CHAPTER ONE
INTRODUCTION

1.1 Back ground:

Biological diversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Biodiversity provides ecosystem services in the form of regeneration of gas, climate, water quality, erosion control, soil formation, nutrient cycling, waste treatment, pollination, primary production, cultural opportunities etc. It should be properly used by country (Jha *et al.,* 2008).

Agro-biodiversity is a subset of biodiversity. It includes all components of biological diversity of relevance to food and agriculture; the variety and variability of plants, animals and microorganisms at genetic, species and ecosystem level which are necessary to sustain key functions in the agro ecosystem, its structures and process (Cromwell *et al*., 2001). Agro-biodiversity is essential for the world for its different functions such as sustainable production of food and other agricultural products which includes the building blocks for new crop varieties. Wider ecological services provided by agro ecosystems and biological support to production via soil biota, pollinators and predators. Local knowledge and culture can be considered as an integral part of agro-biodiversity, because agro ecosystem exists by the grace of human being (Moonen and Barberi, 2008).

The role of agro-biodiversity in conserving biodiversity is demonstrated through the diversity of cropping system and resource management especially indigenous knowledge of the management of fragile and variable environments, the local genotypes of food crops, intercropping and agro forestry system (Liang *et al*., 2010). The variety of tastes, textures and colors in food is a product of agriculture biodiversity. There is greater strength in diversity than in susceptible uniformity. Furthermore, diversity in varieties breeds and species ensure continuous agricultural production. Whatever the threats, hidden in the genetic code of today's crop plants are many invisible traits that may become useful in facing future challenges (Mulvany and Berger, 2003).

The future food supply of the world depends on the exploitation of genetic diversity for crop improvement. Modern agriculture (especially monoculture) is said to be one of the main cause of food plant genetic erosion, as it replace diverse land races (Shrestha and Shrestha, 1999).

The genetic diversity of crop species is recorded as landraces or varieties (Jha *et al*., 2008). Landraces constitute a major fraction of crop's genetic variations and are an important genetic resource for crop improvement (Brown and Munday, 1982). Landraces (Traditional Varieties) and their wild relatives are the key elements of agriculture biodiversity and constitute a key resource maintained and used by farmers in different production environments. Sustainability of agricultural development is dependent on local landraces diversity. Maintenance, utilization and management of this diversity in the fields are vitals for sustainable agriculture (Bajaracharya *et al*., 2008). It has been found that improved and exotic varieties have replaced local crop genetic resources, thus narrowing the genetic base in agro-biodiversity and increasing the dependency of farmers to external source for their seed requirements (FAO, 1996). The rich agro-biodiversity is rapidly disappearing from farmer's fields over time and space due to induced human pressure and other climatic factors. With this disappearance of agro-biodiversity, global community recognized the importance of on-farm conservation (Regmi *et al*., 2007).

Crop genetic resources can be conserved by two approaches: in-situ (on farm, in its place of origin) or ex-situ (off site, out side its place of origin) as in botanical gardens, field gene banks and seed gene banks. On farm (in-situ) conservation of landraces refers to plants or their wild varieties that are conserved in the very place where they developed their present day characteristics (Altieri and Merrick, 1987; Brush, 1995).

The conservation is done by ex-situ storage of genetic materials in gene banks. While the form of conservation remains no doubt useful, especially for immediate use in plant breeding, but it has many drawbacks as an ex-situ gene bank freezes the natural evolutionary process, ex-situ collections are more vulnerable to mismanagement and ex-situ seed bank favors the transmission of seed borne pathogens. Further, ex-situ conservation of genetic resources is expensive whether as seed (orthodox seed crops), in cold stores, or in field gene banks (crops with recalcitrant seeds and clonally

propagated crops). Therefore, in response to these challenges in-situ approach is increasingly appreciated as complementary to the ex-situ conservation (Sthapit, 2008). Formal and informal human managed processes are responsible for conserving, increasing or decreasing and modifying the on-farm genetic diversity. These processes influence the gene frequency and gene flow which ultimately contributes to on-farm diversity (Baniya *et al.,* 2008).

Seeds are carriers of genetic diversity that contains the building blocks required for plant breeding and thus constitute the basis of all food and agricultural production in the world. Plant genetic diversity is probably more important for farming than any other environmental factors, simply because it enables farmers to adapt to changing environmental conditions, such as climate change. Seed storage is the best way to support diversity (Lewis and Mulvany, 1997). Proper grain storage is needed to maintain the quality and characteristics that the grain possessed immediately after harvesting and drying. When grains are stored the main enemies to conquer are fungi .There are many ways to store seeds, one of which through Community Seed Banking (CSB).

In situ (on-site) conservation of farmers' varieties on small scale is providing a valuable option for conserving crop diversity. Moreover, it helps to sustain evolutionary systems that are responsible for the generation of genetic variability. Therefore, in terms of conservation of agro-biodiversity, seed banks have been, and continue to be, the chief support in preserving Food Varieties. But the continuity in this rate depends only on the farming system in their locality. It is likely that they will only continue to support plant genetic diversity if there is no economic penalty to maintaining this diversity (Lewis and Mulvany, 1997).

The Community Seed Bank (CSB) approach is innovative farmers led on farm seed conservation approach, which serves both for conserving the local crop landraces as well as providing seed security to the farming communities by increasing access to genetic materials and enhancing farm level agro-biodiversity (Lewis and Mulvany, 1997; Demissie and Tanto, 2000). CSB also facilitates easier seed flow among farmers by increasing the availability of local seeds to farmers and by widening their varietals choices. In addition CSB provides farmers with modern storage which gives

the seeds longer life and better protection against pest and diseases. It also explores and transfers knowledge on endangered, unique and useful landraces to young generations. Thus, CSB has been very effective community led approach in conserving the rare and threatened but socio culturally important species (Benzabih, 2005).

The concept of community seed bank in Nepal was first started in 1995 and the first seed bank was established in Dalhowki VDC of lalitpur district by the association of Nepal-Canada. Later in 2003 A.D. by the combined association of LI-BIRD, NARC and Bioversity International, it was established in the Kachorwa VDC of Bara District. To achieve its goal and objectives LI-BIRD expends it all over Nepal through its different programs. In Nepal, on the basis of conservation, CSB has established in Kachorwa VDC of Bara, Belwa VDC of Bardia, Gadaria, Masuriya and Pathariya VDC of Kailali, Shankarpur and Beldandi VDC of Kanchanpur. Rampur VDC of Dang, Agyoli VDC of Nawalparasi, Shivganj VDC of Jhapa, Ghanteshwar VDC of Doti, Tamaphok VDC of Shankhuasabha and Jogimara VDC of Dhading. By the association of some local NGOs in Jumla, Sindhuli and Parwat districts also, the CSBs have been established (Shrestha *et al*., 2008).

A large number of fungal pathogens have been recorded in crop plant of Nepal. Among them many are associated with seeds and several are economically important. Seeds are carriers of some important diseases inciting microorganisms which cause heavy losses in the yield by producing diseases on crops arising from them (Neergard 1977). Seed-borne diseases may hinder the proper utilization of plant genetic resources through loss of germplasm and by spread of seed-borne diseases in the field and across. Therefore, proper conservation and utilization of plant genetic resources (seeds) is vital to global food security (Charlotte and Bush, 2011).

1.2 Objectives:

The broad objective of present study is to analyze the role of seed banking in agro-biodiversity conservation.

Following are the specific objectives:

1. To document the major cultivars/landraces of the study area.

2. To assess different tools and techniques applied by farmers for seed selection, processing and storage.

3. To analyzes seed viability (germination) of stored seeds in CSB.

4. To identify the associated mycoflora in stored seeds of paddy in CSB

1.3 Limitation:

The study was conducted in only one VDC of each district.

1.4 Justification:

The effect of commercialization of agriculture is promoting monoculture, which has negative effect on agro-biodiversity. Farmers are commercializing their agriculture using composite, crossbred or hybrid varieties which play major role on degrading the genetic purity. Global food security depends on the conservation and utilization of existing as well as improved agro-biodiversity that are continuously used for food and agriculture. Sustainability of agricultural development is dependent on local landraces diversity. Therefore, maintenance, utilization and management of this diversity in the fields are vital for sustainable agriculture. On-farm conservation of local seed is assuming higher importance in the context of global climate change. Landraces are basic building blocks from which all modern highly productive, stress resistant varieties have been formed and it is essential especially to increase food security in world. The seeds with higher concentration of genetic diversity assume higher importance to mitigate the adverse effect of potential changes in global temperature, regional precipitation and sea level. On farm conservation through Community Seed Banking (CSB) has been a very effective community-led approach in conserving the rare and threatened important varieties of crop plants. CSB is a good practice to conserve, regenerate and multiply the crop seeds within community. Contaminated stored seeds are carriers of some important diseases which cause heavy losses in the yield by producing poisonous mycotoxins and by grain spoilage from fungal growth. They reduce the germination ability of seeds therefore, proper management of storage needed for quality seed production. These studies assess to know how on farm conservation through CSB has been effective in conserving agro-biodiversity.

CHAPTER TWO
LITERATURE REVIEW

2.1 Agro-biodiversity

As a potential resource, biodiversity is the greatest treasure on the earth. Only a few countries in the world are endowed with a rich and varied biological resource as Nepal. It is the twenty-seventh richest country in biodiversity. The specific quality of this resource is that it is renewable, if properly maintained. But biodiversity in Nepal is not translated in the form of biological resources. However, by the sustainable use, biodiversity can play a very important role for the development of this country (Pokhrel and Jha, 2010).

Agro-biodiversity, which is a component of biodiversity, is a combination of life forms and their interactions with one another, and with the physical environment which has made the earth habitable for humans. Biodiversity in agricultural landscape has powerful cultural significance partly because of the interplay with historic landscape associated with agriculture (Munzara 2007). The extensive agricultural areas occupied by small farmers contain much biodiversity that is important for sustainable food production. Indigenous agricultural practices have been and continue to be important elements in the maintenance of biodiversity, but these are being displaced and lost (Uitto and Akiko, 1996).

Agro-biodiversity includes all crops and livestock, their wild relatives and all interacting species of pollinators, symbionts, pests, parasites, predators and competitors. Agro-biodiversity can be grouped into varietals or genetic diversity, crops, animals and other species diversity and farming systems or other agro ecosystem diversity. These are necessary to sustain key function in the agro-ecosystem, its structure and process. Biodiversity provides a life support system in the form of ecological services and renewable natural resources (Upreti and Upreti, 2002; Cromwell *et al*., 2001).

The Food and Agriculture Organization of the United Nations (FAO) defines agro biodiversity as “the variety and variability of animals, plants and micro-organisms that are important to food and agriculture and which result from the interaction

between the environment, genetic resources and the management systems and practices used by people. Agro-biodiversity includes two groups: the wild relatives of domesticated species generally known as crop wild relatives (CWR) from which cultivated crops originated, and which are related closely enough to provide useful genetic material to the crop and the second group is individual breeds of domesticated species of livestock and crops (FAO, 1999).

Planned agro-biodiversity is the biodiversity of the crops and livestock chosen by the farmer, while associated agro biodiversity refers to the biota, e.g., soil microbes and fauna, weeds, herbivores, carnivores, etc., colonizing the agro ecosystem and surviving according to the local management and environment. For provisioning services (e.g., food, fuel, fiber, and fresh water production), functions of agro-biodiversity are better understood than for supporting (e.g., nutrient cycling and soil formation) and regulating services that usually involve assemblages of species and guilds, each with a complex set of functions and interactions. Heterogeneous composition of ecosystem in agriculture landscapes provide insurance value that is not detected by the local scale experiments that are typical of most agricultural research (Jackson *et al*., 2007).

Diversity of agro-ecosystems in the same territory is like having **'**insurance' for income production on at least a part of the territory in case of changing environmental or political conditions. This diversity can also serve as a buffer against the presence of intensive and low diverse agro-ecosystems such as continuous cropping or against large scale land abandonment, and it is likely to increase regional species pools and genome diversity (Moonen and Barberi, 2008).

Conservation efforts in relation to plant genetic resources are usually divided into two categories i.e., in-situ and ex-situ conservation. In-situ conservation is the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations and species in their natural surroundings where they have developed their distinctive properties. In-situ or on farm conservation is used as a means to revive old varieties and increase seed diversity, thus rewarding and supporting farmers' contributions. Ex-situ conservation refers to conservation of germ plasm away from its natural habitat. This strategy is particularly important for crop

gene pool, and can be achieved by propagating and maintaining the plants of genetic resources centers, biological garden and in seed gene banks (OECD, 1999).

Agricultural diversity in Nepal is based on diverse farming systems built upon indigenous knowledge and experiences as well as ecological, biological and cultural diversities (Pratap and Sthapit 1999; Shrestha 1999). Indigenous *in situ* conservation of agro-biodiversity through local initiatives is the strength of Nepalese agriculture, which maintains crop and species diversity and conserves genetic resources (Shrestha and Shrestha 1999; Timsina 2000; Upreti 2000). However, such a self-evolving agro-biodiversity is eroding due to the green revolution mode of agricultural intensification practices and weak conservation policies (Ghale 1999; Shrestha and Shrestha 1999). The rapid loss of agro-biodiversity in Nepal is considered to be the cumulative effect of several factors such as land use change, modification in cropping patterns, expansion of hybrid varieties, migration, defective policies and regulatory framework and weak institutional capacities (Upreti and Upreti, 2002).

2.2 Agro-biodiversity practices in Nepal

In Nepal several programs are in operation for the conservation and management of agro-biodiversity.

Community Based Management (CBM)

CBM is a community based participatory approach in order to strengthen their capacity on the basis of indigenous and traditional knowledge. It helps in conserving, managing and adding value and exchange on farm local crop diversity through community actions. It enables community to improve and increase the access of knowledge, information, education, and genetic material, markets and consumers financial and physical assets on behalf of their own initiative. The CBM approach has been currently implemented in terms of agro-ecosystem and socio cultural background (Subedi *et al*., 2004).

Awareness raising activities

Diversity and seed fairs, biodiversity quiz competition, biodiversity folk songs, food fair and visits organized by Western Terai Landscape Complex Project is found more effective on farmers. The knowledge farmers gain through conservation training, agriculture trainings and visits also affects the varietals portfolio of the crops. By participating in exposure visits in different place farmers get insight on many issues. Generally, farmers are taken in places where other farmers are successful in commercialization of agriculture (Paudel *et al*., 2008).

Rural Radio Program

Radio is considered as a vital medium for communication in developing countries. To share information, it works quite effectively. One example can be included ;" LI-BIRD ko chautari", since 1 October, 2001, to provide common discussion platform in sharing and learning biodiversity related information to farmers and farmers organization, students, academicians, researchers and development workers and policy makers to increase appreciation of and awareness for, the value and importance of biodiversity conservation. The program has broadcasted methods and good practices mainly related to importance of conservation of biodiversity for sustainable agriculture. It result in high demand of the neglected crops like millet in Pokhra valley and neighboring areas (Baral *et al*., 2005).

Biodiversity and Seed fairs

The biodiversity fair is a popular tool for raising public awareness on the value of conserving local landraces. During a fair, farmers from different communities are brought together to exhibit a range of landraces; this continues the traditional system of exchange of seeds and knowledge. In Nepal biodiversity fairs are not only organized for promoting the exchange of knowledge and germplasm; they are also organized to explore diversity rich areas and to recognize communities as custodians of traditional knowledge and biodiversity (Sthapit *et al*., 2003).

2.3 Traditional seeds (Landraces):

A landrace is a local variety of domesticated animal or plant species which has developed largely by natural processes, by adaptation to the natural and cultural environment in which it lives. Landraces posses many useful qualities such as adaptation, diversity, yield stability and resistance (Zeven, 1998). Landraces and their wild relatives are the key elements of agricultural biodiversity and constitute a key resource maintained and used by farmers in different production environment. Global food security depends on the conservation and utilization of existing and improved biodiversity that are continuously used for food and agriculture. Nepal is a sovereign country rich in agriculture biodiversity and agriculture is the mainstay of people of Nepal. Maintenance, utilization and management of agriculture diversity in the fields are vital for sustainable agriculture (Bajracharya *et al.*,2008).

Landraces provide nutritional quality and food security under the harsh environmental conditions. Landraces constitute a major fraction of a crop's genetic variation and are an important genetic resource for crop improvement. Local crop diversity is in a state of flux which is influenced by the population biology of crop itself, environmental and social aspects, farmers' local knowledge and the circumstances of local seed system (Brown and Munday, 1982).

There are two main possible reasons for the survival of landraces: They may belong to crops which are not in the official seed lists and accordingly have not been considered by breeders. Landraces can also survive under agricultural conditions due to geographical and other forms of isolation (ethnographical, geographical, ecological, etc.). Within landraces, the general tendency is that landrace garden plants (vegetables, fruits and some aromatic and medicinal plants) have a better chance of survival, whereas the field crops (cereals and pulses, forage plants, industrial plants) show very strong genetic erosion (Vetelainen *et al.,* 2009).

Genetic diversity is the foundation of all agriculture. Therefore, the conservation of traditional seeds (plant genetic resources) on farms, in the wild and in secure storage is essential to the future of agriculture and thus to humanity. Crop genetic resources that provide dynamic nature to agriculture system are passed from generation to

generation of farmers in countries rich in plant genetic resources for food and agriculture (Upadhyay *et al.,* 2008).

Landrace give resource-poor farmers low cost options to cope with the vulnerability of production systems by its vulnerability of production system by its ability to adopt to changing environments and to manage new pests and diseases (Sthapit, 2008). A wide gentic base provides "built-in insurance" against crop pests, pathogens and climatic vagaries. Under optimal farming conditions, some folk varieties may have lower mean yields than high-yield varieties but exhibit considerably higher mean yields in the marginal environments to which they are specifically adapted (Deb, 2009).

2.4 Community Seed Banking (CSB):

Community Seed Banking is a scheme involves identification, collection, multiplication, storage and distribution of local seeds. Participants can borrow local seeds of available types and amounts The varieties from CSB will be of such a nature that they are either currently planted by some farmers but others do not have access to them or they are varieties that are not currently planted by farmers in the locality but are either available in other localities or in the central gene bank (Lewis and Mulvany, 1997; Demissie and Tanto, 2000). CSB is a contact point to access local seed and associated knowledge through mobilizing social, financial and human capital for community sensitization and conservation of agro-biodiversity. It is emerging as an effective community institution that strengthers farmers' capacities on collection, conservation, distribution and sustainable use of local crop genetic resources for food and agriculture (Maharjan *et al*., 2011)

The Community Seed Bank approach, introduced by the *in situ* conservation project in Nepal, has also been used as an entry point to the community based management of biodiversity. CSB is designed to document knowledge of endangered, unique and useful landraces and to develop conservation action that can be locally supported. The CSB in Nepal has been piloted with different objectives: to improve easy access to farmers' variety seeds at local level, to document knowledge of traditional varieties and maintain small amount of seeds, to promote a contact point for local seeds and

information and to promote on-farm conservation through community based conservation action (Shrestha *et al.*, 2008).

The efficacy of CSB is based on two premises, one is that the CSB seed system expands the availability of local varieties to individual farmers, and therefore, increases diversity. The aim of Community Seed Banking (CSB) is intends to correct imperfections in the local seed system by easy access to local seeds, and to enhance farm level agro biodiversity (Lewis and Mulvany, 1997; Demissie and Tanto, 2000). The productivity increase comes about because of improvement in access to seeds and the resulting improvement in the allocation of resources. Moreover, households may adopt local varieties to reduce the risk of crop failure (Benzabih, 2005).

2.5 Causes of Agro-biodiversity lost:

Major causes of agro-biodiversity loss include direct destruction, conversion or degradation of agro-ecosystems, over-exploitation, habitat disturbance, pollution, introduction of exotic species, selection pressure from human activities, introduction of new technologies and technological innovations like genetic modification (Wood and Lenne, 1999). Degraded biodiversity affects composition of genus and species as well as structures and functions of various ecosystem components (Upreti and Upreti, 2002).

Food and Agriculture Organization of the United Nations (FAO) estimates that 75 % of crop diversity was lost between 1900 & 2000 A.D. One of the most important reasons for loss of seeds and there by the lost of genetic diversity, was the replacement of genetically diverse farmer's varieties (traditional varieties) with modern varieties (improved varieties) (FAO, 2010).

Natural habitats in most parts of the world continue to decline in extent and integrity, although there has been significant progress in slowing the rate of loss for tropical forests and mangroves, in some regions. Fresh water wet lands, sea ice habitats, salt marshes, coral reefs, sea grass beds and shellfish reefs are all showing serious declines. Extensive fragmentation and degradation of forests, rivers and other ecosystems have also led to loss of biodiversity and ecosystem services. Crop and livestock genetic diversity continues to decline in agricultural systems. The five principal pressures directly driving biodiversity loss (habitat change, overexploitation,

pollution, invasive alien species and climate change) are either constant or increasing in intensity (SCBD, 2010).

With regard to biodiversity, the threats are on the increase as the rate and risk of alien species introductions are increasing significantly and are estimated to continue rising as a result of increased travel, trade and tourism. Biodiversity at the ecosystem, species and genetic levels is increasingly lost from agricultural landscapes mainly due to agricultural practices aiming at the maximization of food and fuel production (FAO, 1998; FAO, 2009).

Either extensification of agriculture via the expansion of marginal land into areas rich in wild biodiversity, or intensification via adaptation of monocultures, may be linked to a further decline in biodiversity. Certain traditional crop species varieties and animal breeds are often replaced by more financially profitable “improved” ones, so that agricultural systems can often be increasingly characterized as very intensive with a low level of diversity, thereby undermining the flow of ecosystem services in the long-run (Jackson *et al.*, 2007).

In the tropics, Agriculture is characterized by a wide diversity of landraces. Farmer varieties or traditional varieties of crops and livestock conserve on farm by rural farming communities for food security. The diversity and their underlying local, traditional or indigenous knowledge have come under threat. Forces threatening this agro biodiversity include habitat destruction by production pressure that is closely linked to population growth and poverty (Scientific Advisory Group, 1994).

CHAPTER THREE
MATERIALS AND METHODS

3.1. Study Area:

This research was focused on the assessment of effectiveness of Community Seed Banking in agro-biodiversity conservation. Thus the Village Development Communities (VDCs) where seed banking program were running, were selected for the study. Western Terai Landscape Complex Project (WTLCP) is an eight year long project (August 2005-July 2012), working in 52 VDCs of Western Nepal viz. Bardia, Kailali and Kanchanpur districts. Based on the information of site selection report of WTLCP, one VDC was selected from each district on the basis of diversity of land races.

Table 1: Site Diversity

Interface	High diversity of landraces	Low diversity of land races
Corridor (Wild +Cultivated)		Masuriya (Kailali)
Buffer Zone(wild life +wild +cultivated)	Belwa (Bardia)	Beldandi (Kanchanpur)

Source: Regmi *et al*., 2007.

3.1.1 Physical information:

In Bardia the project area of WTLCP covers 2,025 sq. km out of which 68.73 % is hilly area and 31.27 % is terai area. Geographically, it is located between 28°7'N to 28°39' N latitudes and 81°3'E to 81°41'E longitudes.The altitudinal range of this district lies between 138 and 1,278 masl. The maximum temperature of the district is 39.8°C and minimum of 9.6°C. Average annual rain fall is 1118 mm. It is surrounded by Banke in east, Kailali in West, Surkhet and Salyan in North and India's Baharaich district of Uttar Pradesh in south. The districts headquarter is in Gulariya (CBS, 2008 and DADO, 2060/61 B.S.).

In Kailali, the project area of WTLCP, covers 3235 sq. km out of which 40.3% is hilly area and 59.5% is terai area. Geographically, it is located between 28°22'N to 20°5' N latitudes and 80º30'E to 81°18'E longitudes. The altitudinal range of this district lies between 109 and 1950 masl. This district covers an area of 32,3500 ha,

out of which 27.80% is agricultural land , 64.23% is forest land , 1.94% is river and 5.43% is bare land. The maximum temperature of the district is 44° C and minimum of 7.5° C. average annual rain fall is 1840mm. It is surrounded by Karnali River , Bardia and Surkhet in West, Doti and Dadeldhura and Surkhet in North and Mohana and India's Uttar Pradesh in south. The districts headquarter is in Dhangadhi (CBS, 2008 and DADO, 2063 B.S.).

In Kanchanpur the project area of WTLCP, covers 1610 sq.km out of which forest covers some 54% of its area including 311 sq.km. under a wildlife reserve. Over 36 % land is under cultivation and 20 % of it is irrigated. Geographically, it is located between 28º32'N to 29º80'N latitudes and 80°03'E to 80°33'E longitudes. The altitudinal range of this district lies between 176 and 1,528 masl. The maximum temperature of the district is 43°C and minimum of 3.0°C. Average annual rain fall is 1772 mm. It is surrounded by Karnali in East, Dadeldhura in North and India in west and south. The district headquarter is Mahendra nagar (CBS, 2006 and DADO, 2062/2063 B.S.).

3.1.2. Socioeconomic Information

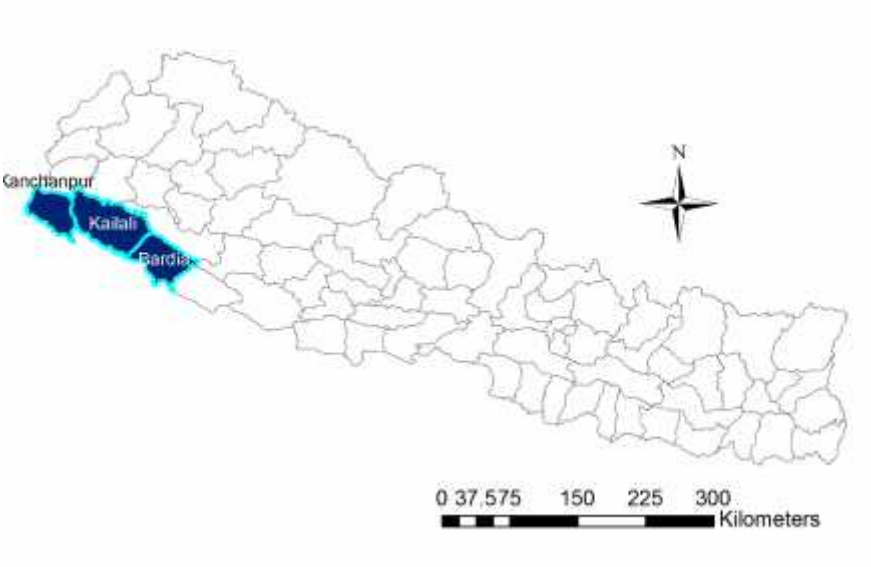
The total population of Bardia district is 463,437 out of which 230,107 are male and 233,330 are female. Out of the total population 12.02 % of the population lives in town and 45.40% of the population is literate. The district is divided into 31VDC's and 1 municipality. The district covers 202,500 ha among which 46,575 ha i.e., 68.65% used only for farming (CBS, 2008 and DADO, 2060/61 B.S).

The total population of Kailali district is 616,697, out of which 312,711 are male and 304,386 are female. Out of total population 17.22% of the population lives in town and 52.6% of the population is literate. The human development index (HDI) of this district is 0.442 with per capatia income of NRs. 217. The district is divided into 42 VDC's and 12 municipalities. The district covers more farmland in comparison to other districts in Far Western Region and is 64155.7 ha. Tharu's are the indigenous people of this area (CBS, 2008 and DADO, 2063 B.S).

The total population of Kanchanpur district is 491,296 out of which 241,799 are male and 249,497 are female. Among the total population 21.39% of the population lives in town and 60% is literate. The district is divided into 20 VDC's and 1 municipality. The district covers 161,000 ha among which 36% used only for farming (CBS, 2006 and DADO, 2062/2063 B.S).

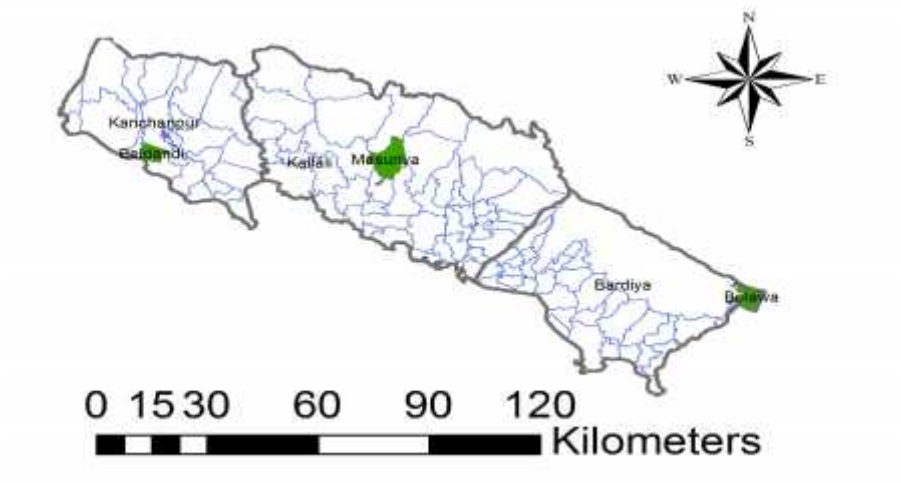
3.1.3 Study location:

The study was carried out in the far western region of Nepal in three districts namely Kailali , Bardia and Kanchanpur showing in map 1. The sampled VDC's are shown in the map 2.



Map 1: Map showing districts of study area

Source: Menris ICIMOD 2011



Map 2: Map showing VDCs of study area

Source: Menris ICIMOD 2011 and Department of Survey

3.2 Methodology

3.2.1 Research site

Bardia, Kailali and Kanchanpur were selected as the study area because of the following reasons:

- The Western Terai Landscape is rich in agriculture diversity.
- More than 80% people involved in agriculture in these districts
- WTLCP has been conducting project to improve and conserve agro-biodiversity and CSB program in these three districts.

Source: Regmi *et al.,* 2007

3.2.2 Research Design and Methods

Basically the study is based on the descriptive and explanatory research method. Household surveys, key informant interviews, focus group discussion, direct observation, seed bank survey, literature review and laboratory works. The research data were collected during month of November to December 2010. Both primary and secondary sources of data collection were used during the study.

3.2.3 Sampling design, Sample methods and Sampling sites

Three VDC's Belwa, Masuriya and Beldadi of Bardia, Kailali, and Kanchanpur districts respectively were selected as sampling sites. The information was gathered from 30 respondents from each VDC.

Table 2: Sample size and population in each VDC

Level of crop diversity	High	Low	Low
VDC	Belwa	Beldandi	Masuriya
Total number of household	2263	1721	1630
Sample size	30	30	30

Source: Paudel *et al.,* 2008.

3.2.4 Primary data collection:

The information gathered from 90 interviewed households was filled in semi structured questionnaire. To carry out the interview, a checklist of questions was used. The checklist consisted of a list of questions on how the CSB was important in agro-biodiversity conservation and other activities related to agro-biodiversity conservation . The house holds survey was divided in to two broad parts (appendix 2). Some key informant interviews (unstructured questions), with key persons such as teachers, people working in seed banks, project staffs, farmers working in fields were also taken.

At first, the socioeconomic survey of households was done to gather the information on the total population of households, occupation of household members, educational status, agricultural production and land holding size. Then, the perceptions of farmers towards the agro -biodiversity conservation were recorded. People were asked about tools and techniques used to store seed and also about the selection process of seeds for storing. They were also asked about the benefits of agro biodiversity conservation through local seeds. Group discussion was also conducted for consistency of the information gathered with appropriate cross checking of data. To identify the educational status, two categories are made (I) Illiterate: cannot read and write (II) Literate: can read and write.

3.2.5 Secondary data collection:

Literature review method was the chief method to gather information about agro-biodiversity conservation and Community Seed Banking. The biophysical and socioeconomic information regarding Kailali, Kanchanpur and Bardiya was collected from Central Bureau of Statistics (CBS) records. The other related information regarding the study area was collected from WTLCP and LI-BIRD publication.

3.2.6 Observation

Direct on site observation of the study area and seed banks give the real view of the project work and their working status. Therefore, the direct observation was conducted in field and seed banks during field visits.

3.2.7 Data analysis

Primary and secondary data has been collected through semi-structured questionnaire survey, key informant interview, direct observation and literature review**.** The data set contained socio-economic and demographic information of farmers, names of varieties/landraces, and means of flow of seed. Microsoft Excel software program

and SPSS 16 software program were used to analyze the data wherever required.

3.2.8. Laboratory analysis

Collection of seed samples

Seed samples were collected from all three seed banks of study area for the purity and viability test and mycoflora analysis. Sampling was done in the month of November-December 2010 during field visit.

500 gm of crop seed samples and 50 gm of vegetable seed samples were collected. The seed samples were collected in well labeled polythene bag with rubber band seals. The seed samples were stored in refrigerator at about 4°C. Sampling was done randomly from different VDCs of different crop and vegetable varieties.

The quality of seeds of Community Seed Banking was analyzed by different laboratory test.

- Seed purity test (ISTA, 1985)
- Seed germination test (ISTA, 1985)
- Mycoflora analysis

Seed Purity Test:

Seed physical purity test is the most fundamental test to be carried out during seed testing, as the subsequent tests are made only on the pure seed component. The collected seed samples were divided into smaller portions but representing whole seed samples and without bias. Seeds were weighed and by using forceps and thin ruler, seeds were divided into various component accordingly (pure seeds, other seeds and inert matter).

Seed Germination Test:

In this germination test (appendix 1), seeds were evaluated for germination by using the standard rolled paper method (ISTA, 1985). For rolled paper method, one hundred untreated seeds were placed on a moistened germination paper in ten lanes of ten

seeds each. Then towels were rolled and their ends were closed with rubber bands. They were then incubated at 30±2°C in an upright portion from 5 to 9 days. Four replicas were made of 100 seeds in each replica. Then samples were incubated at prescribed temperature, away from direct sunlight in germination chamber. Moisture of the medium was maintained and data was collected in four days interval. After incubation, the bands were removed the towel were unrolled and the seedlings were carefully examined for symptoms, number of germinated and non germinated (including rotted) seeds, normal and abnormal seedlings were counted and recorded using ISTA rules (ISTA, 1993). Fungi associated with abnormal seedlings were recorded. The emerged seedlings were graded as normal or abnormal as defined by Anwar *et al.* (1994).

Normal seedlings: Seedlings with well-developed root and shoot; free of disease symptoms.

Abnormal seedlings: Seedlings with under developed either root or shoot or both and exhibiting disease symptoms.

Mycoflora analysis:

The fungi on abnormal seedlings and rotted seeds were examined under stereo microscope. The infected portions were cut and plated on PDA for fungal growth and confirmation of fungal association.

Each seed was examined under stereo binocular microscope at 40X to record the association of fungi based on their habit characteristics. Fungi were isolated from seeds and cultured on Potato Dextrose Agar (PDA) for further identification with the help of various literatures (Booth, 1971; Barnett, 1965; Ellis, 1980 and Singh *et al.*, 1991).The results have been expressed in percentages.

CHAPTER FOUR

RESULTS

4.1 Community Seed Banking:

4.1.1 Role of Community Seed Banks in Conservation of Agro-biodiversity:

Table 4.1 Respondents' perception of different roles of CSB in conservation

VDC	Respondents		Easily availability of seeds	Learn new techniques of conservation of land races	Learn profitable traditional knowledge	CSB change in livelihood
	Involved in CSB	Not involved in CSB				
Masuriya	20	10	22	14	15	15
Belwa	15	15	18	12	13	11
Beldandi	15	15	18	12	14	05

Source: Field survey

Table 4.2 Respondents perception of CSBs role in helping them to learn new techniques of conservation of landraces

			Learn new techniques of conservation of landraces		
			No	Yes	Total
HHs involvement in CSB	No	Count	40	0	40
		Expected Count	23.1	16.9	40.0
	Yes	Count	12	38	50
		Expected Count	28.9	21.1	50.0
Total		Count	52	38	90
		Expected Count	52.0	38.0	90.0

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	52.615[a]	1	.000

In the above chi-square test, calculated chi-square value (52.615) is more than the tabulated value at 1 df and 5% level of significance (3.841) (significance is 0% which is less than 5%). This implies that the household's knowledge of conservation of land races is significantly influenced by its involvement in CSB.

Further, the expected count table indicates that the involvement of the household in CSBs increased their knowledge on the techniques to conserve landraces.

Table 4.3 Respondents perception of availability of seeds through seed banks

			Easily availability of seeds		
			No	Yes	Total
HHs involvement in CSB	No	Count	32	8	40
		Expected Count	14.7	25.3	40.0
	Yes	Count	1	49	50
		Expected Count	18.3	31.7	50.0
Total		Count	33	57	90
		Expected Count	33.0	57.0	90.0

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	58.220[a]	1	.000

In the above chi square test, calculated chi square value (58.220) is more than the tabulated value at 1 df and 5% level of significance (3.841) (significance is 0% which is less than 5%). This implies that the availability of seed to a household's is significantly influenced by its involvement in CSB.

Further, the expected count table indicates that the involvement of a household in CSBs made seeds easily available to the household

Table 4.4 Respondents perception for learning profitable traditional knowledge and techniques

			Learn profitable traditional knowledge and techniques		
			No	Yes	Total
HHs involvement in CSB	No	Count	40	0	40
		Expected Count	21.3	18.7	40.0
	Yes	Count	8	42	50
		Expected Count	26.7	23.3	50.0
Total		Count	48	42	90
		Expected Count	48.0	42.0	90.0

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	63.000[a]	1	.000

In the above chi square test, calculated chi square value (63.000) is more than the tabulated value at 1 df and 5% level of significance (3.841) (significance is 0% which is less than 5%). This implies that the learning of profitable traditional knowledge and techniques by a household's is significantly influenced by its involvement in CSB. Further, the expected count table indicates that the involvement of a household in CSBs made increased the possibility of a HH learning the profitable traditional knowledge and techniques

Table 4.5 Respondents perception of change in their livelihood

			Change in livelihood		
			No	Yes	Total
HHs involvement in CSB	No	Count	40	0	40
		Expected Count	26.2	13.8	40.0
	Yes	Count	19	31	50
		Expected Count	32.8	17.2	50.0
Total		Count	59	31	90
		Expected Count	59.0	31.0	90.0

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.831[a]	1	.000

In the above chi square test, calculated chi square value (37.831) is more than the tabulated value at 1 df and 5% level of significance (3.841) (significance is 0% which is less than 5%). This implies that the change in livelihood of a household is significantly influenced by its involvement in CSB.

Further, the expected count table indicates that the involvement of a household in CSBs increased the possibility of change in livelihood of a HH

4.1.2 Seed Banks:

Our study was conducted in Community Seed Bank (CSB) of 3 VDCs of study area namely Belwa, Masuriya and Beldandi. The seed bank of each VDC had their own storage house. These seed banks were being conducted through committees (Samitis). These committees were divided into sub-committees each having 5-7 members. Each member carried out a particular work. Trainings on management, seed collections, storage, viability test of stored seeds, documentation of stored seeds, community bio-diversity documentation and other important knowledge were given by WTLCP to the committee members for the proper conduction of seed banks so that it could contribute properly to conservation. Before being stored, seed samples were sent to Khajuro Seed Analysis Centre, Banke for viability test. Only if the germination percentage the sample was more than 80%, then the seed sample was stored for use as propagule for the next season. Otherwise, the seed sample was sold for food purpose on price lower than market price. The price was also decided by committe members.

Seed Selection and storage techniques used in study area:

(a) Seed selection for farmers' self use:

Out of total 90 respondents, 44.44 % agreed (Table 4.21) that they used both local and improved seeds for cultivation. 56.6% said they used mixed pattern of seed variety i.e., they used local, improved seeds as well as hybrid. Among all respondents only 10 % used hybrid seeds. Information collected from field site showed that most of the seeds or planting materials for most crops particularly food crops were produced by farmers themselves (some times they purchased seeds from markets within and outside the village). According to farmers the main advantage of this was that the seed quality is known, the seed is readily available and it is cheap. Other sources of seeds they followed were neighboring farmers, friends or relatives and seed banks. Farmers did not select the seeds randomly from farm, usually they judged a variety according to their own criteria. Although yield is always important, small farmers tend to prefer yield stability to maximum yield. Apart from selection criteria like resistance to pest and diseases, which are generally important other specific criteria also includes such as growth period, taste, shape, colors, secondary uses etc. For some major crops as rice, mustard, pulses wheat etc after harvesting they followed the process of winnowing to remove husk and dust. Then they follow the process of hand picking for removing inert materials. Now they spread out a thin layer of grain in the sun for solar drying. After drying, finally they select seeds for storage. For vegetables crops, farmers easily recognize plants of good quality and try to get new planting material from them. For good seed production farmers take good care of purity, cleanness and health of the seed. Direct involvement of farmers in the selection process led to better seed quality.

Despite other sources mostly farmers used their own seeds stored in their own conditions. The tribal people of western region are Tharus. They stored seeds in a special type of clay pot. These clay pots were of different size. Seeds of major crops as paddy, wheat and mustard were stored in larger clay pots, locally known as "Dehari" (Plate 11). It was about of 5 ft long and 2 ft wide. Seeds of other crops such as pulses, maize etc were stored in smaller clay pots, locally known as "Kuthali" (Plate 12). It was about 2-3 ft long and 1 ft wide. After storing the seeds or grain, the pot was covered by a clay plate, and plastered with cow dung paste. It was airtight, allowed minimum moisture content and did not get infested by insects. Tharu, the

ethnic group of Kanchanpur district, were found to be categorized in two different groups, viz. Rana Tharu and Chaudhary Tharu, on the basis of their different cultural behaviors. Both Rana Tharus and Chaudhary Tharus stored seeds inside their houses, the former on the floor while the latter underground. Farmers stored the seeds of vegetables in a small polythene bags, tied them and then kept them in a big bag of paddy or wheat. Seeds of maize, garlic were stored by hanging the corn cob/garlic bulb in bunch either outside or inside of home. Farmers mixed or covered the seeds with the leaves of Neem (*Azadirachta sp.*), Titepati (*Artemesia sp.*), Shaypatri (*Tagetus sp.)* and Sishnu (*Urtica dioica* L.) to make the seeds disease free.

(b) Seed selection for seed banks:

Seeds in seed banks follow process of documentation before storing in seed bank. First it properly weighed then the information required for proper documentation recorded as identification of seed variety, status, collector name and seed locality. In seed banks of study area vegetable and pulses seeds were collected in air tight plastic bottles (Plate 13) available at the seed bank. The cereals as paddy were collected in 50 and 100 kg plastic bags (Plate 14). Paddy was stored for about six months. In Masuriya VDC the seed bank also do the germination test of stored seeds, for this they send the stored seeds to "Agriculture Research Laboratory" at Sundarpur in Kanchanpur district**.**

4.2 Documentation of the major cultivars.

The study showed that annually, farmers in the study area cultivated paddy (*Oryza sativa*), wheat (*Triticum aestivum*) and maize (*Zea mays*) as major crops. Among these three cereals, they cultivated maximum varieties of paddy. According to the key informants and respondents response, about 45 varieties of paddy were stored in Community Seed Banks (CSBs) where as only 10 varieties of maize were stored. The productivity of maize was found to be significantly lower (Table 4.18, 4.19 and 4.20). Detail of all varieties of all three cereals is listed in Table 4.6, 4.7 and 4.8.

Table 4.6 Paddy varieties used by Seed banks of different VDCs

Belwa		Masuriya		Beldandi	
Local	**Improved**	**Local**	**Improved**	**Local**	**Improved**
Lalchand	Radha-4	Anadi	Radha-4	Suhawat	Radha-4
Jhinua	Hardinath	Anjana	Sabitri	Talkanj	Radha-12
Mansara	Ramdhan	Bagari	Hardinath-1	Jarua	Hardinath-1
Southiyari	Natiza	Belkhola	Ramdhan	Basnadar-	Judi-582
Nimoi	Mithila judi-582	Bhatteykhola	Ghaiya	anadi	Mithila
Kalonathy	Barkhey-1024	Ghiyupuri	Barkhy-214	Suga pankhi	Sunowlo- sugandha
Lalchan		Jhinua	Judi-582	KaloJadhan	Barkhey-1024
Ghiyupuri		Kalobasmati	Natiza	Shayam Jira	Barkhey-1036
Ratanpuri		Kalonath		Kalobsmati	Barkhey-2014
Bagari		Karangi		Rahemanua	Barkhey-3019 PVS
Thapachini		Lalchand		Junmuniya	Barkhey-3004
Anjana		Marsi		Jhinwa	Barkhey-3017-7
Setosatha		Nirmohi		Tilki	Barkhey-3017-5
Kalosatha		Pushabasmati		Jadhaniya-	Madhayam-846
Bhattykholy		Rahimanua		Anadi	Madhayam-741
Junali		Ratanpuri		Mansara	Madhayam-742
Gopala		Shyamjira		Kalonath	Madhayam-743
Tilki		Suhawat		Ghiyupuri	Madhayam-744
Suhawat		Talkand		Karangi	Madhayam-906
Bindiya		Thapachini		Kalo satha	Madhayam-845
Shyamjira		Tilakchand		Thapachini	Madhayam-904
Tarkan		Tilaki		Belkheyle	Sawitri -barkhey -
Ghunmuniya		Mansara		LalChand	PH290
Belkholey		Soundhyari		Ratanpuri	Sawitri -barkhey –
Dirua				Bagari	1027 PH52
Karangi				Anjana	Khajura 125
				Nimoi	
				Larangi	
				Manjira	
				Madhukar	
				Lwang	
				Manhara	

Table 4.7 Wheat varieties used in VDCs

Belwa		Masuriya		Beldandi	
Local	**Improved**	**Local**	**Improved**	**Local**	**Improved**
Seto gahun	Gautam	Rato gahun	Gautam	Bangohunwa	Gautam
Bhrikuti	Kundan	Seto gahun	Kundan	Rato gahun	Kundan
	BL-2800	Bhrikuti	BL-2800	Seto gahun	BL-2800
	NL-297		NL-297	Bhrikuti	BL-3264
	BL-3264		BL-3264		BL-3063
	UG-1053		BL-3063		UG-1053
	UG-1073		UG-1053		NL-1053
	NL-1053		UG-1073		
			NL-1053		

Table 4.8 Maize varieties used in VDCs

Belwa		Masuriya		Beldandi	
Local	**Improved**	**Local**	**Improved**	**Local**	**Improved**
Murali makai Rana makai Tharu makai Chaudhari makai Local makai Rato makai Seto makai	Baisakhi Arun II Rampur	Rato makai Seto makai Murali makai	Arun II Rampur	Chaudhari makai Localmakai Rato makai	Arun II Rampur Baisakhi

Table 4.9 Local and improved varieties of vegetables and pulses

Vegetable varieties	**Mustard varieties (*Brassica sp)***	**Soybeans varieties**	**Gram varieties**	**Pulses varieties**	**Finger millet varieties** *(Eleusine corocana)*
Abrakh	Kalo local tori	Kalo Bhatmass	Avarodhi	Hinuady mass-local	Jhaure kodo
Chatpar hariyo	Pahelo local	Seto Bhatmass	Sita	Varkhymass-local	Kalo kodo
Chatpar seto	Gobhi tori		Tara	Pratikhsha mung	Thulo kodo
Tate rato simi	Alas		Sano chana-local	Kalyani mung	Muduare kodo
Thungrua seto	Sarsig			Sano local mung	Seto kodo
Seto chaklo simi	Lahata-6 varities			Laharay mass	Rato kodo
Seto dhungry simi				Botey mass	Tin masy kodo
Hariyo guiti				Simal masuro(lentil)	Kopi kodo
Simi				Sagun masuro	
Seto sano				Khajura masuro	
Seto thulo				Kalo masuro local	
Khairo sano				Khairo masuro local	
Khairo thulo					
Gahate siltung					
Rato masyang					
Seto masyang					
phusro masyang					
Khairo masyang-4 varieties					

4.3 Result of Laboratory analysis:

Laboratory analysis of collected seeds was done in Central Seed Testing Laboratory Hariharbhawan, Lalitpur and Central Department of Botany Tribhuvan University, Kathmandu. Three types of seed quality analysis were done. These were

- Physical purity test
- Germination Test
- Mycoflora analysis

(I) Physical purity test:

The seeds collected from seed banks of study area were tested for physical purity test. Result showed that seed samples had impurity of husks, weeds, soil particles, stem and other crop seeds.

Table 4.10 Result of physical purity test:

S.No	Crop	Seed Sample varieties	Kind of admixture and weeds
1	Paddy	Mansara	Sawa 4, inert matter, dust and stem.
2		Tilak	Ragate, husk particles
3		Anjana	Aakara, leaf dust
4		Sabitri	Sawa and Ragate
5		Kanchi mansuli	Leaf dust and soil particles
6		Bhaiya	Aakara and soil particles
7		Thapachini	Husk and dust
8		Suhawat	Sawa 8 and Ragate 6.
9		Anadi	Leaf dust, inertmatter and soil particles
10		Sawitri-1	Soil particles
11		Radha-4	Husk and soil particles
12	Wheat	Local	Ankhara
13	Maize	Local	Inert matter and soil particles
14	Vegetables and legumes	Amillarcha	Inert matter
15		Rato bethy	Sand and soil particles
16		Soyabean	Leaf dust
17		Rajma	
18		Bodi	
19		Masuro	Soil particles
20		Kalomass	Soil particles

(II) Germination test:

Among the various seed samples collected maximum germination percentage was observed in seed samples of Morcha (94.75 %) while the Amillarcha seed sample collected from Masuriya VDC (Plate 22) did not show any germination.

Table 4.11 Germination percentage of cultivars

Accessory symbol of cultivars	Local name of Cultivars	Germination in first count (In percent)	Germination in second count (In percent)	Total germination (In percent)
AM	**Amillarcha**	0.00	0.00	0.00
AN	**Anjana**	48.50	62.25	55.38
AN-1	**Anadi**	20.00	90.00	55.00
BH	**Bhaiya**	36.25	40.00	38.15
BO	**Bodi**	12.00	96.00	54.00
KA	**Kalomass**	30.00	70.00	50.00
KM	**Kanchi mansuli**	50.00	92.25	71.12
LM	**Local maize**	82.00	98.00	90.00
LW	**Local wheat**	27.00	34.00	30.50
MA	**Mansara**	89.25	94.25	91.75
MA-1	**Masuro**	94.00	97.00	95.50
MO	**Morcha(Ratobethy)**	91.50	98.00	94.75
R-4	**Radha-4**	90.50	95.00	92.75
RA	**Rajma**	92.00	100.00	96.00
S-1	**Sawitri**	54.25	56.25	55.25
S-2	**Sawitri**	20.00	90.00	55.00
SO	**Soyabean**	33.00	43.00	38.00
SU	**Suhawat**	69.50	70.00	69.75
TC	**Thapachini**	12.00	87.50	49.75
TI	**Tilak**	16.25	21.75	19.00

Table 4.12 Percentage seed germination, number of normal and abnormal seedlings and fungal pathogens isolated from abnormal seedlings.

Cultivars	Germination (%)	Condition of seedlings (%)		Isolated fungal pathogens from abnormal seedlings
		Abnormal	Normal	
TI	19	06	13	*Fusarium* sp. 2, *Aspergillus* sp., *Aspergillus flavus* and *Mucor* sp.
SU	70	01	69	*Fusarium* sp. 2 and *Mucor* sp.
S-1	55	05	50	*Rhizopus* sp. and *Mucor* sp.
AN	55	20	35	*Fusarium* sp. 1, *Mucor* sp. and *Alternaria* sp.
TC	50	07	43	*Mucor* sp. and *Aspergillus niger*
AN-1	55	02	53	*Mucor* sp. and *Alternaria* sp.
S-2	55	10	45	*Mucor* sp. and *Fusarium* sp. 2
R-4	93	07	86	*Aspergillus niger* and *Aspergillus* sp.
MA	92	18	74	*Mucor* sp., *Aspergillus niger* and *Aspergillus fumigatus*
KM	71	08	63	*Mucor* sp. and *Aspergillus niger*
BH	38	16	22	*Rhizopus* sp., *Aspergillus* sp. and *Aspergillus fumigatus*

(III) Mycoflora analysis:

Qualitative picture of storage mycoflora on seed samples:

The individual species of storage fungi encountered from different seed samples from the present study are

1. *Aspergillus niger*
2. *Aspergillus fumigates*
3. *Aspergillus flavus*
4. *Aspergillus* sp.
5. *Alternaria* sp.
6. *Fusarium* sp 1
7. *Fusarium* sp 2
8. *Mucor* sp.
9. *Rhizopus* sp.

Among all fungal pathogens *Aspergillus niger* and *Mucor* sp. were dominant.

Percentage infection of fungi

Table 4.13 Quantitative pattern of storage fungi in storage seed samples

S.No.	Pathogens	Infection Percentage
1	*Aspergillus sp.*	29.59
2	*Aspergillus fumigates*	34.69
3	*Aspergillus niger*	40.81
4	*Aspergillus flavus*	6.12
5	*Alternaria sp*	22.44
6	*Rhizopus sp*	21.42
7	*Mucor sp*	88.77
8	*Fusarium sp 1*	20.40
9	*Fusarium sp 2*	17.34

Table 4.14 Fungal pathogens isolated from 10 cultivars of Rice

Accessory symbol of cultivars	Locality	Local name of Cultivars	Seed Percentage		Associated fungal pathogens
			Healthy	Infected	
TI	Kanchanpur	Tilak	28	72	*Aspergillus* sp., *Aspergillus flavus, Mucor* sp. and *Fusarium* sp. 2.
SU	Bardia	Suhawat	95	5	*Mucor* sp.
S-1	Kailali	Sawitri	90	10	*Rhizopus* sp. and *Mucor* sp.
AN	Kanchanpur	Anjana	48	52	*Fusarium* sp. 1, *Mucor* sp. and *Alternaria* sp.
TC	Kailali	Thapachini	71	29	*Mucor* sp. and *A. niger*
AN-1	Bardia	Anadi	68	32	*Alternaria* sp. and *Mucor* sp.
S-2	Kanchanpur	Sawitri	73	27	*Fusarium* sp. 2 and *Mucor* sp.
R-4	Kanchanpur	Radha -4	77	23	*Aspergillus* sp. and *Aspergillus niger.*
MA	Kailali	Mansara	72	28	*Mucor* sp. and *Aspergillus fumigatus.*
KM	Kanchanpur	Kanchimansui	70	30	*A. niger* and *Mucor* sp.
BH	Bardia	Bhaiya	70	30	*Rhizopus* sp., *Aspergillus fumigatus* and *Aspergillus* sp.

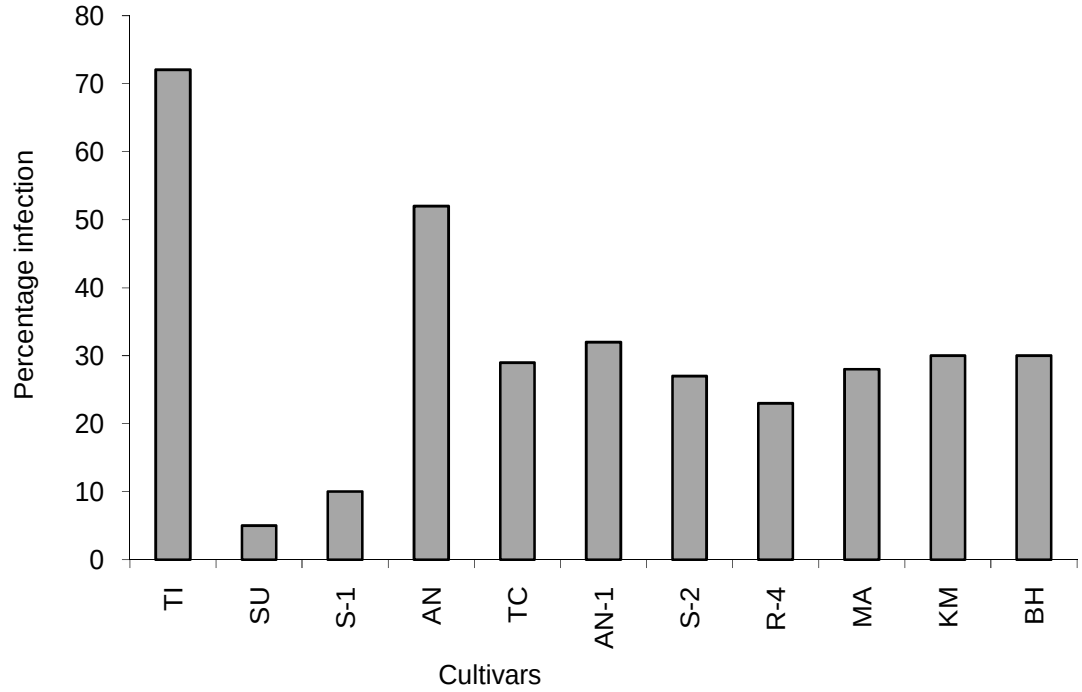


Figure 4.1 Percentage infection of different cultivars.

During this study a total of 9 fungi were isolated and identified from seeds samples of 11 rice cultivars. The percentage of seeds showing fungal growth ranged from 5 % to 72 %. The seed samples of two paddy cultivars including Tilak and Anjana exhibited highest infection of *Aspergillus* and *Mucor* respectively. Whereas others 8 cultivars namely Sawitri-1, Thapacini, Anadi, Sawitri-2, Radha-4, Mansara and Kanchi mansuli had intermediate infection where as Suhawat exhibited the lowest infection. The healthy seed percentage ranged from 28 % to 95 % (Table 4.14).

4.3 Socio economic profile of the study area

4.3.1 Sex composition

The Table 4.15 shows female respondents were higher than male respondent

Table 4.15 Sex composition of the sampled households.

Gender	Sample HHs of Belwa	Sample of Masuriya	Sample of Beldandi	Total	Percent
Female	11	24	16	51	56.60
Male	19	06	14	39	43.33
Total	**30**	**30**	**30**	**90**	**100.00**

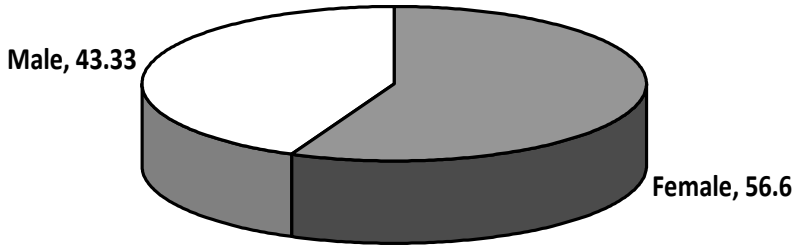


Figure 4.2 Sex composition of the sampled households

4.3.2 Occupation

The table 4.16 shows that among all 90 respondents 75.6 % respondents are dependent on farming only.

Table 4.16 Occupation of the sampled households

Occupation	Sample HHs of Belwa	Sample HHs of Masuriya	Sample HHs of Beldandi	Total HHs	Percent
Agriculture	23	20	25	68	75.55
Services	02	02	00	04	20.00
Agriculture and others	05	08	05	18	4.44
Total	**30**	**30**	**30**	**90**	**100.00**

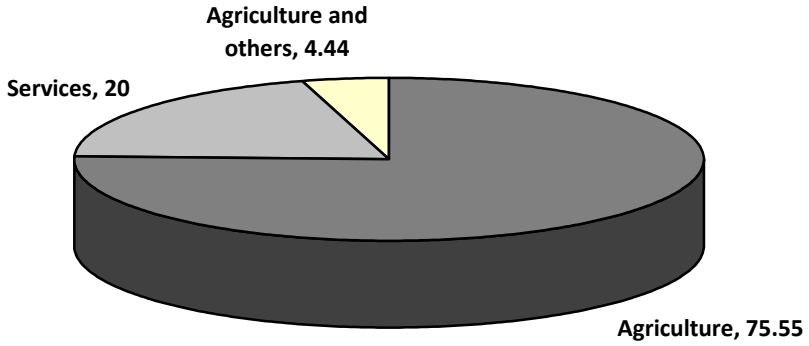


Figure 4.3 Occupation status of the sampled households

4.3.3 Educational Status:

The data table 4.17 shows that among all 90 respondents 61.1% are literate.

Table 4.17 Educational status of the sampled households

Literacy	Sampled HHs of Belwa	Sampled HHs of Masuriya	Sampled HHs of Beldandi	Total	Percentage
Literate	20	25	10	55	61.11
Illiterate	10	05	20	35	38.88
Total	**30**	**30**	**30**	**90**	**100.00**

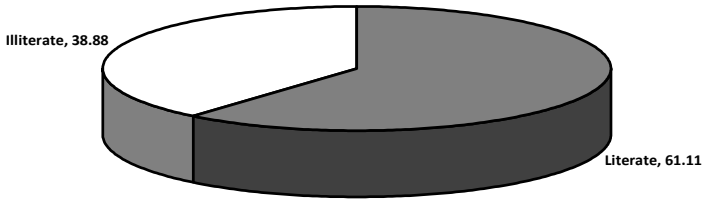


Figure 4.4 Educational status of sample household

4.3.4 Crop Production

4.3.4.1 Production of Paddy:

The data of table 4.18 shows the production quantity of paddy by all ninety respondents. The maximum percentage i.e. 43.3% of respondents grows 100-1000 Kg. of paddy whereas; the minimum percentage i.e. 3.3% of respondents grows 5001-6000 Kg. of paddy.

Table 4.18 Production of Paddy of the sampled households

Production of Paddy (Kg.)	Sample households	Percentage (%)
100-1000	39	43.3
1001-2000	21	23.3
2001-3000	12	13.3
3001-4000	06	6.7
4001-5000	05	5.6
5001-6000	03	3.3
6001-more	04	4.4
Total	**90**	**100.0**

4.3.4.2 Production of Wheat

The data of table 4.19 shows the production quantity of wheat by all ninety respondents. The maximum percentage i.e. 50.0 % of respondents grows 0-500 Kg. of wheat whereas; the minimum percentage i.e. 1.1% of respondents grows more than 5001 Kg. of wheat.

Table 4.19 Wheat production of the sampled households

Production of Wheat (Kg)	Sample households	Percentage (%)
0-500	45	50.00
501-1000	21	23.30
1001-1500	14	15.60
1501-2000	06	6.70
2001-2500	00	0.00
2501-5000	03	3.30
5001-more	01	1.10
Total	**90**	**100.00**

4.3.4.3 Production of Maize

The data of table 4.20 shows the production quantity of maize by all ninety respondents. The maximum percentage i.e. 43.3 % of respondents grows 0-50 Kg. of maize whereas; the minimum percentage i.e. 3.3% of respondents grows 501-700 Kg. of maize.

Table 4.20 Production of Maize of the sampled households

Production of maize (Kg.)	Sample households	Percentage (%)
0-50	39	43.30
51-100	15	16.70
101-500	28	31.10
501-700	03	3.30
701-high	05	5.60
Total	**90**	**100.00**

4.4.4.4 Seed varieties used in different VDCs

Table 4.21 Seed varieties used in different VDC

The table 4.21 shows among all three VDCs of study area 66.7% respondents of Belwa VDC use local seeds whereas only 16% respondents of Beldandi VDC use local improved seeds.

Seed variety Used in different VDCs	Samples HH of Belwa VDC	Sample HHs of Masuriya VDC	Sample HHs of Beldandi VDC	Total HHs of different VDCs	Percentage
Local and improved	20	15	05	40	44.40
Local, improved and hybrid	10	11	20	51	56.60
Hybrid	00	04	05	09	10.00
Total	**30**	**30**	**30**	**90**	**100.00**

Table 4.22 Use of seed varieties by households (HHs) in Belwa VDC

Seed variety	Sample HHs of Belwa VDC	Percentage
Local and improved	20	66.70
Local, improved and hybrid	10	33.30
Hybrid	00	00.00
Total	**30**	**100.00**

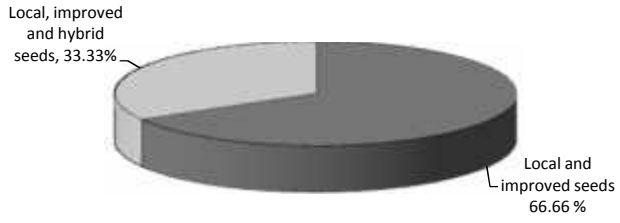


Figure 4.5 Seed variety use by HHs in Belwa VDC

Table 4.23 Use of seed varieties by households (HHs) in Masuriya VDC

Seed variety	Sample HHs of Masuriya VDC	Percentage
Local and improved	15	50.00
Local, improved and hybrid	11	36.70
Hybrid	04	13.30
Total	**30**	**100.00**

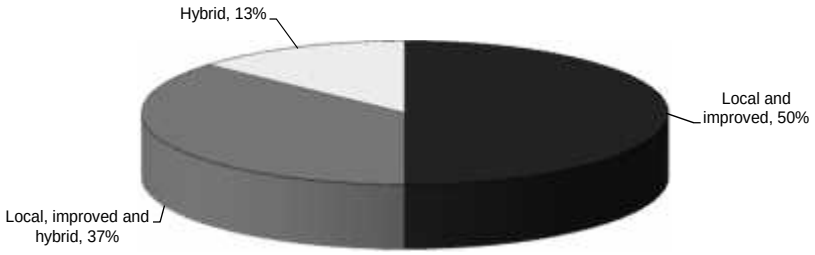


Fig 4.6 Seed variety use by HHs in Masuriya VDC

Table 4.24 Use of seed varieties by households (HHs) in Beldandi VDC

Seed variety	Sample HHs of Beldandi VDC	Percentage
Local and improved	05	16.70
Local, improved and hybrid	20	66.70
Hybrid	05	16.70
Total	**30**	**100.00**

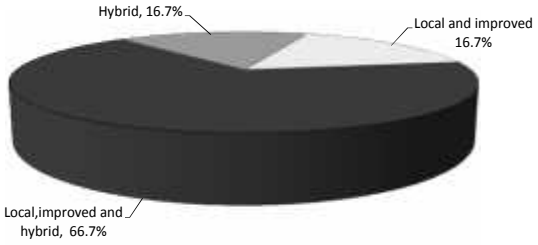


Figure 4.7 Use of seed varieties by HHs in Beldandi VDC

CHAPTER FIVE

DISCUSSION

5.1 Community Seed Banking in Agro-biodiversity conservation:

According to Demissie and Tanto (2000), Community Seed Banking (CSB) works as a store house of crop diversity and behaves as an emergency source of seeds if crop fail due to pests, disease or bad weather. This study was conducted to determine the role of CSB in agro-biodiversity conservation. Deb (2009) reported in his research that food security and sustainability at the production level are a consequence of the agro-ecosystem's resilience which can only be maintained by using diversity on both species and crop genetic levels. According to Zeven (1998), a landrace is a variety having high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and an intermediate yield level under a low input agriculture system. During this study also, the three CSBs understudy were also found to store different varieties of landraces and help in agro-biodiversity conservation. Adhikari (2010) reported that the extinction of local varieties is mainly due to people's low preference of local varieties. According to Zimmer (1996), a rational farmer must think from benefit point of view and abandon traditional varieties which do not have immediate benefit. Adhikari (2010) studied "Agro-biodiversity conservation practices in Kailali district" and reported that most of the farmers of the area were illiterate so, not confident on agriculture vital decision. But in this study, by socioeconomic survey, the result showed that people who were just literate or slightly educated were more interested in conservation of local varieties, whereas the illiterate and highly educated people were not showing any interest. Hodgekin *et al*., (2006), reported that conservation of landraces is heavily dependent on the continued functioning of informal seed exchange network. This study also indicated that all three CSBs were contributing to sustainable conservation strategy and supporting seed exchange of traditional varieties among farmers. Benzabih (2005) reported a significant impact of participation in CSB on farm level agro-biodiversity. Sthapit *et al*., (2003) reported that local knowledge and culture considered as integral part of agriculture biodiversity and diversity fair is the most popular method for sensitizing from local community to minister level. Lewis and Mulvany (1997) reported that seed fairs acts not only as commercial markets, but also an opportunity to exchange seed and knowledge between local communities. Deb and Malhotra (2001) reported that a large number of elements of local biodiversity, regardless their use value, are protected by the local cultural

practices. Current study also indicated that in order to increase awareness about agro-biodiversity conservation, seed fairs were conducted every year in all three CSBs. According to Lewis and Mulvany (1997), seed banks are an important method of seed supply and multiplication for small scale farmers. Maharjan *et al*., (2011) reported total number of seed conserved in Belwa was only 52 in 2007 and increased to 88 in 2009 this study also reported 105 in 2010. According to Lewis and Mulvany (1997), CSB is a scheme which aims at improving the existing seed system by easy access of seeds. Shrestha *et al.,* (2008) reported that CSBs in western terai of Nepal made the rare landraces available to common, ensuring seed security in local context. During this study, CSBs were found to have benefited farmers in many ways such as easy availability of seeds, on farm conservation of local varieties, conservation of local and traditional knowledge and change in livelihood too. The result showed that HHs interest to participate in the conservation activity differed significantly by sex and education.

5.2 Mycoflora analysis in stored seeds of Paddy:

The agricultural production is influenced by the number of environmental and non environmental factors (Jha *et al.,* 2008). The climate, soil characteristics, seed quality, water availability, labor etc. plays crucial role in determining the agriculture production along with socio-economic status of people. Seed play a vital role in introduction of plant pathogens into new areas. Approximately 90% of all crops grown on earth are propagated by seeds (Neergaard, 1977). Therefore, infested seed is major limiting factor of low yield. In addition to other factors causing low yield, the most significant are the diseases which are seed-borne, soil-borne and air-borne. Therefore, good seed is an important input in any agriculture production system. So seed health testing is needed. One of the important aspects of good seeds, besides high germination and purity, is that the seed should be free from pathogens. Seed health testing of storage seeds determine whether a seed sample suffer from many seed borne pathogens that caused reduction in germination at initial stage leading to poor crop stand as well as foliage and inflorescence diseases at the adult stage. The result of physical purity test of storage seeds showed seed containing impurities of husks, weeds, soil, stem and other crop seeds (Table 4.10). Mc Gee *et al., (*1980) reported the fungi had been reported to cause loss of seed germ inability leading to reduction in seed germination and seedling diseases. Konde *et al*., (1980) and Karim

(2005*)* reported *F.moniliforme* and *A.alternata* reduced germination and induced seedling blight. Current study also reported germination percentage ranged from 0 to 96 percent (Table 4.11). Comparative study of all three VDCs showed the seeds from Beldandi VDC had more infection percentage in storage seeds than other two VDCs. This might be due to the location of the Beldandi seed house in flooded area. Over all, 9 varieties of fungi were isolated from 11 rice cultivars. The most dominant fungal infection was of *Mucor* species (Table 4.13). Williams and McDonald (1983) reported seed-borne pathogens, such as *A. flavus* and *A. niger*, affect plant growth at seedling, foliage and flowering stages. Elisabeth *et al*. (2001) reported the association of seed-borne pathogens such as *Fusarium* spp. in various samples causing deterioration in seed germination. Karim (2005) reported *Fusarium* as a highly pathogenic fungus and its different spp. had been reported to cause seed rot, seedling blight and wilt in a number of crops. During this study, 37.74% of seed samples were found to be affected by *Fusarium* sp. (Table 4.13). Mishra and Prakish (1975) reported *Alternaria alternata* delay or reduce in seed germination due to decay of seeds. The result of current study showed 22.44% seed samples were affected by *Alternaria* sp. (Table 4.13). The high incidence of field fungal pathogens of seeds suggests that the seed got contaminated in the field during harvest. The association of field and storage fungal pathogens with rice seed has been reported. Storage fungal genera, namely *Aspergillus* and *Penicillium*, with seeds indicates that these seed becomes contaminated during storage. Shakir and Mirza (1992) and Dawar (1994) reported that presence of *A. fumigatus* and *A. flavus* on seeds, abnormal seedlings, rotted and ungerminated seeds confirmed the findings that species of *Aspergillus*, though occur as saprophytes, may cause low germination of seeds. Jain and Pathak (1996) reported the metabolites of *Aspergillus flavus* cause reduction of shoot and root elongation. Ijaz *et al.,* (2001) reported *Aspergillus niger* as damaging storage fungus that deteriorates the seed quality and reduce seed germination. In this study, 40.81% seeds were found to be infected by *Aspergillus niger*, 34.69% infected by *A. fumigatus* and 6.12% seeds were affected by *A. flavus* (Table 4.13).

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Conclusions of the present study are:

- ☞ Community Seed Bank has benefited farmers in many ways, as by giving training for learning new techniques of landrace conservation, easily availability of seeds, conserving local and traditional knowledge and conserve diversity.
- ☞ Agriculture is the main occupation of the respondents. About 75.55% respondents (Table 4.16) based on income source were engaged in agriculture.
- ☞ Major crops in the study area were rice, wheat and maize (4.18, 4.19 and 4.20). Rice farming was the major source of livelihood for farmers depend on farming only. .
- ☞ Different species of vegetable were cultivated in the study area. Mostly local varieties few improved ones were cultivated (Table 4.9).
- ☞ The respondents were gradually shifting their agricultural practice from inorganic to organic.
- ☞ Farmers were seems actively participated in program organized by WTLCP as conservation training, agriculture training, pest and disease control training. It was found that the farmers participate on the training were more interested to grow landraces.
- ☞ Female farmers were seems more active in comparison to male farmers in different program related with conservation training.
- ☞ It was found the farmers participate in different program does not share their knowledge in community except few one only.
- ☞ It was found during field visit the seed storage houses were neither in good situation nor properly managed.
- ☞ The laboratory analysis of collected seeds showed that the storage seed samples having impurities of husks, weeds, soil particles and other crop seeds.

- ☞ Stored seeds showed germinating tendency ranges from 0 to 96 %. Over all nine fungi were isolated by rolled paper method among 11 cultivars of paddy (Plate 1 to 10).

6.2 Recommendations

Based on the field survey of the study area and laboratory analysis some recommendation should be applied for betterment of Community Seed Bank (CSB) as

- ☞ There is an urgent need to increase the level of protection of crop genetic diversity with adequate levels of protection.
- ☞ Traditional and local food variety should be promoted because traditional food varieties have better taste.
- ☞ Indigenous people and their tradition should also be promoted because traditional techniques for managing seeds and farming have served an important function for conservation of land races (LRs).
- ☞ Detailed research into functioning of different types of seed banks should be conducted in both technical and socio-economics terms.
- ☞ Nepal government should set up some appropriate policy and institutional environments to promote and protect LR. Agro biodiversity conservation should be included in school curricula.
- ☞ Farmer to farmer exchange program among the farming communities should be initiated to help in exchange and dissemination of knowledge which can be applied on CSBs.
- ☞ The proper storage of seeds under hygienic condition is a measure for quality control. The seed should be dried well before storage and should be kept in dry insect proof storage conditions. The proper ventilation for air crossing should be maintained in store houses. Before storage of grains, the store house or seed bank must be disinfected. The periodical inspection of the seed should be carried out and control measures must be taken to avoid losses.
- ☞ Seeds should bring to the bank after undergoing a cleaning process to remove contaminants from the seeds.
- ☞ Germination tests should be conducted every year to assess seed viability. Seeds with low germination percentage should regenerate before storing in seed bank.

- ☞ Community Seed Bank should be collaborated with the National gene bank.
- ☞ Traditional seed protectent such as castor oil, Neem oil or Neem cake, should be used for seed protection in seed storage.
- ☞ For reducing fungal infection to the grain, it should be free of damaged kernels or foreign material.
- ☞ Seed should be stored for a shorter period.

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http://www.libird.org

http://www.wtlcp.org.np

Appendix II

Agro biodiversity Conservation Survey Questionnaire

Date …….

A. Farmers general information

1.Name ……

2.Gender ……

3.Caste/Ethinicity …….

4.Address ……..

5.Occupation …….

6.Education ……..

7.Household size

Male	Female	Total

Family members	Age	Education	Activities	Earning

8.Land size(in Kattha)

Khet ( ) Bari ( )

Land type

Own ( ) Government ( ) Mohi .( ) Rente ( )

B.Information about farm

1.What are the crop varities used in your farm

A…….b…….c…….d…….

2.Crops used are

A.Local B.Improved C. Hybrid D.All

3.Years of farming. Forfathers( ) Years( )

4.Name of crop used are

Appendix III: Plates

Plate 1: CSB of Masuria VDC

Plate 2: Conservation of Mango varieties in Belwa VDC.

Plate 3: Kuthali, the earthen pot used in Masuriya VDC

Plate 4: Dehari, used by Tharus to store paddy

Plate 5: Rice stored in CSB of Beldadi VDC.

Plate 6: Seed conserve in CSB of Belwa VDC

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Plate 7: Interview with the respondent.

Plate 8: Group discussion with farmers of Beldadi VDC

Plate 9: Physical purity test in laboratary

Plate 10: Seed germination analysis in laboratory

Plate 11: Seed samples used for laboratory work

Plate 12: Non-viable seeds of Amillarcha

Plate 13: Culture of different mycoflora associated with rice seeds in PDA media.

Alphabates on each Petriplates indicating

A: *Rhizopus sp*
B: *Mucor sp*
C: *Fusarium sp1*
D: *Aspergillus sp*
E:*Aspergillus fumigatus*
F: *Alternaria sp*.
G: *Aspergillus flavus*
H :*Aspergillus niger*
I: *Fusarium sp2*

Appendix II

Agro-biodiversity Conservation Survey Questionnaire

Date…….

A. Farmers general information

1. Name ……....
2. Gender ……....
3. Caste/Ethnicity …….
4. Address ……...
5. Occupation ……..
6. Education ……
7. Household size

Male	Female	Total

Family members	Age	Education	Earning and activities

8. Land size (in kattha)

Khet ( ) Bari ( )

Land type

Own ( ), Government ( ), Mohi ( ), Rente ( ).

B. Information about farm

1. What is the crop varieties used in your farm?

a…….. b…… c…….. d……

2. Crops used are

A. Local B. Improved C. Hybrid D. All

3. Name of crop used is

	Rice	Wheat	Maize	Others
Local				
Improved				
Hybrid				

C. Information about Community Seed Banking

1. For seeds and sampling are you totally depend on CSB

a. YES ( ) b. NO ( )

2. If no then tell other sources name

……..
3. Your family involve or not in CSB
a. YES ( ) b. NO ( )
4. Amount of money invest in CSB
(Nrs.) ……..
5. Which type of tools you used to store seeds?
……
6. What techniques you used for prevention of seed by
Rat or pest……....
7. Type of sample you store are
a. Seeds ( ) b. Seedlings ( )
8. Do you participate in any workshop for CSB by WTLCP
a. YES ( ) b. NO ( )
9. What are the trainings you have taken from CSB
……..
10. When the project work will terminate then also do you carry on CSB
a. YES ( ) b. NO ( )
11. Do you learn any new technique from CSB for conserving land races?
a. YES ( ) b. NO ( )
12. If yes then what?
……
13. Do you sale seed in market
a. YES ( ) b. NO ( )
14. Do you communicate with other people to tell about CSB?
a. YES ( ) b. NO ( )
15. Selection of seeds for CSB
a. Selected ( ) b. Randomly ( ) c. On farm ( ) d. Of farm( )
16. Before storing seeds undergo in dehydration or not
a. YES ( ) b. NO ( )
17. If yes then by which techniques?
……..
18. How CSB effect your livelihood?
……...
19. What is your opinion about CSB to make it more profitable?
……..
……..
D. Information about Agro-biodiversity conservation
1. What type of fertilizer do you use in farm?

Chemical fertilizer	Compost

2. Do you observe pest in your farmland
a. YES ( ) b. NO ( )
3. How have you managed till now?
a. Spraying inorganic pesticides whatever found in market ( )
b. Through crop rotation practice ( )
c. Using Biopesticides. ( )
d. Others ( )

4. Have you planted trees in your farmland?
   a. YES ( ) b. NO ( )
5. What is your general practice to enrich the soil nutrient?
   a. Adding inorganic fertilizer. ( )
   b. Adding organic fertilizer. ( )
   c. Adding inorganic and organic fertilizer. ( )
6. Do you sale your production in market?
   a. YES ( ) b. NO ( )
7. Income generation from sale of agricultural products
   Amount (Nrs.) ( )
8. Have you taken any special training for conservation of agro Species
   a. YES ( ) b. NO ( )
9. If yes then what type of training mention.
   …….
10. How much production do you have in a year?

Crop	Production		Consumption	
	2010	2011	2010	2011
Wheat				
Paddy				
Maize				
Others				

11. Who decide the use of income?
    a. male b. Female c. both
12. Who spend most time in farm?
    a. male b. female c. both
13. Are there any organized farmers group in your village for the agro species management and conservation?
    a. YES ( ) b. NO ( )

If yes then which group mostly formed?
a. Male group ( )
b. Female group ( )
c. Mixed group ( )
14. What are the main tasks of this group?
……..
15. What type of tools do you use?
a. Modern tools ( ) b. Indigenous tools ( )
16. Any suggestion
……

……
……
……
……
……
……
……
Thank you,