is being cultivated from the very beginning; from generations to generations in farming communities. It is long established crop and is also attached with cultural and religious aspects of the society. Farmers infer that rice bean was probably introduced in the time when maize was introduced in the area. Farmers used to plant rice bean in marginal areas to make soil fertile without providing fertilizer from the time when they started growing maize in the area. So, farmers regard rice bean as traditional and ancient crop. All cultivated varieties of rice bean were landraces which disseminated from one village to another and from one generation to another in informal system. Farmers were solely responsible for management and cultivation of rice bean.

4.3.3 Rice bean landraces diversity

Farmers considered seed color, maturity and seed size for naming their landraces at Ramechhap. The landraces were named as *thulo* (big), *mailo* or m*adhyam* (medium) and s*ano* (small) in terms of seed size; *rato* (red), *seto* (white), *pahelo* (yellow), or *kalo* (black) in terms of color and *bhadaure* (early) *or madhyam* (medium) *and dhila* (Late) in terms of maturity. Rice bean is known by different local names in different areas of Nepal (Khanal and Paudel, 2007). *Masyang, siltung, jhilunge,* and *ghore mas* were some commonly used local names (Khanal and Paudel, 2007). *Masyang and ghore mas* were quite common in Ramechhap. Farmers' knowledge was documented to distinguish the farmer-named landraces based on their own morphology, growing environment and utility (Chart 5). Farmers were mostly consistent in describing and distinguishing the cultivars based upon grain shape, size, color, yield, maturity time, eating quality, vine length, leaf texture, steam texture etc. Appearances were most common and 2-3 traits were used to distinguish landraces. *Sano seto, ghorle, kalo, rato*, and p*ahelo* were identified as locally common rice bean landraces across the study sites. Rice bean landraces diversity with their classification based on farmer's descriptors has been presented in the Chart 5. According to the Marshall and Brown (1975), the critical target for collection is, alleles that are locally common and the above populations with locally common alleles may be the primary targets for on-farm conservation. Locally rare types are hard to capture and there, strategic *ex situ* collection should be done. Common and widespread landraces are most cost effective for on-farm conservation as public and farmers' utility values are high and meet common goals.

Chart 5. Assessment of rice bean landraces diversity through farmers' descriptor approach

Landraces	Farmer descriptors
Sano seto	Small round grain, creamy white grain color, dwarf to semi-dwarf plant, determinate to semi-determinate growth habit, synchronized to un-synchronized flowering behavior, early maturity, low shattering losses, grown by large number of households, low productivity, resistant to water filled pod (p*anikosa*) formation problem, resistant to fatty pod (b*ose kosa*) formation problem, highest market price, best for different kinds of recipes.
Ghorle	Large elongated grain, greenish black to brown mottled grain color, indeterminate growth habit, heavy lodging habit, un-synchronized flowering behavior, late maturity, moderate shattering losses, grown by large number of households, high productivity, susceptible to water filled pod (*panikosa*) formation problem, susceptible to fatty pod (*bose kosa*) formation problem, best of boiled grain and green fodder.
Kalo	Elongated grain with dark black color, Indeterminate growth habit, un-

	synchronized flowering behavior, moderate maturity, high shattering losses, grown by few households, moderate productivity, high market demand, best for *dal* (soup).
Rato	Small to large grain size, light to dark red grain color, indeterminate growth habit, moderate lodging habit, unsynchronized flowering behavior, medium maturity, high shattering losses, grown by few households, low productivity, low market demand, best of roasted grain.
Pahelo	Large elongated grain, ivory to pale yellow in grain color, Indeterminate growth habit, heavy lodging habit, un-synchronized flowering behavior, moderate maturity, moderate shattering losses, grown by few households, high productivity, good for different kinds of recipes.

4.3.4 Farmers' classification of landraces on the basis of maturity

Mainly three types of landraces were classified by farmers on the basis of time of maturity viz. early, mid and late.

Early types

Early types of landraces were called b*hadaure* as their harvesting time is around last week of *bhadau* (2nd -3rd week of September). They were planted along with maize planting or broadcasted just after maize is emerged out. These landraces have small vine growth .Farmer had less diversified landraces under this category. Early white (*sano seto*) was found mainly in lower altitude regions (foot hills) (*bensi* areas) under this category.

Medium types

Planting time of these landraces was commonly during second earthing-up of maize (last week of *jestha* to first week of *ashadha*) however, the time depends on the moisture with altitude. Generally, farmers used to harvest during 3rd week of Oct to 1st week of Nov. Color ranges from yellow, red, purple, brown, yellowish white to grey mottled. Farmers reported more diverse landraces under this category. Farmers generally preferred the early harvesting types within this category to ensure the planting of mustard (*tori)*. *kalo, pahelo* and r*ato* were the medium type landraces.

Late types

Late maturing landraces were planted at the same time with mid (i.e. last week of *jestha* to first week of *ashadha*) but harvesting time goes up to 1^{st} week of December. Landraces have bigger grain size and longer pods. Farmers prefer these landraces for food purpose. They have luxuriant growth habit with higher biomass yield. These types of landraces need strong stake. They yield more if planted in sunny and comparatively more fertile lands with stakes. Seed color of landraces has been reported as yellow, grey mottled, white, black and light green. Though landraces have good yield and superior grain quality, fewer farmers are cultivating this type because of its late maturing trait. *Ghorle* was the dominant landraces under this category.

4.3.5 Cropping systems adapted for rice bean

Farmers had been growing rice bean in different cropping systems at Ramechhap. Following cropping systems were generally adopted by the farmers.

Intercropping with maize on *bari* lands

This was the dominant cropping system for rice bean at Ramechhap. In this system rice bean is planted in between maize using maize plant as stake for rice bean. Planting time of rice bean however, differs from altitude and type of landraces, rice bean is planted at that time when its twinning habit does not affect the yield potential of maize plant. Early maturing types of landraces were planted at the time of maize planting while those of mid and late types were generally planted after first or second earthing-up of maize. For intercropping with maize, farmers prefer medium maturing landraces with optimum vine growth for intercropping system. In certain areas, farmers were growing rice bean in borders of main *bari* land. This practice was more common in the areas where finger millet was cultivated as relay cropping with maize.

Selection of maize/millet varieties for intercropping with specific rice bean landraces

There were no specific maize and millet varieties which were best suitable for intercropping with specific rice bean landraces that were adopted by farmers in their farming system. Most of the farmers had been cultivating local maize and millet varieties/landraces in intercropping system with rice bean landraces. But during field study it was observed that they used to select tall type of maize variety/landrace for intercropping rice bean landraces with indeterminate growing habit because such landraces have vigorous vine growth and heavy twining habit. They had been planting determinant and semi-determinate type of rice bean landraces as intercrop in rice bunds and at the edge of the millet terrace.

On rice bunds

Rice bean was also cultivated on rice bunds particularly at lower foot hill regions (i.e. *bensi*) of Ramechhap District. In this system, farmers do not provide stakes for rice bean. Instead, upper shoots or tips of vine are cut down to maintain size.

Sole cropping in home gardens or uplands

In some areas, farmers used to grow rice bean as sole crop in their home gardens, small piece of land around their homestead. In this case, crop is provided with stakes. The main purpose of growing rice bean in home gardens was for family consumption. Farmers were using green pods and seeds of rice bean as fresh vegetable. Landraces with long pods and bold grain size were generally cultivated in home gardens.

4.3.6 Farmers' classification of soil in the area

Based on soil color

Rato mato

Rato mato was red in color and was moderate in fertility status. Crop grows well provided good moisture status on soil.

Kalo mato

Kalo mato was black in color and was regarded as most fertile soil. It was more porous, friable and needs less irrigation or watering.

Fusro mato

This was yellowish gray colored soil. It was less fertile.

Kamero mato

This soil was white to creamy in color. It was also used to paint the walls of rural houses. It was less fertile.

Based on physical properties of soil

Sano mato

Sano mato was the soil having low soil depth and with more pebbles and stones in it is called *Sano mato* by farmers. This soil even with less care, tillage and manuring; yield good. Farmers used to pay little attention on this soil. This type of soil was generally found on borders and corners of main *bari* and in dry *kharbaries*.

Thulo mato

Thulo mato was the soil with good soil depth, less pebbles and stones. It requires more inputs and tillage and gives higher crop yield. Farmers used to pay more attention on this type of soil than *Sano mato*.

Gagreto mato

Gagreto was pebble or small stone mixed soil which is known as gravelly soil. This soil was moderately fertile.

4.3.7 Farmers' local knowledge associated with rice bean growing land

Farmers had been cultivating rice bean on marginal to sub marginal land at Ramechhap. In Ramechhap area, rice bean was cultivated just from 600 m (foot of the hill) to 1800-2200 m (top of the hill). Dry hills raised from river basin areas were the major domains in Ramechhap. Usually dry hills and southern or eastern facing slopes were the major areas for rice bean cultivation. They had distinct knowledge about choosing the appropriate land for rice bean. Farmers’ local knowledge associated with rice bean growing land has been discussed below.

- Medium to low fertility status of soil is suited for rice bean than with high fertility status. Plant gets luxuriant growth with more biomass in much fertile soil. So, rice bean grain yield is more in dry, marginal land of hilly areas than in plain area with high fertility. Rice bean yield is more in red soil than in black soil.

- Rice bean does not require much soil depth. The crop is also cultivated in unproductive corners or margins of land. It is cultivated in marginal drought areas to make soil porous.
- Rice bean grows well in dry hilly areas than deep and shady side of the same hummock. This crop needs sunny area and it is best suited in eastern or southern facing *bari* lands.
- Damp and shady areas where residue of rain water or dew is not directly exposed to intense sunlight are called *ripyan* or *tapken*. *Ripyan* or *tapken* areas are not suitable for rice bean grain production. In such areas, vegetative growth would be higher with more p*ani kosa* (non-seed bearing pods). Rice bean bears turgid and thick pods if grown in such areas and these pods are also called *bose kosa* (fatty pods) as inner surface of pods bear thick and moisten fat like substance.

Rice bean cultivation to enrich soil fertility and farmers' local knowledge

- Some farmers had trend of cultivating rice bean just to enrich soil fertility. In some areas, farmers rotationally grow rice bean in different piece of lands to make their every piece of land enriched with plant nutrients. Farmers reveal that the soil becomes porous and friable after rice bean cultivation. Rice bean root is thicker than the other legumes. The root of rice bean has the special effect to make soil fertile from the root zone area and this effect is greater than that of the cowpea, black gram, *gahate simi*, lentil and chickpea.
- Farmers infer that chickpea make soil acidic and wheat makes the soil exhaust. They explained it using the term '*amilo'* meaning sour/acidic and *'rukho'* meaning exhaustible. In the *bari* lands where wheat and chickpea are previously grown, rice bean makes the soil appropriate and also enriches the soil fertility. Rice bean makes the soil black. The leaves of rice bean fall after senescence and make the soil black and

fertile. It is easier to dig and plow the rice bean growing lands. So, the trend of growing rice bean in marginal and exhaustive land is common in the area. One farmer at Ramechhap told that rice bean fixes the atmospheric nitrogen with the help of nodules present at the root and enriches soil fertility. But he acquired this knowledge during farmers training on agriculture at District Agriculture Development Office, Ramechhap.

4.3.8 Local knowledge on ecosystem and rice bean landraces diversity

Delineation of rice bean ecosystems using focus group discussion with knowledgeable farmers form a given community can be reliably done. Farmers employ multiple criteria to characterize rice bean ecosystem (Table 15). However, moisture (ability to retain water for longer time period) and inherent fertility status of soil as well as productivity potential influenced by human managed factors (application of compost and/or farm yard manure, chemical fertilizers and irrigation) were the major determinants in characterizations of rice bean ecosystems. Exercise on deployment of varieties in each ecosystem suggests that farmers have intimate understanding of ecosystem characteristics and varietal performance and the interaction between the two, which represent the ‘best fit’ arrangement under farmers given circumstances. Findings also suggest that only a limited number of landraces exit for extreme condition, whereas plenty of options exit for favorable conditions for farmers to choose from local diversity bank (Table 15). For instance, there was not introduced a single modern variety of rice bean. Therefore, farmers operating in marginal ecosystems have limited choice of genetic materials at their disposal which greatly reduces their capacity to manoeuvre the production systems in such environments. Farmers have been cultivating rice bean on marginal lands. Usually dry hills and southern or eastern facing slopes were the major areas for rice bean cultivation. In Ramechhap area, rice bean was cultivated just from 600 m (foot of the hill) to 1800-2200 m (top of the hill). Dry hills raised from river basin areas were the major domains in Ramechhap District. Farmers have distinct knowledge about choosing the appropriate land for rice bean

Table 15. Classification of rice bean landraces diversity by agro-ecological domains

Landraces	Altitude (masl)	Adaptation by habitat type		
		Land type	Farmers soil type	Cropping system
Sano seto Determinate	600-1050	Upland *Bari* Rice bunds	*Kalo gagreto mato* (Black stony soil)	Sole and mixed cropping with maize
Semi-determinate	600-1500	Upland *bari*	*Rato gagreto mato,* (Red stony soil)	Mixed cropping with maize
Ghorle	1200-2200	Upland *bari*	*Rato chimte mato* (Red sticky soil)	Mixed cropping with maize
Kalo	850-1500	Upland *bari*	*Khairo mato* (Brown soil)	Mixed cropping with maize
Rato	850-1500	Upland *bari*	*Rato gagreto mato* (Red stony soil)	Mixed cropping with maize
Pahelo	800-1500	Upland *bari*	*Kalo domat mato* (Black loamy soil)	Mixed cropping with maize

The analysis clearly indicates that one landraces is best suited in only one ecosystem, though farmers might grow the same variety in more than one ecosystem. This implies that a landraces competes with other varieties from within the ecosystem, and that there is less competition between varieties across ecosystems, except when there is an overlap of ecosystems. This entail the need of situation specific participatory crop improvement programmes. Overlap signifies the presence of transitional zones between ecosystems, which explains the presence of landraces in two different but adjacent ecosystems. Within ecosystems, farmers' socio-economic status, market forces, cultural factors, preference for specific traits, and abiotic and biotic factors explain the type, area and number of landraces maintained at household level (Rana *et al.,* 2006). Although, landraces may overlap in adjacent ecosystems, no case was observed where a landrace was found in more than two ecosystems. This suggests that landraces have specific adaptations. Because of the specificity of varieties to ecosystem, aggregated information at community or landscape level may not be very useful for making decisions pertaining to landraces conservation on-farm, diversity deployment or repatriation programme. Therefore, ecosystem characterization and varietal deployment exercise contribute significantly in making conservation decisions as well as to monitor the varietal dynamics over time.

4.3.9 Cultivation practices of rice bean and underlying knowledge

Different crop management activities traditionally practiced by farmers in rice bean cultivation are discussed hereunder.

Planting time and methods

Planting time differs with type of landraces and farming systems adapted. Under intercropping system with maize, planting time of rice bean was correlated with that of maize at Ramechhap District. Maize planting, however, differs from altitude and rainfall pattern; generally ranges from April to May. Early types of rice bean landraces were planted at the same time with maize while that of mid and late types were planted after first or second digging up of maize. On rice bunds, rice bean was planted in mid May to mid July. Farmers were commonly adapting two planting methods viz. dibbling and broadcasting or sowing. In case of broadcasting, seed rate was higher leading to more plant population per unit area. This dense population was retained to optimum level by thinning out practice and the uprooted vines were used as green fodder to livestock. Planting method also depends on moisture status of soil. In case of adequate soil moisture and friable soil, seed was broadcasted after plowing or digging up for maize while in low moisture status, 2-3 seeds per hill was dibbled.

Seed rate

Seed rate differs with planting method, farming system and practices. On average, following seed rate was reported by farmers in intercropping with maize in *bari* lands.

Planting method	Seed rate (*mana ropani* $^{-1}$)	Seed rate (kg ha^{-1})
1. Broadcasting	4 - 5	29.49 – 36.86
2. Dibbling	2-3	14.74 - 22.11

Intercultural operations

Weeding

Rice bean does not need much care. One to two weeding was practiced by farmers. Weeding was done at vegetative growth stages.

Staking

Staking was needed for indeterminate types of varieties. Late maturing landraces had luxuriant growth and thus, need strong stakes. In intercropping system with maize, maize plant was used as stake while in case of sole cropping and in home gardens, farmers had provided stakes. Staking was done at the time when vine gets twinning tendency. During maize harvesting only upper 1/3rd portion (above maize cob) of maize stalk is removed and the basal portion of the stalk left *in situ* which serves as stake for rice bean.

Training/pruning/trimming

When maize cob gets adequate maturity, tip of dried maize plant is cut off just above the cob and retained as stake for rice bean. From the same point, farmers decapitate the rice bean vine maintaining adequate size for stake. . In case of rice bean planted on rice bunds, upper shoots or tips of vine are cut down to maintain size.

Harvesting

Early types of landraces were matured with maize and were harvested during maize harvest. Mid maturing landraces generally matured in last week of October to first week of November while late types of landraces stand till mid November. At the time of maturity, rice bean vine dries and pod color changes from green, yellow to brown. In indeterminate types of landraces, there was no synchronization of maturity of upper and lower pods. Picking matured pods as and when matured was also a practice which needs 2-3 harvest. This practice was more adapted in late maturing landraces. But most of the farmers used to harvest whole vine when more than 60% pods of a vine mature.

Threshing

After harvesting, farmers used to thresh vine with sticks. It is better to thresh dried vine immediately after harvest in the sunlight. After first threshing, cut vine is dried in sunlight if there are green pods remained in vine.

Yield

Yield is a dependent variable that is governed by genetic, environmental and managemental factors. The yield was observed different for different rice bean landraces at farmers' managemental condition. The average yield of different rice bean landraces that were observed in farmer field has been presented in the Table 16.

Table 16. Average yield of rice bean

Rice bean Landraces	Yield (mt ha^{-1})
Sano seto	0.65
Ghorle	0.80
Kalo	0.75
Rato	0.83
Pahelo	1.08
Total	0.67

Seed/grain storage

Farmers used to store rice bean seed after proper drying in sunlight. 2-3 sun drying was generally practiced depending on intensity of sunlight. Farmers revealed that rice bean seed is less prompt to post harvest pests if properly dried.

Farmers' local knowledge associated with seed and seed management

- Farmers prefer to keep seed from the first threshing lot. They used to store rice bean separately for seed purpose. Bold and vigor grains on the basis of eye judgment were used for seed purpose. Most of the farmers just after harvest and adequate drying used to separate estimated quantity of rice bean as seed and store for coming season. They used to keep rice bean seed themselves for next season. They store the seed in wooden and earthen pods because seed stored in earthen pots (i.e. g*hainto*) get low pest attack because they are airtight and damp proof.
- Most of the farmers separately store the seeds of rice bean landraces on the basis of color and size at Ramechhap because mixed seed produces mixed grain of different color, which receive low market price as such mixed grains are less preferred by consumer due to poor eating quality. They also separately store the seed of early, mid and late maturing landraces because sowing time and crop growing environment is different for different landraces (early, mid, and late maturing). However, few farmers do not separate seeds of landraces on the basis of color and size. Mixed seed of different color and size is being used. This system is inherent among rice bean growers from the time unmemorable. But they separately keep the seed of early, mid and late maturing landraces.
- Rice bean grains need at least 3-4 sun drying before storage. Properly dried seeds get less insect-pest infestation.

- In comparison to other legumes such as cowpea, chickpea and common pea, rice bean seeds get low insect pest attack during storage.
- Rice bean grains from the vine cultivated in northern sloping lands are not suited for seed purpose because they generally get wrinkled while drying and they also have more chances of pest attack in storage.
- *Timur* (*Xanthoxylum alatum*), *titepati* (*Artemisia* sp.), *neem* (*Azadirachta indica*) treatment in seed storage minimizes the pest infestation in storage.
- Rice bean can be stored for one year for seed purpose. Seed stored more than one year have low germination capacity.

Farmers' local knowledge associated with rice bean cultivation practices

- If continuous rainfall occurred during flowering period of rice bean (generally in the month of September), then the yield drastically decreases due to formation of *pani kosa* (non-seed bearing pods).
- Rice bean vines decapitated at the time of maize maturity yield more. This practice allows the vine to generate lateral branches.
- First week of *jestha* (second week of May) was the best time for rice bean planting. In case of late planting in intercropping system, maize plant may suppress the rice bean growth due to its shading effect.
- At the time of rainfall and in early morning, the vine should not be shaken. If disturbed the vine, some swelling occurs in the node which may result the vine breakage from nodes.
- In semi determinate types of landraces and those cultivated in rice bunds such as s*ano seto* and *pahelo* plants are trained to spread in bunds. This practice should be done when the plant attains maximum vegetative growth. If it is not practiced, then plant gets low fruiting.

- There was no practice of manuring for rice bean. Rice bean if planted in high fertile soil, gets luxurious vine but with low fruiting. In highly fertile soil, the problem of *pani kosa* (non seed bearing pods) was more.
- The yield of rice bean is high in intercropping (with maize) system as compared to sole cropping system because, indeterminate landraces without maize stalk as stakes or planting without stakes yield low grain because in contact with soil and its moisture, vine may undergoes rotting and get collapse. In this case, there is also more chance of attack from rodents. After maize harvest, maize steam should be left as stake for indeterminate vines that prevent the vine from rotting and damage from rodents. So, indeterminate rice bean landraces yield more in intercropping system with maize than sole cropping.
- The yield of maize is high in intercropping (with rice bean) system as compared to sole cropping system because, the leaf litter fallen from the rice bean vine increases the soil fertility and porosity.
- Some farmers reveal that rice bean needs warm temperature and adequate sunlight during flowering and pod formation. So, it can only be cultivated in summer season.

Farmers' local knowledge associated with *pani kosa* (non-seed bearing pods) problem

- In rice bean pods, if there are no seed inside the pod then such types of pods are called *pani kosa* in local language. In *pani kosa,* creamy white thick moist layer is developed in inner surface of the pods and thus, is also called *bose kosa.* If continuous rainfall occurs in flowering stage of rice bean, then *pani kosa* will be developed.
- Problem of *pani kosa* is more in north facing sloping lands and is least in south and east facing areas because southern and eastern facing areas are sunny and dry.

- The landraces cultivated in *lekh* (higher altitude >1500 masl) such as *ghorle masyang* have more problem of *pani kosa*. Further, this problem is more observed in *lekh* than in *bensi* (lower altitude below1050 masl) areas because *lekh* areas get more foggy days.

Knowledge associated with shattering loss of rice bean

- Shattering loss is minimum in determinant and semi-determinate types of landraces such as *sano seto* because of synchronize flowering habit and vice versa in the landraces with indeterminate type of growth habit (e.g. *kalo, rato, ghorle and pahelo*) Shattering loss can be minimized by harvesting rice bean at early morning.

Knowledge associated with *daino seed* (hard seed coat/ hard seeds) problem

- Some seeds of the legume do not imbibe water properly and are not soft while cooking and soaking, then these seeds are known as *daino* seed in vernacular language. In comparison to pea, cowpea and horse gram, rice bean has low problem of *daino* seed formation.
- The older the seed, the more would be the problem of *daino* seed.
- *Daino* seed problem is not specific to particular landraces. This problem can not be identified before soaking or cooking.
- Some farmers assume that if rainfall occurred during harvest, then there would be more chances of hard seed coat development.

Farmers' classification of pulses as cold and hot to human health

- Farmers' have their own classification of pulses as g*armi* (hot) and s*ardi* (cold*) dal* and explained it as a concept. Farmers revealed that different pulses have different effect on human health and thus, can be classified as *garmi* and *sardi* pulses. Pulses such as horse gram, lentil, and cowpea are considered as *garmi dal* while black gram and rice bean is regarded as *shardi dal.*

- ❖ Rice bean is considered as *shardi dal* and it is better to take with some *garmi* food items such as finger millet flour mixed on its soup. Some farmers have the trend of mixing rice bean with lentil and cowpea and even with mutton soup.
- ❖ Rice bean is nutritious and have good quality elements and nutrients in it. But, if someone can not digest it, he/she may get some gastritis problem. So, rice bean is best pulse for those who need more physical work. Consumption of rice bean is less among children and elders.
- ❖ Some farmers reveal that freshly harvested rice bean has much cold effect. This effect goes on declining when it is stored. So, rice bean if consumed after some months of storage would have no cold effect.
- ❖ Being *shardi dal* does not mean to cause common cold or flue. But it is generally not given to the lactating mother till two or three months of the delivery because rice bean may invite some coldness, gastritis or some uneasiness due to indigestibility.
- ❖ Rice bean grain that of one year old can be cooked easily but the grain that of more than one year have poor cooking and eating quality.

4.3.10 Gender analysis

Women farmers make significant farm decisions in Nepalese farming and have also been playing important roles in spreading the genetic materials and information through women-women and women-men networks (subedi and Garforth, 1996). Since seed management is one of the important responsibilities of women farmers that has direct relevance to agrobiodiversity conservation and utilization (Gurung, 1998), it is necessary to further explore and examine gender roles in decision-making on such aspects. Gender analysis was done by conducting focus group discussions in each VDC. Total participants of the focus group discussion in each VDC were 15.

4.3.10.1 Analysis of gender role and responsibilities in rice bean farming activities

Women and men had different roles and responsibilities in different activities of rice bean production while some were carried out jointly (Table 17). The selection of parcels of land for rice bean cultivation was carried out jointly by men and women. Women farmers were exclusively involved in seed selection, storage, management and processing while ploughing, land preparation and carrying of seed/grain sacks from field to home were the responsibilities of men farmers across the study sites (Table 17).

Table 17. Gender role and responsibilities in rice bean farming activities across the study sites

Activities	VDC								
	Ramechhap			Bhaluwajor			Pakarbas		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Selection of parcels	1(6.66)*	4(26.66)	10(66.66)	2(13.33)	3(20.00)	10 (66.66)	1 (6.66)	5 (33.33)	9(60.00)
Ploughing/field preparation	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15 (100)	0(0.00)	0(0.00)
Seed sowing	3(20.00)	12(80.00)	0(0.00)	3(20.00)	11(73.33)	1(6.66)	0(0.00)	13(86.66)	2(13.33)
Weeding	0(0.00)	11(73.33)	4(26.66)	0(0.00)	14(93.33)	1(6.66)	0(0.00)	13(86.66)	2(13.33)
Staking management	3(20.00)	9(60.00)	3(20.00)	3(20.00)	8(53.33)	4(6.66)	2(13.33)	10(66.66)	3(20.00)
Harvesting	0(0.00)	13(86.66)	2(13.33)	1(6.66)	12(80.00)	3(20.00)	0(0.00)	14(93.33)	1(6.66)
Carrying to threshing yard	1(6.66)	12(80.00)	2(13.33)	2(13.33)	11(73.33)	2(13.33)	2(13.33)	11(73.33)	2(13.33)
Threshing	0(0.00)	14(93.33)	1(6.66)	0(0.00)	12(80.00)	3(20.00)	2(13.33)	13(86.66)	0(0.00)
Carrying grain to home	13(86.66)	0(0.00)	2(13.33)	9(60.00)	3(20.00)	3(20.00)	11(73.33)	1(6.666)	3(20.00)
Seed selection	1(6.66)	12(80.00)	2(13.33)	1(6.66)	11(73.33)	3(20.00)	1(6.66)	11(73.33)	3(2.00)
Drying	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)
Cleaning	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)
Seed storage	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)	0(0.00)	15(100.00)	0(0.00)

* Figure in parenthesis indicates percentage.

4.3.10.2 Gender and decision making

Seed source and decision making

The main source of rice bean seed was farmers own retention, but at the same time the farmers, as is also shown in seed supply study by Baniya *et al* (1999). If seed supply from different sources is considered as one activity, it is perceived as joint decision making responsibility of men and women. However, disintegration of seed sources revealed that for seeds from within the household or community, women make the decision on which source (s) to be used. Exchange with grains or seed-for seed exchange and obtaining or giving seed as gift was mainly decided by women across the study site (Table 18).

Landraces choice and decision making

Adaptation of a particular variety/landrace, growing conditions of land parcel, importance in terms of economic, socio-cultural, religious and medicinal uses and values are the major determining factors in the choice of cultivation particular variety/landrace or combination of different types (Paudel *et al.,* 1998). The focus group discussion revealed that in normal situation, the decisions on how many landraces/varieties are to be cultivated, was made jointly by male and female members of the household. Decision, on which variety/landraces is to be planted, was made by women across the study site. However, such a matter was also discussed with the farmers with adjacent farms, neighbors and certain other community members in the crop season. Regarding the decision on allocation of a particular variety or landrace for a particular land parcel, women farmer used to take the leading role although both of them participate in decision making. The major reason indicated by the farmers for the decision on this by respective gender group were relatively more knowledge and experience of a specific gender group about the conditions of the land parcel, varietal characteristics and judging the suitability of a particular variety/landrace for a specific land area.

Seed selection, storage maintenance and decision making

Most of farmers across the entire study site preferred to select seed form the first lot of harvesting. The decision on these stages of seed selection was perceived to be made jointly by men and women across the study sites; it was reported that this has been the tradition followed for many years. However, the actual selection of rice bean seed was made by women farmer. After harvest, seed storage and further maintenance are women's responsibility. Hence, all decisions concerning where to store, what types of storage structure to use, which specific location in the house the seed containers are to be kept, when to dry, how to take precautions, when to do further cleaning were all done by women (Table 18).

Table 18. Gender role in decision making in rice bean seed across the study sites

Activities	VDC								
	Ramechhap			Bhaluwajor			Pakarbas		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Overall seed supply system	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15 (100)	0(0.00)	0(0.00)	15 (100)
Own retention of seed	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Use of seed from neighbors	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Seed exchange	0(0.00)	13(86.66)	2(13.33)	0(0.00)	14(93.33)	1(6.66)	0(0.00)	15(100)	0(0.00)
Gift seed	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Planting number of landraces	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)
Choice of landraces	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Allocation of landraces to specific parcels/plots	0(0.00)	12(80)	3(20)	0(0.00)	15(100)	0(0.00)	0(0.00)	14(93.33)	1(6.66)
Stage of seed selection	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)
Seed selection	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Storing seed	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Seed container placement	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)
Drying, cleaning, and protection of seed	0(0.00)	15(0)	0(0.00)	0(0.00)	15(100)	0(0.00)	0(0.00)	15(100)	0(0.00)

* Figure in parenthesis indicates percentage.

4.3.11 Rice bean use diversity

Rice bean landraces have socio-economic and cultural (food security, market, religious and cultural uses) and adaptive (abiotic and biotic) traits which jointly represent 'use value' of a landrace, that determine the continued existence of these traditional varieties on-farm. Farmers have been cultivating rice bean for its food, fodder and fertilizer value in Ramechhap District. However, major aim of growing rice bean was strongly associated to its food value across the study sites. Unlike the other common pulses, rice bean was mainly taken as whole grain pulse for soup purpose. In some areas of Ramechhap, farmers use green pods of rice bean for vegetable purpose. As vegetable, they mix rice bean green pods with grains with potato and other vegetables and even with mutton soup for better taste. Farmers prepare different food items from rice bean. The use diversity of rice bean landraces has been presented in the Chart 6 and appendix 2. Higher the diverse use value 'utility' of landraces greater is the landraces diversity of a crop (Rana *et al.,* 1999). The association between use value and diversity was apparent in case of rice bean, where the specific use value of landraces in preparing certain items had guaranteed its continued cultivation. Moreover, food culture was another factor that influences diversity. The extent and distribution of genetic diversity is influenced by decisions made at household levels (Rijal *et al.,* 2001). As shown in Table 18, farmers make decisions depending up on the degree of their use values. Local communities were using the rice bean green pods with immature grains, matured grains and vines in more than 15 different ways. Farmer preference for rice bean landraces varied with *sano seto, ghorle, pahelo, kalo*, and *rato,* appeared more frequently, suggest they have multiple use values. Among these landraces *kalo* and *rato* have limited use value for specific purpose. So these were maintained by few households only whereas, cultivars like *sano seto, ghorle* and *pahelo* have multiple use values and were widely grown by many household in large plots.

Despite natural factors, the uses of rice bean also determined the population size to be maintained on-farm. This suggests that cultivar preference and degree of use value often go together.

Chart 6. Farmers' classification of rice bean landraces diversity by use value and cultural significance in the study site

Use value	Part used	Ethnic group	Special occasion	More preferred landraces
Biramla	Grain	Sarki, Tamang	13^{th} anniversary day	*Sano seto, pahelo, ghorle*
Chhanta	Grain	All	*Dashain, tihar, teej*	*Sano seto, kalo*
Furaula	Grain	All	*Maghe sakranti*	*Sano seto, pahelo*
Masausra	Grain	All	During lean period	*Pahelo, sano seto*
Dal	Grain	All	Evergreen	*Sano seto, kalo*
Boil grains	Grain	All	Summer season	*Ghorle, pahelo*
Quwanti	Grain	All	*Janaipurnima*	*Pahelo, ghorle,*
Batuk roti	Grain	All	*Dashain, tihar, teej*	*Sano seto, pahelo*
Rosted grain	Grain	All	Winter season	*Rato, kalo, ghorle,*
Biramla	Grain	Newar	*Nakha*	*Sano seto, ghorle*
Bara (wo)	Grain	Newar	*Siddinakha*	*Sano seto, pahelo*
Soup	Grain	Newar	*Nakha*	*Sano seto, ghorle*
Khyala	Grain	Newar	*Nakha*	*Sano seto, pahelo,*
Khichadi	Grain	All	*Maghe sakranti*	*Sano seto, pahelo,*
Mandawabyata	Grain	Newar	*Kija puja*	No specific
Green Fodder	Vine	All	Milch animal	*Ghorle,kalo, rato*
Dry Fodder	Husk	All	During lean period	No specific
Compost	Biomass	All	-	No specific
Green manure	Vine	All	-	No specific

Fodder use of rice bean and underlying knowledge

Farmers use rice bean as fodder for the livestock. It was regarded as a nutritious grain and fodder for the farm animals in Ramechhap District. Green fodder of rice bean, leaves, dried vine and pod husk were used to feed the livestock. Grain residues from threshing and winnowing were also regarded as the nutritious feed for the animal. Farmers' knowledge associated with the fodder value of rice bean is listed below.

- *Kusauro*, dried residue from threshing and winnowing of rice bean is nutritious to feed farm animals. Dried vine and leaves are more appropriate to feed farm animals during dry seasons.
- Farm animals (cattle and buffaloes) prefer rice bean green fodder and if animals are habituated to take the green fodder of rice bean, they refused to take other fodders. So, farmers assume that the green fodder of rice bean is highly palatable for livestock.
- Farmers reveal that milch animals yield more if green rice bean fodder is fed to them. However, farmers assume that fresh green fodder has some cold effect and do not give to the animals of early lactating period (around 15-30 days of delivery).

4.3.12 Influence of cultural factors on landraces conservation

Nepal is a multi-cultural, multi-ethnic nation. So, with ethnic diversity, diversity is observed in feeding and drinking habits as well. There are variety of foods, particularly consumed during festivals, and on special occasions due to diversity in culture across the ethnicity, and geography. Festivals in Nepal begin with religion, and ending as social event. There are more than 50 major festivals in a year celebrated by Nepalese. Although most of these festivals are religious some have historical significance as well, while others are seasonal celebrations. There were some rice bean landraces with identifiable socio-cultural and religious uses values, i.e. landraces used in making special dishes for offering to deities or making traditional dishes specific to certain ethnic groups. This was not the case for modern crop varieties because farmers reported that modern varieties are considered 'impure' for socio-cultural and religious ceremonies. Landraces falling in this category were grown by many households but in small areas. Such landraces were attached with the cultural and religious aspects of the Nepalese society as presented in the Chart 6. They have a distinct value in some festivals. The importance of culture in conservation of landraces diversity cannot be over emphasized (Rana *et al.,* 1999). In case of rice bean some of the landraces were primarily kept to prepare special recipes for consumption or offering during festivals. The characteristic feature of such landraces was that many households within a community but in small areas cultivated them. So long the people continue to respect culture and enjoy traditional food, landraces associated with cultural aspects would survive and conserve for future (Rana *et al.,* 1999). In this aspect market expansion of landraces amongst the urban consumers, who do not produce but are potential buyers, would guarantee the economic incentives to continuous production of landraces with cultural value. However, the question might arise on the fate of existence of such landraces when the culture itself is very much influenced by the transformation process in community, national and international levels. Moreover, the present study has pointed out that only a limited landraces with its special traits were utilized in cultural context. Thus, not many landraces were amenable to cultural factor for conservation. For this reason the cultural factor for landraces conservation has to be viewed as a component of holistic approach to landraces conservation. Further more, there is need to assess genetic benefits of conserving such landraces *per se*.

4.4 Production situation

4.4.1 Total area under rice bean landraces

Households were cultivating rice bean in different proportion of their farmland in the study sites. The total area under rice bean landraces has been presented in the Table 19.

Table 19. Area under rice bean landraces by VDC

Area allocation for	VDC			
	Ramechhap	Bhaluwajor	Pakarbas	Total
	Mean ± SE	Mean± SE	Mean ± SE	Mean ± SE
Rice bean landraces	0.66 ± 0.06	0.61 ± 0.07	0.41 ± 0.10	0.56 ± 0.04
❖ *Sano seto*	0.36 ± 0.04	0.48 ± 0.06	0.29 ± 0.04	0.38 ± 0.02
❖ *Ghorle*	0.22 ± 0.04	0.19 ± 0.03	0.06 ± 0.02	0.16 ± 0.02
❖ *Kalo*	0.06 ± 0.01	0.02 ± 0.01	0.03 ± 0.02	0.04 ± 0.01
❖ *Rato*	0.05 ± 0.01	0.01 ± 0.00	0.04 ± 0.02	0.03 ± 0.01
❖ *Panhelo*	0.03 ± 0.01	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.00
Other crops	1.24 ± 0.25	0.76 ± 0.20	0.53 ± 0.18	0.84 ± 0.12
Total operational land	1.91 ± 0.30	1.38 ± 0.26	0.95 ± 0.28	1.41 ± 0.16
% share of rice bean to total operational land	*50.20*	*57.51*	*54.62*	*54.11*

SE = Standard Error, % = Percentage.

Average farm size of rice bean landraces was observed 0.56 ± 0.04 hectare. The average farm size of rice bean landraces in Ramechhap was higher than that at Bhaluwajor and Pakarbas. In other way, rice bean landraces occupied higher percent of area coverage in Ramechhap than Bhaluwajor and Pakarbas. About 54.11 percent of the total operational land in the study site was observed under rice bean landraces. On comparison the share of rice bean to total operation land was observed highest in Bhaluwajor (i.e. 57.51 %) as compared to Pakarbas (i.e. 54.62 %) and Ramechhap (i.e. 50.20 %). Among the rice bean landraces *Sano seto* was grown extensively at larger area (i.e. 0.38 ± 0.02 ha), followed by *ghorle* (i.e. 0.16 ± 0.02 ha), *kalo* (i.e. 0.04 ± 0.01 ha), *rato* (i.e. 0.03 ± 0.01 ha) and *pahelo* (i.e. 0.02 ± 0.008 ha), respectively across all the study sites. But at Bhaluwajor *ghorle* was grown at large area (i.e. 0.48 ± 0.06) as compared to other landraces.

4.4.2 Comparison of area under rice bean landraces over time

The great concern focused nowadays by many workers in biodiversity conservation about the varietal replacement of the local landraces by modern variety. So, keeping this in mind the study was focused to find whether there is replacement of local rice bean landraces by other crops or not. For this study only those households cultivating at least one rice bean once a year since last six years were included to derive the result.

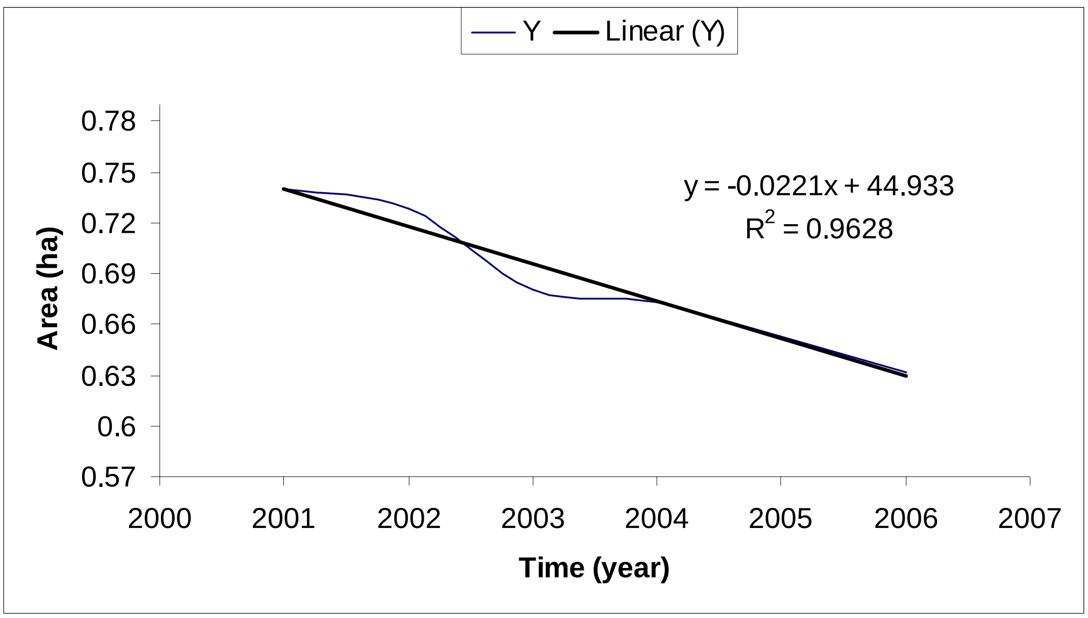


Figure 8. Trend of average area allocation for rice bean over the years in the study site

The study revealed that the average area allocation for rice bean across the study site has been decreasing significantly ($p< 0.01$) over last six years (Figure 8) & (Appendix 3). In other words the area under rice bean landraces has been replaced by other crops. So, the null hypothesis, "there is no change in area allocation for rice bean over time" has been rejected. The decreasing trend of average area allocation for rice bean over the time has been shown with the help of regression line:

Y = 44.933 - 0.022X ………………………………..(ii)

Where, Y= average area allocation for rice bean over the time across the study site

X= time in years

The slope of the line is 0.022 and the negative value of slope indicates the decreasing trend in area allocation over the years. Most of the producer (i.e. 70 %) of the study site felt that introduction of modern high yielding crops (e.g. French bean, cow pea, different vegetable crops, hybrid maize etc) in to the existing farming system and change in cropping system were the major reason for gradual decline of average of under rice bean. Most of the producers had been shifting to produce modern high yielding new corps across the study sites.

4.4.3 Status of rice bean landraces

The study revealed that the farmers throughout the study sites were cultivating 5 rice bean landraces (Table 20). Among 102 sampled households' about 23.4 percent had cultivated *sano seto* and 15.4 percent had cultivated *sano seto and ghorle* on their land. Likewise, about 0.5 percent households had cultivated *sano seto and kalo, sano seto and panhelo, rato and panhelo* landraces, respectively on their land. About 64.7 percent households had cultivated only *sano seto* land races at Pakarbas and about 50.0 percent household at Bhaluwajor had grown both *sano seto and ghorle* landraces on their land. From this study it can be said that among all rice bean landraces *sano seto* was the leading rice bean landraces grown by farmers followed by *ghorle.* Majority of the farmers had grown these two rice bean land races on their field because these two landraces have wider adaptability, higher yield, better test, high market price as compared to other available landraces across the study sites.

Table 20. Status of rice bean landraces across the study sites (number of HH growing)

Rice bean landraces	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%
Sano seto	10	*29.4*	12	*35.3*	22	*64.7*	44	*23.4*
Ghorle	3	*8.8*	1	*2.9*	1	*2.9*	5	*2.7*
Ghorle, rato and kalo	3	*8.8*	0	*0.0*	0	*0.0*	3	*1.6*
Sano seto, ghorle, kalo, Rato,panhelo	8	*23.5*	3	*8.8*	2	*5.9*	13	*6.9*
Sano seto and ghorle	8	*23.5*	17	*50*	4	*11.8*	29	*15.4*
Sano seto, ghorle, kalo	2	*5.9*	1	*2.9*	0	*0.0*	3	*1.6*
Sano seto and kalo	0	*0.0*	0	*0.0*	1	*2.9*	1	*0.5*
Sano seto and panhelo	0	*0.0*	0	*0.0*	1	*2.9*	1	*0.5*
Rato and panhelo	0	*0.0*	0	*0.0*	1	*2.9*	1	*0.5*
Sano seto, ghorle and rato	0	*0.0*	0	*0.0*	2	*5.9*	2	*1.1*

F = Frequency and % = Percentage.

4.4.4 Productivity of rice bean landraces

Altogether there were 5 rice bean landraces grown by farmers. *Sano seto* was the leading landrace across the study site followed *ghorle*. The average productivity of rice bean was observed 0.67 ± 0.02 mt ha^{-1} through out the study site. But among the rice bean landraces the average productivity of *pahelo* was highest (i.e. 1.08 ± 0. mt ha^{-1}) followed by *rato* (i.e. 0.83 ± 0.13 mt ha^{-1}), *ghorle* (i.e. 0.80 ± 0.05 mt ha^{-1}), *kalo* (i.e. 0.75 ± 0.07 mt ha^{-1}) and *sano seto* (i.e. 0.65 ± 0.02 mt ha^{-1}).The average productivity of rice bean was observed highest in Ramechhap (i.e. 0.82 ± 0.04 mt ha^{-1}) and lowest in Pakarbas (i.e. 0.49 ± 0.02 mt ha^{-1}) but the standard error associated with average productivity was observed highest in Bhaluwajor (i.e. 0.05) which indicates the wider range of variation in productivity in this VDC as compared to other. Similarly the average productivity of *sano seto* was observed highest in Ramechhap (i.e. 0.82 ± 0.03 mt ha^{-1}) and lowest in Pakarbas (i.e. 0.50 ± 0.03 mt ha^{-1}). The average productivity of *ghorle* (i.e. 0.90 ± 0.12 mt ha^{-1}), *kalo* (i.e. 0.82 ± 0.14 mt ha^{-1}), and *rato* (i.e. 0.98 ± 0.14 mt ha^{-1}) were observed highest in Bhaluwajor and vice versa was in Pakarbas. But the average productivity of *pahelo* was observed highest (i.e. 1.20 ± 0.40 mt ha^{-1}) in Ramechhap and lowest (i.e. 0.86 ± 0.32 mt ha^{-1}) in Pakarbas (Table 21).

Table 21. Productivity of different rice bean landraces in the study site (mt ha^{-1})

Productivity	Ramechhap	Bhaluwajor	Pakarbas	Total
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Sano seto	0.82 ± 0.03	0.65 ± 0.03	0.50 ± 0.03	0.65 ± 0.02
Ghorle	0.82 ± 0.05	0.90 ± 0.12	0.55 ± 0.06	0.80 ± 0.05
Kalo	0.77 ± 0.09	0.82 ± 0.14	0.59 ± 0.12	0.75 ± 0.07
Rato	0.91 ± 0.21	0.98 ± 0.14	0.58 ± 0.11	0.83 ± 0.13
Panhelo	1.20 ± 0.40	1.00 ± 0.14	0.86 ± 0.32	1.08 ± 0.23
Rice bean	0.82 ± 0.04	0.71 ± 0.05	0.49 ± 0.02	0.67 ± 0.02

SE = Standard Error.

4.4.5 Comparison of productivity of rice bean landraces over time

Serious case of genetic erosion of crop diversity has been reported in Nepal (Jarvis & Hodgkin, 1997). One of the major reasons may be the reduction in the productivity of landraces, because no household grow landraces for sake of conservation.

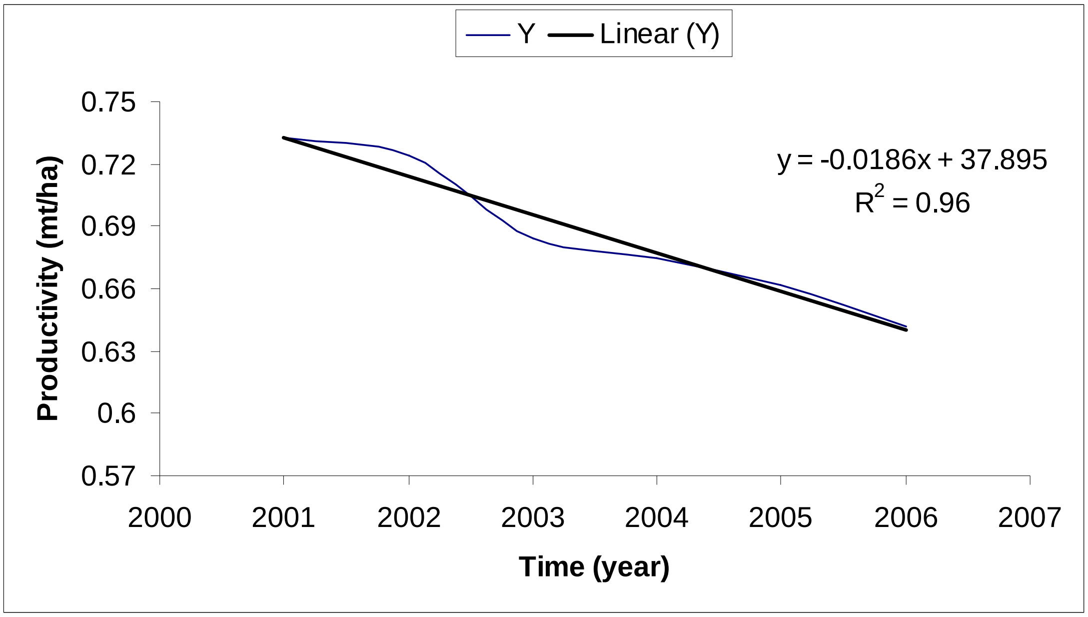


Figure 9. Trend of average productivity of rice bean over the years in the study site

The study was designed to analyze the productivity of rice bean landraces over the period of times. The study revealed that the average productivity of rice bean across the study site has been decreasing significantly ($p<0.01$) over the years (Figure 9) & (Appendix 4). So, the null hypothesis "there is no change in the productivity of rice bean over time" has been rejected. The decreasing trend of average productivity of rice bean over the time has been shown with the help of regression line:

Y = 37.895 - 0.018X ……………………………………….(iii)

Where, Y= average productivity of rice bean over the time across the study site

X= time in years

The slope of the line is 0.018 and the negative value of slope indicates the decreasing trend in productivity of rice bean over the years.

Reasons for decreasing productivity of rice bean

There were several factors that affect the productivity of rice bean. The complex of factors, like management, environment and agro-ecology of production domain, soil characteristics, insect pest infestation as well as genetic makeup determines the productivity of rice bean. In this study, farmer reasoning regarding the decreasing of rice bean productivity was analyzed. Productivity of rice bean was directly related with climate. Rice bean was very much sensitive to rainfall. If continuous rainfall (for 5-6 days) occurred during flowering, productivity of rice bean vastly decreases. So, untimely rainfall and drought was the reason for the decline in productivity. Most of the respondent (i.e. 70.6 %) of the study sites felt that the use of inorganic fertilizers (chemical fertilizer) in the field was a leading factor contributing loss of productivity (Table 22). Some people (i.e. 9.8 %) have also reported that increasing insect pest infestation as a reason for decreasing productivity of rice bean.

Table 22. Reasons for decreasing productivity of rice bean across the study sites

Reasons for decreasing productivity of rice bean	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%
Use of chemical fertilizer	34	*100.0*	21	*61.8*	17	*50.0*	72	*70.6*
Increasing insects, pest attack	0	*0.0*	0	*0.0*	10	*29.4*	10	*9.8*
Use of low quality seed	0	*0.0*	13	*38.2*	7	*20.6*	20	*19.6*
Total	34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*

F = Frequency and % = Percentage.

Side by side, the fertilizer use pattern in the study site was also studied. This showed that majority (i.e. 96.1%) of households in the study site were applying inorganic fertilizer on land for growing maize crop (Table 23). Among the inorganic fertilizers most of them used to apply urea only. The repeated use of urea on land reduces the soil PH and increase soil acidity (Khatri Chhetri, 1991). In addition to this, the microbial activity in the soil will slow down if the soil PH is less than 6 and it will tends to stop when the soil PH drops below than 4.5 (i.e. when soil become extremely acidic in reaction). The optimum PH range for mineralization of organic matter by microorganism, and releasing plant nutrients like N, P, S is 6 to 8 (Khatri Chhetri, 1991). Further this nitrogen fixing bacteria operate beast in the PH range of 6.5 to 7.5. Iron and Boron are the important minerals that are essential for nodulation in leguminous plant. But in acidic soil there is the toxicity of metal cations like, Fe, Mn, Zn, Cu, and B and deficiency of several other essential plant nutrients like N, P, K, S, Ca, Mg, Mo etc (Khatri Chhetri, 1991). Due to toxicity and deficiency of such essential nutrients the microbial activities in the soil get reduced and that consequently reduced the process of nodulation in rice bean. This poor nodulation lead to the reduction in the atmospheric nitrogen fixing capacity of rice bean crop on soil. In addition to this, the applied nitrogen undergoes losses through leaching and surface runoff on sloppy land of hilly region during rainy season. Due to all these phenomenon soil become deficit in nitrogen and several other essential plant nutrients (i.e. reduced soil fertility). Similarly in the past, only 1 or 2 crops were cultivated in the land per year. But now, 3-4 crops are planted on the same land in a year. So, farmers also supposed that overall fertility status of the cultivable land has been decreased. Hence, decrease in soil fertility was the main reason behind decreasing rice bean productivity across the study site.

Table 23. Use patterns of chemical fertilizer in maize field across the study sites

Use of chemical fertilizer	VDC							
	Ramechhap		Bhaluwajor		Pakarbas		Total	
	F	%	F	%	F	%	F	%
Yes	32	*94.1*	32	*94.1*	34	*100.0*	98	*96.1*
No	2	*5.9*	2	*5.9*	0	*0.0*	4	*3.9*
Total	34	*100.0*	34	*100.0*	34	*100.0*	102	*100.0*

F = Frequency and % = Percentage.

4.4.6 Cost of production and return

Cultivation of rice bean landraces incur various types of cost, since it uses various kinds of input in terms of labor, fertilizer, seed, irrigation, chemicals etc. The study showed that average cost of production of *kalo* was highest (i.e. 19.09 ± 0.49 thousand rupees ha^{-1}) followed by *rato, ghorle, pahelo and seto* across the study site (Table 24). Comparing the average cost of production of *sano seto*, households of Bhaluwajor incurred lowest (i.e. 17.41 ± 0.28 thousand rupees ha^{-1}) cost of cultivation. The average return form *sano seto* was lowest (i.e. 20.78 ± 0.73 thousand rupees ha^{-1}) in Pakarbas and it may be due to lower productivity of *sano seto* at Pakarbas as compared to Ramechhap and Bhaluwajor. The benefit cost (B/C) ratio of *sano seto* was observed highest (i.e. 1.78 ± 0.05) in Ramechhap followed by Bhaluwajor (i.e. 1.52 ± 0.07) and Pakarbas (i.e. 1.14 ± 0.04). In case of *ghorle,* the average cost of production was observed lowest in Bhaluwajor (i.e. 17.71 ± 0.29 thousand rupees ha^{-1}) but the total return was observed highest in Ramechhap (i.e. 28.43 ± 0.82 thousand rupees ha^{-1}). Therefore, the B/C ratio for *ghorle* was highest in Ramechhap (i.e. 1.45 ± 0.05). Likewise in case of *kalo,* the average cost of production was observed lowest in Bhaluwajor (i.e. 18.53 ± 0.34 thousand rupees ha^{-1}) but the total return was observed highest in Ramechhap (i.e. 32.20 ± 1.37 thousand rupees ha^{-1}). Therefore, the B/C ratio for *kalo* was highest in Bhaluwajor (i.e. 1.50 ± 0.15). In case of *rato,* the average cost of production was observed lowest in Pakarbas (i.e. 18.54 ± 0.01 thousand rupees ha^{-1}) but the total return was observed highest in Bhaluwajor (i.e. 27.09 ± 1.05 thousand rupees ha^{-1}). Therefore, the B/C ratio for *rato* was highest in Ramechhap (i.e. 1.48 ± 0.07). Similarly, in case of *pahelo,* the average cost of production was observed lowest in Pakarbas (i.e. 18.53 ± 0.06 thousand rupees ha^{-1}) but the total return was observed highest in Bhaluwajor (i.e. 32.84 ± 1.29 thousand rupees ha^{-1}). Therefore, the B/C ratio for *pahelo* was highest in Bhaluwajor (i.e. 1.74 ± 0.05).

Table 24. Average cost and return of rice bean landraces (in thousand rupees ha^{-1})

Landraces	Items	Ramechhap	Bhaluwajor	Pakarbas	Total
		Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Sano seto	Average return	34.31 ± 0.90	26.47 ± 1.28	20.78 ± 0.73	27.12 ± 0.79
	Average cost	19.42 ± 0.40	17.41 ± 0.28	18.27 ± 0.15	18.36 ± 0.18
	B/C ratio	1.78 ± 0.05	1.52 ± 0.07	1.14 ± 0.04	1.48 ± 0.04
Ghorle	Average return	28.43 ± 0.82	22.41 ± 1.26	17.44 ± 0.65	23.67 ± 0.79
	Average cost	19.70 ± 0.42	17.71 ± 0.29	18.41 ± 0.08	18.67 ± 0.22
	B/C ratio	1.45 ± 0.05	1.26 ± 0.07	0.94 ± 0.03	1.27 ± 0.04
Kalo	Average return	32.20 ± 1.37	28.04 ± 3.30	19.19 ± 2.55	29.42 ± 1.52
	Average cost	19.31 ± 0.76	18.53 ± 0.34	18.85 ± 0.32	19.09 ± 0.49
	B/C ratio	1.46 ± 0.16	1.50 ± 0.15	1.02 ± 0.15	1.40 ± 0.12
Rato	Average return	23.91 ± 3.16	27.09 ± 1.05	14.04 ± 2.91	21.65 ± 2.24
	Average cost	19.28 ± 0.89	18.86 ± 0.16	18.54 ± 0.01	19.02 ± 0.51
	B/C ratio	1.48 ± 0.07	1.43 ± 0.04	0.91 ± 0.06	1.35 ± 0.07
Panhelo	Average return	32.59 ± 1.60	32.84 ± 1.29	21.67 ± 1.29	30.31 ± 1.57
	Average cost	18.58 ± 0.91	18.86 ± 0.16	18.53 ± 0.06	18.63 ± 0.50
	B/C ratio	1.64 ± 0.24	1.74 ± 0.05	1.16 ± 0.07	1.56 ± 0.15

SE = Standard Error.

4.5 Factors affecting rice bean landraces diversity

The middle hills (transition between plain and high hills) with lots of heterogeneous environments (niches) provide a fertile ground to flourish crop diversity (Rana, *et al*., 1999). Establishing the role of socio-economic and agroecological parameter in landraces diversity on-farm has been achieved through multiple regression analysis. Out of 7 variables, 6 of them showed statistically significant associations with the dependent variable. Landraces diversity in the study sites was attributed to seven variables, namely number of parcels of land, area under *Bari* land, food sufficiency, sex of household decision maker, access to market, no of family members who work regularly on farm and membership of group. Multiple regression analysis using OLS (Ordinary Least Square) technique has been used to determine the important factors that affect rice bean landraces diversity. The outputs (t value and significance of t value) along with descriptive statistics have been presented in Table 25.

Table 25. Factors affecting rice bean landraces diversity in the study site

Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig
	(B)	SE	(Beta)		
Constant	0.31	0.134		2.385	0.019**
Parcels of land	0.11	0.017	0.37	6.61	0.000*
Area under Bari land	0.16	0.048	0.16	3.41	0.001*
Food sufficiency	0.02	0.059	0.03	0.44	0.661
Membership of group	-0.02	0.057	-0.01	-0.51	0.610
Access to market	-0.21	0.068	-0.08	-3.19	0.002*
Number of family members who work regularly on farm	0.10	0.017	0.28	5.90	0.000*
Sex of respondent	0.32	0.108	0.13	3.01	0.003*

Dependent Variable: No of rice bean landraces (number HH^{-1}) and SE = Standard Error.
R = 0.982, R^2 = 0.965, Adjusted R^2 = 0. 963, Standard Error of Estimate = 0.2195
Durbin – Watson (d) = 2.22, F statistics = 368.78*
Note: * and ** refers to the significant at 0.01 and 0.05 level of significance, respectively.

A perusal of the regression result suggest that parcels of land, area under *Bari* land, access to market, number of family member who work regularly on farm and sex of respondent are the significant factors that affect rice bean landraces diversity at household level. Based on regression analysis an econometric model (first order polynomial equation) for factors affecting on-farm conservation of rice bean landraces diversity has been developed as:

$$\mathbf{R_n = 0.31 + 0.11X_p + 0.16X_a + 0.02X_f - 0.02X_g - 0.21X_m + 0.10X_l + 0.32X_s} \quad \text{..........(iv)}$$

Where,

R_n = number of rice bean landraces maintained (number HH^{-1})

X_p = number of parcels of land (number HH^{-1})

X_a = area under *Bari* land (ha HH^{-1})

X_f = HH food sufficiency level (months $year^{-1}$)

X_g = group membership (%) [Dummy, Yes = 1 and No = 0]

X_m = access to market facility (%) [Dummy, Have access = 1 and No access = 0]

X_l = number of family members who work regularly on farm (number HH^{-1})

X_s = sex of HH decision maker in agriculture (%) [Dummy, Male = 1 and Female = 0]

The equation (iv) is a least-squares multiple regression equation which is used to isolate the separate effects of the independent variables and to predict scores on the dependent variable. However, in many situations, using this equation (iv) to determine the relative importance of the various independent variables will be awkward especially when the independent variables differ in terms of units of measurement. In situation where the units of measurement differ, we will not necessarily be able to tell form the partial slope which independent variable has the strongest effect on the dependent variable and is thus, the most important of the independent variables (Healey, 1999). Comparing the partial slopes of variables that differ in units of measurement is a little like comparing apples and oranges (Healey, 1999). The independent variables can be made more nearly comparable by converting all of the variables in the equation to a common scale and there by eliminating variations in the values often partial slopes that are solely a function of differences units of measurement (Healey, 1999). We can for example, standardize all distribution by converting all scores into 'Z' scores. These standardized partial slopes are called beta-weights. The beta-weights will show the amount of change in the standardized scores of dependent variable for a one-unit change in the standardized scores of the independent variables while controlling for the effects of the other independents. The standardized regression equation can be further simplified by dropping the term for the intercept, since this term will always be zero when scores have been standardized (Healey, 1999). This value is the point where the regression line crosses the 'Y' axis and is equal to the mean of 'Y' when all independent variables are equal to zero. Thus, the standardized regression equation, with beta-weights noted would be:

$$\mathbf{Z_r = 0.37Z_p + 0.16Z_a + 0.03Z_f - 0.01Z_g - 0.08Z_m + 0.28Z_l + 0.13Z_s} \quad \text{.............(v)}$$

Where,

Z_r = number of rice bean landraces maintained (number HH^{-1})

Z_p = number of parcels of land (number HH^{-1})

Z_a = area under *Bari* land (ha HH^{-1})

Z_f = HH food sufficiency level (months $year^{-1}$)

Z_g = group membership (%) [Dummy, Yes = 1 and No = 0]

Z_m = access to market facility (%) [Dummy, Have access = 1 and No access = 0]

Z_l = number of family members who work regularly on farm (number HH^{-1})

Z_s = sex of HH decision maker in agriculture (%) [Dummy, Male = 1 and Female = 0]

The value of multiple correlation coefficient ($R = 0.982$) indicates the strong correlation between dependent and independent variables in the analysis. Likewise, the value of coefficient of multiple determination ($R^2 = 0.965$) indicates about 96 percent variation explained in dependent variable is by all independent variables combined. In the regression context, the classical linear regression model assumes that autocorrelation does not exist in the disturbances μ_i (Gujrati, 2006). Symbolically,

$$\mathbf{E(\mu_i \mu_j) = 0 \quad i \neq j} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(vi)$$

The Durbin – Watson d statistics (d = 2.22) in the analysis illustrate that there is no first order autocorrelation, either positive or negative. Hence, the disturbance term relating to any observation has not influenced by the disturbance term relating to any other observations.

The standardized regression equation (v) shows different beta-weights for all independent variables. So based on relative strength of standardized partial slopes, the null hypothesis "all factors equally affect the rice bean landraces diversity" has been rejected. The effect of each explanatory variable on rice bean landraces diversity has been discussed below.

Parcels of land

The result obtained from the multiple regression analysis has illustrated that 1 percent increase in parcel of land would tend to raise the number of rice bean landraces diversify by 0.11 percent, *ceteris paribus* (Table 25). Household with more number of parcels of land maintained significantly ($p<0.01$) more no of rice bean landraces across the study site Increase in the number of parcels of land holding is associated with increase in the heterogeneous growing environments (niches) (Rana *et al.*, 1999). At the same time heterogeneity in growing environments necessitates farmers to grow a variety of landraces to suit the growing conditions and diverse farming systems (Rana *et al.,* 1999). Similarly, parcels of land and land fragmentation are positively related to each other. So according Rana *et al.,* (1999) land fragmentation is directly proportional to landraces/varietal diversity in Nepalese farming system. Another very important fact emerged from the research was that landraces were specific to certain agro-ecological domain and they performed best or compete better than modern high yielding varieties within that domain, though same landrace could be found in other domain mainly due to presence of transitional zones between domains. But transgressing of domain boundaries other than adjacent one was not observed. Different parcels of land across the study sites were associated with different agroecological domain and different landraces were best adapted to specific domains. This information has important implication on the analysis of diversity, which first needs to be done on domain basis then aggregated at community level. Consequently prioritizing and devising, conservation strategy on-farm must take into account the landraces distribution within and across domains.

Area under *bari* land

The result obtained form the regression analysis has shown that household with more area under *bari* land maintained significantly ($p<0.01$) more no of rice bean landraces across the study sites (Table 25). It means that 1 percent increase in area under *bari* land would tend to raise the number of rice bean landraces diversify by 0.16 percent, *ceteris paribus*. Therefore, there must be a strong influence of land holding on landraces diversity at eco-site level. *bari* was the upland (even marginal) where different drought resistance crops like millet, maize, rice bean and seasonal vegetables are cultivated. Under marginal environment the landraces become more competitive than the modern varieties. On the poor, unirrigated, upland *bari* land and swampy conditions traditional landraces remain superior (Rana *et al.,* 1999). Furthermore, the number of landraces choices greatly reduces in unfavorable environments mainly due to lack of adoption. The baseline information on landraces diversity on rice been across agroecological domains has clearly demonstrated that landraces were the only options of natural resources for the farmers had in marginal environments (extreme growing conditions: rainfed, steep sloppy). Moreover, the choices they had even for landraces were limited in such environments whereas in favorable environments the choices were enlarged with modern varieties competing in such areas. The specific landraces have been selected over the years in given environment. So they were bound to be more adaptive as compared to others. Thus, they could be expected to possess specific adaptive traits that need to be conserved and utilized in breeding programmes.

Food sufficiency level

The study has revealed that 1 percent increase in food sufficiency level would tend to raise the number of rice bean landraces diversify by 0.02 percent at household level, *ceteris paribus* (Table 25). Food sufficiency level was associated with economic status of the household. A household with high economic status had high food sufficiency level (Rana *et al.,* 1999). Therefore, this finding indicates that resource endowed households' maintained diverse types of rice bean landraces in their farm. Owing to their resource endowment (more land holding, spread in different agro-ecological domains, and fragmentation of land) they have the capacity and the need for plant genetic diversity to manage diverse ecosystems and to spread the labor demand across seasons. Besides, resource-rich farmers could afford to satisfy their higher level needs of quality and diverse products derived form variety of landraces.

Membership of group

During field study it was observed that, a household with no affiliation to membership in farmers group had maintained relatively higher number of rice bean landraces as compared to the households with at least one family member affiliated to the farmers group at community level (Table 25). However, the difference was statistically significant ($p>0.05$) at 90 percent level of confidence, which suggests that, there was not strong influence of farmers group in varietal diversity management at household level. But according to Rana *et al.,* (2006), individuals with no affiliation to membership in farmers groups maintained higher landraces diversity than otherwise. Therefore, this finding matches with the finding of Rana *et al.,* (2006) though it was statistically non-significant.

Access to market

The households who have access to market had maintained significantly ($p<0.01$) lower number of rice bean landraces (Table 25). Farmers who were near about the market had grown vegetables (both on season and off season), fruits, and other modern high yielding high value crops on their land because of easy marketing in local market. Rana *et al.,* (2006) have reported that the mid-hill eco-site with less intervention from formal research and development agencies and limited market integration harbored higher landraces diversity. Further this, during field study most of the respondents of such household reported that vegetable farming was more profitable to them as compare to rice bean on market access area. But those households had maintained at least one rice bean landrace for household consumption purpose and because of cultural and social value.

Number of family members who work regularly on farm

The analysis of the data obtained during field study shows that, the households with large number of family members who work regularly on farm had maintained significantly ($p<0.01$) higher number of rice bean landraces on their farm (Table 25). 1 percent increase in number of family members who work regularly on farm would tend to raise the number of rice bean landraces diversify by 0.10 percent, *ceteris paribus* (Table 25). The major reason behind such phenomenon was the easy availability of family members as working labor force, because availability of family labour force to work on-farm determined the level of management provided for a landraces or varietal diversity (Rana *et al.,* 1999). Similarly, the availability of family labor force has been regarded as one of the key variables to be monitored at household level for change in management practices and shift of variety (from intensive management requirement to less management demanding one or vice versa) in response to changed management (Smale, 2000).

Sex of household decision maker

Contrary to general belief that female decision makers maintain higher amount of landraces diversity (Rana *et al.,* 1999), the result has showed the opposite. The study concluded that the gender of decision maker had significant ($p<0.05$) bearing on landraces diversity on-farm (Table 25). Majority of the households (about 58.8 percent households in Ramechhap, 85.3 percent households in Bhaluwajor and 70.6 percent households in Pakarbas) were dominated with male leadership throughout the study sites (Figure 7). Therefore, during field study it was observed that, households with male counterpart at decision making position maintain significantly ($p<0.05$) higher number of rice bean landraces as compared to the households with female at decision making position. This finding coincides with the finding of Rana *et al*., (2006), which states that, male household head maintained higher number of landraces as compared to their female counterparts. However, it is important to focus conservation programmes on women farmers because out migration of male members is a widespread phenomenon in rural Nepal. Thus, participation of female farmers in every aspect of conservation interventions becomes vital for success.

Overall analysis of regression result have established that, parcels of land holding, area under *bari* land, access to market, productive labor force in family and membership of farmer's group were the important factors that have significant contribution on on-farm maintenance of rice bean landraces diversity. Therefore, proper management of these socioeconomic variables is the prerequisite for on-farm conservation of valuable rice bean landraces diversity.

4.6 Economic valuation and cost-benefits of landraces conservation

The economic values or benefit of rice bean genetic resources tends to be measured exclusively by the market value of primary and secondary rice bean products and byproducts (i.e. the price of grain, *dal,* rice bean straw/vine, etc). These values accrue to the farmers who produce the primary products, to the marketing and distributional chain for the secondary products, and to the world at large through trade (Smale and Mcbride, 1996). There are three major types of values e.g. direct use value, indirect use value and non-use value, which accrue at these various levels. Direct use value includes marketable primary and secondary products deriving from the plant such as grain, straw, processed products and others. This also includes host plant resistance to biotic and abiotic stress and non-marketable products, which have value at the local level.

The concept of "opportunity cost" approach or potential income lost by not planting modern rice varieties was employed to identify and assign monetary value for the cost of rice bean landraces conservation *in situ*. This has been done both at individual household and community level using direct use value (marketable products) of the landraces. Two different situations are considered for such valuation.

i. Subsistence systems with favorable environments

ii. Subsistence systems marginal risk prone environments

Opportunity costs of rice bean and rice production.

Table 26 provides comparative cost benefits of growing rice bean landrace (*sano seto*) and modern rice variety (*khumal-4*) in partial irrigated favorable environment. The valuation of rice bean cultivars has been done here based on direct use value (grain and by product yield) accruing at the local level. The inputs and outputs were valued at prevailing market price for those commodities, which are traded in the market. Family labors were valued at opportunity wage rate available in the local market. The wage good (rice grain paid in kind) was quantified in monetary terms by adding the costs of snacks that farmers serve to labors during particular rice farming operations. The value of rice and rice bean by products such as straw was imputed at harvesting season local market price. Farmers were under severe economic pressure to replace rice bean landraces by modern rice high yielding varieties. After the construction of irrigation canal that passes across the cropping land from the top of the hill at Ramechhap, several households have replaced rice bean landraces such as *sano seto, ghorle, rato, pahelo* by modern rice varieties like, *khumal-4, radha-7, radha-4* etc. If farmers opt to grow rice bean landrace like *sano seto* instead of modern high yielding rice varieties like *khumal-4* in partially irrigated semi-commercialized system, they have to forgo Rs. 12121.24. This means the cost of *in situ* conservation of rice bean landrace at the household level for a farmer owning a hectare of land will be Rs. 12121.24 (Table 26), which indicates the high opportunity cost of growing the rice bean landraces in these favorable environments.

Table 26. Opportunity cost of growing rice bean landrace (*sano seto*) instead of modern variety of rice (*khumal-4*), in rice dominated farming system of Ramechhap

Losses	Total Amount (Rs.)	Gains	Total Amount (Rs.)
Extra costs: Rice bean		Cost saved: Rice	
Seeds	1179.6	Seeds	1769.4
Bullock labor	2000	Bullock labor	2800
Human Labor	9000	Human Labor	14000
Stationary	3700	Stationary	7000
		Fertilizer	10093.52
Total	15879.6	Total	35662.92
Revenue forgone		Extra revenue	
Grain yield of rice	41050.08	Grain yield of rice bean	35388
Straw yield	4000	Straw yield	2000
Total	45050.08	Total	37388
Total loss	60929.68	Total gains	73050.92
Net benefit forgone	12121.24		

Subsistence system with marginal risk-prone environments

Since in subsistence and marginal risk-prone systems landraces are economically viable and no modern varieties are presently possible to grow, the opportunity costs or benefit forgone will be low in such case (Gauchan, 1999). Farmers' varieties were well adapted to poor risk-prone environmental conditions. In the difficult and unpredictable growing conditions that characterize much of the country (poor or erratic rainfall, flood, very long or short growing seasons, no external inputs), it is landraces which provide small holder farmers with a more reliable crop yield. Thus, farmers continue grow/conserve them because they give higher value for their immediate subsistence use and income.

Cost-benefits of producing *ghorle* landrace

The production of certain landrace in the unique environments such as *ghorle*, in marginal upland at high altitude (i.e. 1800-2200 masl) and humid area was economically profitable to grow. Because in such risk-prone environments there were no alternatives to these landraces e.g. no modern crop varieties and other enterprises were feasible. Thus, opportunity cost or benefit forgone from growing rice bean landraces was zero. Table 27 shows the actual cost-benefit analysis of landraces production in their given agroecological and farmers management and economic conditions. Inputs and outputs for this analysis were valued similarly as for *sano seto* and *khumal-4* (Table 26). The monetary valuation of hired labour was estimated based on the actual farm gate price of the rice landraces. The inputs and outputs were valued at prevailing market price.

Table 27. Costs and benefits of producing rice bean landrace (*ghorle*) at Ramechhap (in Rs ha^{-1})

Particulars	Quantity	Rate	Total Amount (Rs)
Activities and cost			
Seed	30 Kg	36 Rs Kg^{-1}	1080
Bullock labor	10 Hall	200 Rs $Hall^{-1}$	2000
Human labor	90 Man days	100 Rs Man day^{-1}	9000
Stationary			3700
Total costs			15780
Gross value			
Grain yield	820 Kg	32 Rs Kg^{-1}	26240
Straw yield			2000
Total value			28240
Net benefit			12460
B/C ratio			1.78

Hall = Local unit used to represent draft bull

The cost and benefit of in situ conservation of rice bean landrace (i.*e. ghorle*) in subsistence system with marginal environment was 15780 Rs ha^{-1} and 28240 Rs ha^{-1}, respectively (Table 27). The benefit cost (B/C) ratio of *ghorle* landrace was 1.78. Therefore, the analysis has revealed that such landraces are economically beneficial to grow in the given ecological niches as no modern crop varieties are well adapted in these harsh environments.

4.7 Rice bean value chain analysis

The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky & Morris, 2000). The structure of rice bean value chain has been presented in the Figure 10. As can be seen from this, production *per se* is only one of a number of value added links. Moreover, there were ranges of activities within each link of the chain. Although often depicted as a vertical chain, intra-chain linkages were most often of a two-way nature – for example, specialized design agencies not only influence the nature of the production process and marketing, but are in turn influenced by the constraints in these downstream links in the chain. Value chain analyses include the study of marketing system, marketing channels, marketing margin, producer's shares and marketing efficiency (Kaplinsky & Morris, 2000). Marketing cost, marketing margin and price spread were different for different value chain. Therefore, value chain analysis approach has been used here to study the marketing system, marketing channels, marketing margin, producer's shares and marketing efficiency of *sano seto* landrace at Ramechhap District (Figure 10).

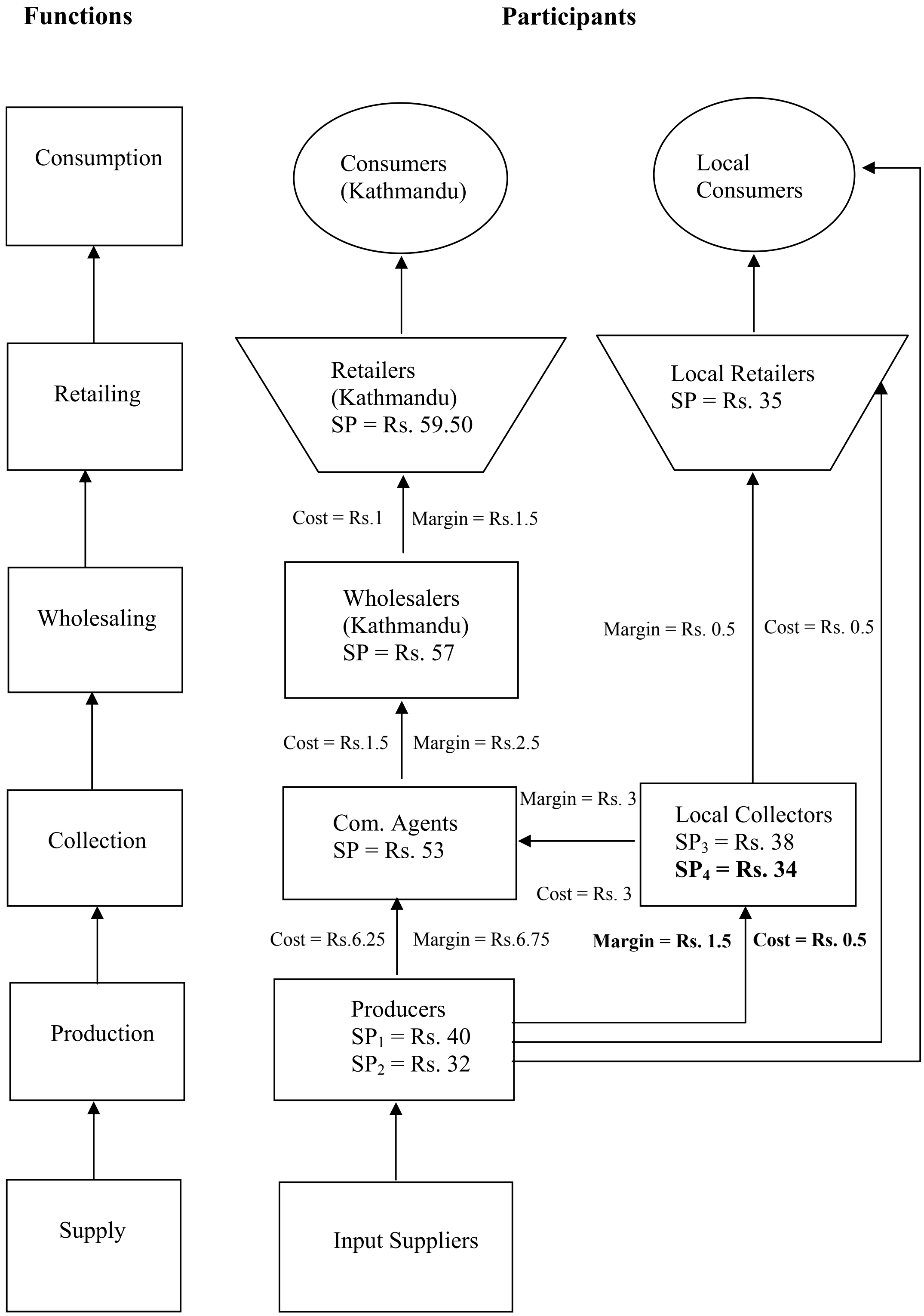


Figure. 10. Value chain map for rice bean (*sano seto*) in the study site

Where,

SP = Selling price

Com. Agents = Commission Agents

SP_1 = Selling price for commission agents at local Hat/Bazzar

SP_2 = Selling price for local collectors, retailers and consumers

SP_3 = Selling price for commission agents

SP_4 = Selling price for local retailers

Rice bean producers, market intermediaries and consumers were the stakeholders of rice bean value chain map. Rice bean from producer was found to flow from different market intermediaries to final consumers. Most of rice bean was traded through the involvement of middle men (*commission agents*). Few village level collectors, local retailers and commission agents had been involving in collection of rice bean directly form producers at household level across the study sites. But most of the producers (about 87%) used to bring their produce at local hat/bazzar for sell. The local hat/bazzar had been occurring once up on a week. Producer used to bring rice bean grain at local hat/bazzar for sell and after selling rice bean, they used to purchase other food grains (e.g. milled rice) vegetables, meat, clothes, stationary items and other daily necessary goods from the cash receipt from rice bean. At local hat/bazzar, commission agents used to purchase rice bean grain from producers and local level collectors. The commission agents used to sell the rice bean to the wholesalers. Those wholesalers may be local (wholesale market at Manthali) or distant (i.e. Kalimati wholesale market, Kathmandu). From wholesaler rice bean was distributed to retailers and from retailers to consumers. The flow of product form producer at Ramechhap to consumers at Kathmandu valley, marketing margin and price spreads across the different stakeholders has been presented in the value chain map (Figure 10). Increase in selling price of rice bean from first stage of marketing (i.e. producers) to final stage of marketing (i.e. retailers – consumers) was due to value addition and marketing cost involved on post harvest handling and marketing. The value addition activities that were observed in rice bean were, cleaning, drying, coloring, milling (i.e. making pulse) etc. of grains. Such types of value addition activities had been performing by producers, wholesalers and sometime by retailers of rice bean. Milling in rice bean was very rare, only two producers at Ramechhap used to sell rice bean pulse (*masyang ko dal*) after milling.

4.7.1 Marketing costs, margins and marketing efficiency

Marketing efficiency is essentially the degree of market performance. The movement of goods from producer to consumers at the lowest possible cost, consistent with the provision of the services desired by the consumer, may be termed as efficient marketing (Acharya and Agarwal, 1999). A change that reduces the costs of accomplishing a particular function without reducing consumer satisfaction indicates an improvement in the efficiency. An efficient marketing system is an effective agent of change and an important means for raising the income levels of satisfaction of the consumers. Marketing margin and producer share give an indication of efficiency of existing marketing system. Lower marketing margin and higher producer share on retail price ensures efficiency of marketing system (Acharya and Agarwal, 1999).

4.7.1.1 Gross margin analysis

The univariate analysis of variance of gross margin from rice bean landraces has been done to test whether the gross margin received by producer from different rice bean land races were differ significantly or not. Similar analysis was done by Bastakoti, (2001) on mandarin orange. The study revealed that the gross margin (Rs kg^{-1}) of different rice bean landraces were significantly different ($p<0.01$) each other and the gross margin (Rs kg^{-1}) of rice bean landraces were also differed significantly ($p<0.05$) across the different VDC (Table 28 and Appendix 5). Therefore, the null hypothesis “per unit gross margin of all rice bean landraces are same”, has been rejected.

Among the rice bean landraces, the gross margin (Rs kg^{-1}) was observed maximum for *sano seto* in Ramechhap (Table 28), that was observed maximum for *pahelo* in Bhaluwajor. But in case of Pakarbas, the gross margin (Rs kg^{-1}) was observed maximum for *sano seto.* The reason behind the different gross margin value of rice bean landraces within same agroecological domain and under same management condition was due to difference in productivity and market price for each landraces. The productivity is a multidimensional and complex factor, which is governed by management, soil characteristics, microclimatic condition, and genetic makeup of plant species (Jarvis *et al.,* 2000). The difference in productivity for each rice bean landraces within the same agroecological domain and under the common management condition is associated with their respective genetic makeup. Therefore, this finding further strongly proves that the rice bean landraces were not only morphologically diversified but also they differ genetically among each other.

The market price for rice bean was determined by market forces like and demand and supply of commodity in the market. Therefore, the different market price for each rice bean landraces were associated with determinants of demand and supply like consumers tests and preference, consumers purchasing capacity, cultural and spiritual value in the community, supply of commodity in the market, availability of other complementary and substitutionary commodities in the market etc. Different rice bean landraces had different socioeconomic values in the society. Therefore, this finding further proves that those rice bean landraces had not only morphological diversity, but also they had socioeconomic diversity. Conclusively, it can be said that the rice bean landraces were differ genetically and socio-economically among each other throughout the study sites.

Table 28. Average gross margin from rice bean landraces across the study sites

Location	Landraces	Gross margin (Rs kg^{-1})
		Mean ± SE
Ramechhap	*Sano seto*	15.78 ± 0.82
	Ghorle	7.96 ± 0.87
	Kalo	12.94 ± 1.17
	Rato	8.22 ± 1.35
	Panhelo	14.74 ± 1.86
Bhaluwajor	*Sano seto*	9.56 ± 1.62
	Ghorle	2.30 ±1.98
	Kalo	9.52 ± 3.61
	Rato	8.09 ± 0.76
	Panhelo	15.09 ± 0.76
Pakarbas	*Sano seto*	11.70 ± 0.82
	Ghorle	5.19 ± 1.00
	Kalo	8.40 ± 1.77
	Rato	4.24 ± 0.82
	Panhelo	11.69 ± 1.26
Location	F ratio	5.955**
	P value	0.026
Landraces	F ratio	12.362*
	P value	0.002

SE = Standard Error.

Note: * and ** refers to the significant at 0.01 and 0.05 level of significance, respectively

4.7.1.2 Marketing channels and marketing efficiency

Altogether, five marketing channels were identified that had been operating for rice bean marketing throughout the study sites. Those marketing channels have been presented hereunder.

1. Producers → Consumers
2. Producers → Local Retailers → Consumers
3. Producers → Local Collectors → Local Retailers → Consumers
4. Producers → Commission Agents → Wholesalers → Retailers → Consumers
5. Producers → Local collectors → Commission Agents → Wholesalers → Retailers → Consumers

Rice bean value chain analysis has revealed that marketing efficiency and producer's share on consumer rupees was decreasing with increasing in the number of intermediaries in the marketing channels. Among these marketing channels, channel-1 was most efficient because of highest (128) index of marketing efficiency. The producer had 100 percent share on consumer rupees in that channel because of almost no involvement of any marketing intermediaries. But that channel was followed by very few stakeholders (<5 %) because producer could not sell all their produce through this channel and there was the compulsion to go in local hat/bazzer to purchase other necessary goods. Therefore, this channel was most efficient but not dominant at Ramechhap District. In an ideal market condition, the producers would have maximum shares on consumers' rupee if all the stakeholders operate through this channel. But at ground reality, the channel-5 was dominant because more than 80 percent of rice been produced at Ramechhap District used to pass through this channel. The index of marketing efficiency and producers share associated with this channel were 1.45 and 67.22 percent, respectively. Similarly, channel-6 was least efficient (1.25) and producer's share on consumer rupees was also lowest (53.78 %) for this channel. Therefore, conclusively it can be said that the prevailing marketing system of rice bean landraces was not efficient and most of the produces were receiving low share on consumer's rupees in Ramechhap.

Critical analysis over the price spread of rice bean across the market participants shows that the share of middlemen on consumer rupee was more as compare to producer in all marketing channel (Figure 10) (Table 29). It is not unusual to encounter the view that the farmer's share of the retail price of agricultural commodities is too small and that retail-farm gate margin are excessive and include elements of excess profit (Bastakoti, 2001). In many instances this charge has been judged to be unsupported since a careful analysis of the profits of middlemen and processing firms shows them to be commensurate with the business risk involved. Generally, a higher farm-retail margin is associated with the demand of marketing services and the cost uncured for these. In developing countries like Nepal, marketing services are costly due to very poor transportation infrastructure and marketing margins tends to be high (Bastakoti, 2001). This is highly affected by the accessibility condition of production sites. Generally, high marketing margin was linked with exploitation of middlemen. However, the higher marketing margin may not necessarily be due to innate efficiency and excess profits of the middlemen.

Table 29. Estimates of marketing costs, margins, and marketing efficiency for rice bean

Particulars	Marketing Channels*				
	1	2	3	4	5
Net price received by producer (FP)	32.00	32.00	32.00	40.00	32.00
Total marketing costs (MC)	0.25	0.50	1.00	11.75	11.75
Total marketing margins (MM)	-	2.50	2.50	15.75	13.75
Retailer's sale price (RP)	32.00	35.00	35.00	59.50	59.50
Value added (VA)	-	3.00	3.00	19.50	27.5
Producer's share (PS) %	100.00	91.42	91.42	67.22	53.78
Index of marketing efficiency (MME)	128.00	10.66	9.14	1.45	1.25

* Numbers 1 to 5 are explained in 4.7.1.2 section.

4.8 Production and marketing problem analysis

Responses regarding various problems in production and marketing were recorded and analyzed during field study. The respondents were asked to identify, choose and prioritize the various categories of problems they had been facing on rice bean farming for a long time period. Problem analysis was done by conducting focus group discussion with key informants at community level. The severity of problems was identified by ranking with appropriate score. The intensity of problems related to production and marketing of rice bean with their ranks has been presented below (Table 30) and (Table 31).

4.8.1 Production problems

The major production problem of rice bean landraces as perceived by the producers at Ramechhap was the problem of decreasing rice bean productivity (Table 30). Degradation of soil fertility due to repeated use of chemical fertilizer, loss of top fertile soil of sloppy land by surface runoff water (water erosion) during monsoon period and repeated use of poor quality seed year after year on the same land were the vital causes behind decreasing productivity of rice bean. Unavailability of working labour force was another production problem after decreasing productivity at Ramechhap. Temporary migration of productive human resource to gulf countries, India and Kathmandu in search of employment were the major reasons associated with unavailability of labour. Damage of crop by wild life (e.g. deer and rabbit), attack was the major production problem perceived by the producers at Bhaluwajor. Most of the people at Bhaluwajor reported that the attack of wild animals on crop land had increased significantly after converting the government forest into community forest. Formation of *bose kosa* in rice bean was another most severe problem at Bhaluwajor. Locally this problem was known as *bosine*. Several years of farmers experience showed that high relative humidity and low sunlight exposure during flowering and pod formation stage is the conducive environment behind the formation of *bose kosa*. During field study it was observed that this problem was more severe at north facing landscape than otherwise. This problem was more common at Bhaluwajor, because it was north facing, humid and steep sloppy land surrounded by dense warm-temperate forest. Increasing insect pest attack on rice bean field followed by decreasing productivity were major problems associated with rice bean farming at Pakarbas.

Table 30. Intensity of production problems faced by rice bean producers

Problems	Ramechhap		Bhaluwajor		Pakarbas	
	Index	Rank	Index	Rank	Index	Rank
Decreasing productivity	0.89	I	0.82	III	0.85	II
Decreasing soil fertility	0.64	III	0.46	VII	0.47	VII
Wild life attack on crop field	0.38	VII	0.94	I	0.27	VIII
Insect pest infestation	0.58	V	0.39	VIII	0.91	I
Decreasing trend of hired labor	0.79	II	0.79	IV	0.52	VI
Scarcity of irrigation water	0.52	VI	0.53	VI	0.55	IV
Lack of improved seed	0.32	VIII	0.66	V	0.70	III
Pani kosa or bose kosa	0.61	IV	0.90	II	0.54	V

Note: Scale value range form 1 to 0, where 1 = most serious, 0.75 = serious, 0.5 = moderate, 0.25 = little bit and 0 = no problem at all.

4.8.2 Marketing problems

Marketing is as important as the production techniques in case of agricultural commodity. Unless and until marketing systems are improved, no incentives to increase the production will benefit the growers. In the current poor marketing system of rice bean landraces in Nepal, producers and traders were facing several marketing problems. Study showed that the major marketing problems as perceived by traders were the problem of lack of transportation facility form the zone of production to zone of consumption. Inadequate supply of rice bean grain in the market was another problem being faced by traders. Most of the producers were resource poor and marginal farmers with fragmented land holding, so that they were not able to produce and supply rice bean on commercial scale. Low and fluctuating price followed by frequent strikes on road , lack of marketing infrastructures and lack of subsidized loan were other important problems being faced by traders on rice been marketing. The intensity of problems along with their rank has been presented in the Table 31.

Table 31. Intensity of marketing problems faced by rice bean traders

Problems	Index	Ranks
Poor quality grain	0.81	V
Lack of transportation facilities	0.95	I
Lack of appropriate marketing facilities	0.68	VI
Lack of well equipped storage facilities	0.60	VII
Inadequate supply	0.93	II
Low price	0.88	III
Fluctuation in price	0.42	VIII
Frequent strikes	0.84	IV

Note: Scale value range form 1 to 0, where 1 = most serious, 0.75 = serious,
0.5 = moderate, 0.25 = little bit and 0 = no problem at all.

5 SUMMARY AND CONCLUSION

This section includes the summary of the research; conclusion derived based on findings, suggestions for policy implication, and suggestions for further research.

5.1 Summary

Global food security depends on conservation and utilization of existing and improved biodiversity that are continuously being used for food and agriculture. Sustainability of agricultural development is dependent on local landrace diversity. Landraces and their wild relatives are the key element of agricultural biodiversity and constitute a key resource maintained and used by farmers in different production environments. Maintenance, utilization and management of this diversity in the fields are vital for sustainable agriculture. On-farm conservation of plant genetic resources refers to the continue cultivation and management of a diverse set of crop populations with intra and inter-population variation in the agro-ecosystems where crops have evolved. Farmers practice on-farm conservation have maintained and managed the diversity at different levels depending upon their traditional knowledge, practices availability or resources and production environments available over time and space. Diverse set of rice bean landraces have been maintained by the farmers in Ramechhap District and have paid contribution to rural food and nutrition security. Due to several problems related with production and marketing aspects of rice bean, farmers were discouraged to further expand the area under rice bean. Though there are still a lot of farmers willing to produce rice bean, all these production and marketing disincentives along with increasing population had been forcing people to opt for cultivation of other high yielding crops and involvement in non-farm alternatives. Consequently these valuable and diverse rice bean landraces prevalent in different parts of the country are disappearing from farmer's field in alarming rate.

Keeping view on these aspects, this study was designed to assess the conservation and commercialization prospects of rice bean landraces in Ramechhap District of Nepal.

5.1.1 Study area

Ramechhap District is one of the rich districts in terms of agrobiodiversity due to wide range of climatic variation. The total arable land in Ramechhap District was 50908 ha, out of which 46715 ha was cultivated. The economy of the district mostly depends upon the agriculture, where about 84.54% of the work forces used to derive their income from this sector. Three VDCs namely Ramechhap, Bhaluwajor, and Pakarbas were selected based on the potentiality of growing rice bean crop for the study purpose.

5.1.2 Sampling and survey techniques

Primary data were collected from 102 rice bean producers, 23 rice bean traders, 10 rice bean consumers and 18 key informants' with the help of research tools like household survey, focus group discussion and key informants survey. Simple random sampling technique was applied to conduct household survey. Secondary data were collected by reviewing the published and unpublished documents of related national and international intuitions.

5.1.3 Household characteristics

Average family size throughout the study site was 8.94 and agriculture was the major occupation of people. Around 71.6 percent respondents (HH decision maker) were male and among them 67.6 percent were literate. On comparison, around 82.4 percent of the respondents were literate in Ramechhap while, only 58.8 percent were literate in Bhaluwajor. Brahmin, Chhetri, Newar, and Tamang were the dominant ethnic groups across the study sites. The average size of operational land holding was 1.41 ha. Around 11.8 percent of households had shared-in others land for cultivation and 18.6 percent of households had shared-out their own land for cultivation. The average size of herd (LSU) was 12.97. On comparison, the average size of herd was highest in Pakarbas (14.05) and lowest for Bhaluwajor (i.e. 12.32). On an average, around 10.8 percent household across the study sites were food self sufficient (> 12 months) and around 12.7 percent of household were food sufficient only for 9-12 months. But around 43.1 percent of households across the study sites were food sufficient of 3-6 months only and were regarded as resource poor households. The share of total farm cash income to the annual household cash income was significantly high (i.e. 79.69 %) as compared to total annual off-farm cash income (i.e. 20.30 %). The share of cereal crops to the total annual household cash income was observed highest (i.e. 48.05 %). Likewise, the contribution of rice bean enterprises to the total annual household cash income was 10.86 percent throughout the study site.

5.1.4 Area, production and productivity of rice bean

Rice bean is an important summer legume crop grown as sole crop, intercrop with maize in marginal *bari* land and on rice bund under different farming systems for all categories of rural people in Ramechhap District. Rice bean along with other pulses like Field pea, Cow pea, Broad bean, *Phaseolus*, and Mungi occupies 319557 ha area with production 274375 mt and productivity 859 kg ha^{-1} in Nepal. Average area of rice bean landraces was 0.56 ha with 0.67 mt ha^{-1} productivity in the study site. The average area under *sano seto, ghorle, kalo, rato, and pahelo* were 0.38 ha, 0.16 ha, 0.04 ha, 0.03 ha, and 0.02 ha, respectively. Likewise the average productivity of *sano seto, ghorle, kalo, rato, and pahelo* were 0.65 mt ha^{-1}, 0.80 mt ha^{-1}, 0.75 mt ha^{-1}, 0.83 mt ha^{-1} and 1.08 mt ha^{-1} , respectively. The average area was observed highest for *sano seto* but the average productivity was observed highest for *pahelo* landraces. Average benefit cost ratio of *pahelo* was observed highest (i.e. 1.56) and that of *ghorle* was observed lowest (i.e. 1.27). The study revealed that there was significant decrease in the average area and productivity of rice bean over last six years throughout the study sites. Most of the producer of the study site felt that introduction of modern high yielding crops (e.g. french bean, cow pea, different vegetable crops, hybrid maize etc) in to the existing farming system and change in cropping system were the major reason for gradual decline of average area under rice bean. Similarly majority (i.e. 70.6 %) of the producer respond that repeated use of inorganic fertilizer year after year on the same field is the major reason responsible for gradual decline in the rice bean productivity across the study sites.

5.1.5 Local knowledge on rice bean

Rice bean is known by different local names in different areas of Nepal. *Masyang, siltung, jhilunge,* and *ghore mas* were some commonly used local names. *Masyang and ghore mas* were quite common in Ramechhap. Farmers' knowledge was documented to distinguish the farmer-named landraces based on their own morphology, growing environment and utility. Farmers were mostly consistent in describing and distinguishing the cultivars based upon grain shape, size, color, yield, maturity time, eating quality, vine length, leaf texture, steam texture etc. *Sano seto, ghorle, kalo, rato*, and *pahelo* were identified as locally common rice bean landraces across the study sites. Farmers had been cultivating rice bean on marginal lands. Usually dry hills and southern or eastern facing slopes were the major domains for rice bean cultivation. Rice bean was cultivated just from 600 m (foot of the hill) to 1800-2200 m (top of the hill). Dry hills raised from river basin areas were the major production domains in Ramechhap. Farmers had distinct knowledge about choosing the appropriate land for rice bean. Farmers employ multiple criteria to characterize rice bean ecosystem. Moisture (ability to retain water for longer time period) and inherent fertility status of soil as well as productivity potential influenced by human managed factors (application of compost and/or farm yard manure, chemical fertilizers and irrigation) were the major determinants in characterizations of rice bean ecosystems.

Among the rice bean landraces *sano seto* was extensively cultivated at lower foot hills (below 1050 m above sea level). Like wise, *ghorle* was cultivated at high hill, north facing slope at an altitude range of 1200 to 2200 m above sea level. Other landraces were adapted to the environment in between those *sano seto* and *ghorle*. Findings have suggested that only a limited number of landraces exit for extreme condition (marginal ecosystem), whereas plenty of options exit for favorable conditions for farmers.

5.1.6 Rice bean use diversity

Rice bean landraces have socio-economic, (food security, market, cultural and religious uses) and adaptive (abiotic and biotic) traits which jointly represent 'use value' of a landrace, that determine the continued existence of these traditional varieties on-farm. Farmers had been cultivating rice bean for its food, fodder and fertilizer value in Ramechhap District. Unlike the other common pulses, rice bean was mainly taken as whole grain pulse for soup purpose. Major food recipes prepared form rice bean were rosted grain, *biramla, furaula, masausra, dal*, *boil grains, quwanti, batuk roti, bara (wo), khyala, khichadi,* and *chhanta*. Among these food recipes some were prepared daily as day to day food while, others were prepared during special occasions with respect to culture of people.

5.1.7 Gender role in crop management

The roles, responsibilities and decision making of women farmers in rice bean production, seed selection, management and use were dominant across the study sites. The direct involvement and decision making of women farmers in varietal/landrace choice, allocation of land parcels to variety/landrace, seed selection, storage, maintenance and further management, indicate that women farmers have access to and control over genetic resources.

5.1.8 Factor affecting rice bean landraces diversity

Rice bean landraces possessed significant amount of genetic diversity and had met the various needs of local farmers. The studies have confirmed the facts that many inter-disciplinary forces agro-ecological, socio-economical, genetical, cultural, and biological are at play on-farm with diverse consequences on extent and distribution of rice bean diversity. Multiple regression analysis for analyzing factors affecting rice bean landraces diversity showed the significant influence of biophysical and socio-economic factors to grow and maintain rice bean landraces. Among these factors number of parcels of land, size of *bari* land, access to market, sex of household decision maker, number of family members who work regularly on farm were found statistically significant and all these variables had expected signs. But the variables food sufficiency level and membership of group were found statistically non significant though both of them had expected signs.

5.1.9 Commercial feasibility of rice bean landraces

The economic valuation of rice bean cultivars has been done based on direct use value (grain and by product yield) accruing at the local level. The study showed that the cost of *in situ* conservation of rice bean landrace at the household level for a farmer owning a hectare of irrigated land was Rs. 12121.24, which indicates the high opportunity cost of growing the rice bean landraces in the favorable environments. Since at subsistence and marginal risk-prone environment landraces were economically viable and no modern varieties were possible to grow, the opportunity costs or benefit forgone was low in such case. The cost and benefit of in situ conservation of rice bean landrace (i*.e. ghorle*) in subsistence system with marginal environment was 15780 Rs. ha^{-1} and 28240 Rs ha^{-1}, respectively. It indicates the commercial feasibility of such landraces in marginal environments.

5.1.10 Rice bean value chain

Rice bean value chain analysis showed that the product was found to flow from producers through different market intermediaries to consumers. All together there were 5 marketing channels involved in rice bean trading. The index of marketing efficiency and producer's share on consumer's rupees were decreasing with increase in the number of market participants. Village level collectors, commission agents, wholesalers and retailers were the major intermediaries in rice bean marketing. Few village level collectors, local retailers and commission agents had been involving in collection of rice bean directly form producers at household level across the study sites. But most of the producers used to bring their produce at local hat/bazzar for sell. At local hat/bazzar the commission agents used to purchase rice bean grain from producers and local level collectors. The commission agents used to sell the rice bean to the wholesalers. From wholesaler rice bean was distributed to retailers and from retailers to consumers. The value addition activities that were practiced in rice bean were, cleaning, drying, coloring, milling (i.e. making pulse) etc. of grains. The average per kg farm gate price of *sano seto, ghorle, kalo, rato, and pahelo* were Rs. 32, 28.4, 31.49, 27.59 and 32, respectively. The univariate analysis of variance of gross margin from rice bean landraces revealed that the gross margin (Rs kg^{-1}) of different rice bean landraces were significantly ($p<0.01$) different. Among the rice bean landraces the gross margin (Rs kg^{-1}) was observed maximum for *sano seto* in Ramechhap and that was observed maximum for *pahelo* in Bhaluwajor. But in case of Pakarbas, the gross margin (Rs kg^{-1}) was observed maximum for *sano seto.* The reason behind the different gross margin value of rice bean landraces within same agroecological domain and under similar management condition was due to difference in productivity and market price for each landraces.

5.1.11 Major problems in rice bean farming

Major production problems of rice bean landraces as felt by producers were decreasing productivity, decreasing soil fertility, wild life attack, increasing insect pest infestation, decreasing trend of hired labor availability, problem of hard seed coat formation (*daino pasne*) and problem of *bose kosa* or *pani kosa* formation. Similarly, major marketing problems were, lack of transportation facility, inadequate supply low market price, lack of appropriate marketing facility, poor quality grain supplied in the market, frequent strike, fluctuation in price, lack of well equipped marketing infrastructure. In addition to these, the marketing system in the study area was poorly organized and at rudimentary stage. The traders were exploiting the farmers by giving a very low price for the produce. The market information system was very poor and was accessible only to the traders. The marketing system was lacking in some important marketing functions such as grading, packaging, storage, and processing. The marketing system was not in favor of the producers which was evident form wider marketing margin and very low producers share.

5.2 Conclusion

Rice bean is an important summer legume crop grown as sole crop, intercrop with maize in marginal *bari* land and on rice bund under different farming systems by all categories of rural people in Ramechhap. The study conducted in relation to conservation and commercialization prospect of rice bean landraces has shown that Ramechhap District has a great diversity on this crop. The district is highly characterized with subsistence farming with marginal risk prone environment. In such highly variable risk-prone environments and subsistence systems, landraces are economically competitive. In addition to this, in such marginal and risk-prone environments there were no alternatives at present to these landraces. Therefore, the opportunity costs or benefit forgone from growing such landraces was very low. Thus, farmers have been continuing to grow and conserve rice bean landraces because they give higher value for their immediate subsistence use and income.

The study revealed that farmer's decision to maintain, incorporate or discard a variety at any given time is determined by a set of socio-economic, cultural, environmental and policy factors which satisfy farmer for undertaking on-farm conservation of crop diversity. Although environment mainly determines the genetic diversity, in the process of planting, managing and harvesting, farmers also make crucial decisions that affect genetic diversity of the crop populations. Social and cultural identity also shapes the traditional food culture (tastes and preferences), ritual and religious values in the society and thus, influences the crops and varieties grown. The roles, responsibilities and decision making of women farmers in rice bean production, seed selection, management and use were dominant across the study sites. Generally, farmer's decision regarding deployment of varieties to specific agro-ecological domains is determined by the farmer's indigenous/traditional knowledge on the suitability of varieties to specific domains.

The study illustrate that total area under rice bean, its production and productivity over time have been declining significantly in Ramechhap District. Introduction of modern high yielding crops/varieties (other than rice bean) in to the existing farming system and changing cropping patters were the major reason behind gradual decline in area under rice bean crop. Likewise repeated use of inorganic fertilizers and poor quality seeds were the key factors responsible for gradual decline in production and productivity of rice bean landraces. The gradual decline in area and productivity of rice bean landraces over time has become a potential threat to the loss of valuable genetic resources form the environment. On the other hand farmer's managemental activities may alter the genetic structure of a crop population over time. Therefore, the responsible institutions/agencies must focus on formulation and implementation of on-farm crop conservation policies and programmes to encourage farmers to select, maintain, and exchange local crop diversity for the benefit of humankind. In addition, to allowing evolution to continue, on-farm conservation contributes to the conservation of diversity at all levels- the ecosystem, the species, and the genetic diversity within species. It also empowers the farmers to exercise access and control over their local crop genetic resources, the major biological asset and use it to improve their livelihoods.

Farmers have been maintaining rice bean landraces for time immemorial due to social, cultural, economic and geographical reason in Ramechhap District. All the landraces have potentiality to grab competitive and comparative advantage in the world market. Lack of farmer’s networks, access to market information and poor institutional capacities were some of the key problems that exclude farmers to receive direct economic benefits from the existing technologies and biodiversity. On the other hand, the study has illustrated that there is high market demand of rice bean products in urban areas of Nepal like Kathmandu, Bhaktapur, and Lallitpur. Rice bean products are not readily available in these urban markets, and urban people don’t have access to the countryside to buy these products. This situation reveals that both producers in rural areas of Ramechhap District and consumers in urban cities of Kathmandu valley would be mutually benefited if an effective marketing system of these local products could be established. In addition, this mechanism will help to realize local communities that local products prepared form the locally available biodiversity could be marketed for urban consumers and cash income could be ploughed back into the rural community. Thus, it is also possible to increase farm incomes of many rural farmers through targeted commercialization and diversification of the rice bean landraces, and it is important to link these local products to the market. Therefore, commercialization and diversification of rice bean products and linking these products to the national market not only gives an economic return to farming communities but also contribute to conserve biodiversity for future.

5.3 Suggestions for policy implication

With the empirical evidence of the study, following recommendations have been made which might prove significant step for the sustainable use and conservation of rice bean landraces diversity.

- Rice bean landraces in Nepal are informal. So, documentation programs for formal recording of such indigenous resources should be initiated soon in Nepal for the safeguarding of valuable gene pools from potential threat of erosion.
- The impact of group approach is negative in on-farm management of rice bean landraces diversity. Therefore, group programmes should focus on the conservation, management and efficient utilization of local minor crop diversity in Nepal.
- Product diversification and value addition through processed items should be initiated soon in rice bean to make the produce more competitive in the global market.

5.4 Future research areas

From the finding of this study, certain research gaps are found and are highlighted for further study.

- Assessment of genetic diversity of rice bean landraces through molecular analysis.
- Study of factors affecting of rice bean product quality variation.
- Study of linkage between rice bean diversity and market.
- Study of temporal and spatial price variation of rice bean.
- Conservation and farmers' livelihood links.
- Linkage between in situ and ex situ systems for dynamic conservation.

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APPENDICES

Appendix 1. Distribution of respondents by gender and VDC

VDC	Respondent					
	Male		Female		Total	
	F	%	F	%	F	%
Ramechhap	20	*58.8*	14	*41.2*	34	*100.0*
Bhaluwajor	29	*85.3*	5	*14.7*	34	*100.0*
Pakarbas	24	*70.6*	10	*29.4*	34	*100.0*
Total	73	*71.6*	29	*28.4*	102	*100.0*

F = Frequency and % = Percentage.

Appendix 2. Different items (food, feed, and decorating) prepared form rice bean

Items	Method of preparation
Biramla	*Biramla* is one of the common recipes from rice bean. Preparation method for *biramla* varied with ethnicity. All people used it as snacks. Boiled and dried rice bean grains after mixed with spices is ready to take as snacks and is called *biramla* in Ramechhap. In some areas, whole night soaked rice bean grains after frying in oil and is also called *biramla.*
Chhanta	It is a valuable food item of rice bean which is prepared by rough grinding of grain followed by removing husk. The remaining cotyledons are the *chhanta*. It is cooked by boiling in water with oil and spices and consumed with staple food.
Furaula	This is a delicious recipe prepared from rice bean. Overnight soaked rice bean grains are pulverized and made the paste. Paste is mixed with salt, zinger and other spices. Then small round shaped stuffs after deep fry in cooking oil are called *furaula*.
Masausra (Nuggets)	Farmers also prepare some nuggets called *masaura* from rice bean. *Masaura* is prepared from legume flour. Rice bean flour after mixing

	with taro or Colocasia, soaked to make paste and after dry in sunlight is called *masaura*. *Masaura* is used for vegetable and soup purpose especially in the lean period of green vegetables.
Dal	'*Dal-Bhat-Tarkari'* is the main staple of Nepali people in most part of the country. *Dal*, a major component of the staple food, is the soup of legumes that is prepared after pressure cooking or normal cooking of pulses. Most of the legumes such as pea, lentil and pigeon pea are milled or broken up before cooking as *dal*. Farmers have reported that the *dal* is the main use of rice bean in the area. Unlike the common pulses, whole grain cooking of Rice bean is reported to be more common than the milled one. *Dal* is taken with cooked rice or *chapaties* as the main food item in the study area.
Boil grains	The practice of taking boiled or pressure cooked rice bean grain as snacks was also common in the area. It is taken as snacks with other items such as puffed rice, beaten rice and wheat bread.
Quwanti	*Quwanti* is prepared by overnight soaking of rice bean grain mixed with other legumes like pea, chickpea, cow pea, french bean etc. in water allowing it for 1-5% sprouting. Such sprouted gains are boiled in water with spice and consumed.
Batuk roti	This is a delicious recipe prepared from rice bean. Overnight soaked rice bean grains are pulverized and made the paste. Paste is mixed with salt, zinger and other spices. Then small circular shaped stuffs after deep fry in cooking oil are called *batuk roti.*
Bara (wo)	It is prepared by over night soaking of rice bean grains and makes paste by grinding, adding spice, egg and fry in oil.
Soup	It is prepared by boiling of grain along with spice and oil
Khyala	A type of soup prepared by boiling rice bean grain along with spices, oil and Bamboo shoot (*tama*).
Khichadi	It is prepared by boiling rice been grain with milled rice along with spices.
Mandawabyata	Use of uncooked rice bean in *bhaitika* to decorate *mundap* called *mandawabyata* in Newari language.

Appendix 3. Parameter estimates of linear regression models for area allocation for rice bean crop over the years

Independent variables	Un standardized coefficients		Standardized coefficients	t-value	Sig
	(B)	SE	(Beta)		
Constant	45.743	4.348		10.522	0.000
Time (year)	-0.022	0.002	-0.982	-10.361	0.000*

Dependent Variable: Average area (ha) in successive years SE = Standard Error.

R = 0.982, R^2 = 0.964, Adjusted R^2 = 0.955 and Stand error of estimate = 0.009

F statistics = 107.34*

Note: * refers to the significant at 0.01 level of significance.

Appendix 4. Parameter estimates of linear regression models for productivity trend analysis of rice bean crop over the years

Independent Variables	Un standardized Coefficients		Standardized Coefficients	t-value	Sig.
	(B)	SE	(Beta)		
Constant	37.895	3.799		9.976	0.001
Time (year)	-0.018	0.002	-0.980	-9.795	0.001*

Dependent Variable: Rice bean productivity (mt ha^{-1}) over the years SE = Standard Error.

R = 0.981, R^2 = 0.961, Adjusted R^2 = 0.952 and Stand error of estimate = 0.007,

F statistics = 95.95*

Note: * refers to the significant at 0.01 level of significance.

Appendix 5. Univariate analysis of variance (ANOVA) of gross margin of rice bean landraces (Rs kg^{-1})

Source	Type III Sum of Squares	df	Mean Square	F- Value	Sig.
Corrected Model	198.464	6	33.077	10.226	0.002
Intercept	1409.798	1	1409.798	435.849	0.000
VDCNAME	38.524	2	19.262	5.955	0.026**
LNDRCENAME	159.940	4	39.985	12.362	0.002*
Error	25.877	8	3.235		
Total	1634.140	15			
Corrected Total	224.341	14			

Dependent Variable: Mean gross margin of rice bean landraces in Rs kg^{-1}.

Where, $R^2 = 0.885$ and Adjusted $R^2 = 0.798$

Note: * and ** refers to the significant at 0.01 and 0.05 level of significance, respectively

Appendix 6. Calendar of operations of different activities for maize and rice bean inter cropping in *bari* dominated farming system at Ramechhap

Activities	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Planting of maize										
First earthing-up of maize										
Second earthing-up of maize										
Rice bean seed sowing										
Harvesting of maize										
First weeding of rice bean										
Second weeding of rice bean										
Harvesting of rice bean										
Threshing and storage of rice bean										

BIOGRAPHICAL SKETCH

The author was born on November 26, 1983 AD as the first son of Mr. Gopal Prasad Paudel and Mrs. Bhagawati Paudel in Saipu VDC-8, Ramechhap, Nepal.

He completed his School Leaving Certificate (SLC) in 1999 A.D from Shree Nepal Rastrya Secondary School, Manahrwa-7, Bara. He joined Makwanpur Multiple College, Hetauda, Makwanpur for higher secondary education in science and completed in 2001 A.D. He pursued his Bachelors Degree in Agricultural Science (B.Sc. Ag.) with Elective Soil Science from Tribhuvan University, Institute of Agriculture and Animal Science, Rampur, Chitwan in 2005. With the aim of specialization in Agricultural Economics, he enrolled in Postgraduate Program (Masters of Science in Agriculture with Major in Agricultural Economics) in 2006.

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