COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

NEPAL

Country Report
on
The State of the Nepal's Plant Genetic Resources for Food and Agriculture

Submitted to:
COMMISSION ON GENETIC RESOURCES FOR
FOOD AND AGRICULTURE

Submitted by:
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ACRONYMS

ABD	Agriculture Botany Division
ADCS	Agriculture, Development and Conservation Society
AGDP	Agriculture Gross Domestic Products
AGRBS	Access to Genetic Resources and Benefit Sharing
APP	Agriculture Perspective Plan
ARS	Agriculture Research Station
BRCC	Biodiversity Registration Coordination Committee
CBD	Convention on Biological Diversity
CBM	Community-based biodiversity management
CBR	Community biodiversity register
CBSP	Community Based Seed Production
DADO	District Agriculture Development Offices
DISSPRO	District seed self-sufficiency programme
DoA	Department of Agriculture
FAMPAR	Farmer Managed Participatory Research
FAO	Food and Agriculture Organization
FDD	Fruit Development Division
GDP	Gross Domestic Products
GI	Geographic Indicator
GMO	Genetically Modified Organism
GO	Government Organization
GoN	Government of Nepal
GRPI	Genetic Resources Policy Initiative
HMRP	Hill Maize Research Programme
ICARDA	International Center for Agricultural Research in the Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ILO	International Labour Organization
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
ITPGRFA	International Treaty for Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
MoAC	Ministry of Agriculture and Cooperatives
MoF	Ministry of Finance
MoFSC	Ministry of Forestry and Soil Conservation
MoI	Ministry of Industry
NABSC	National Agro-Biodiversity Steering Committee
NARC	Nepal Agriculture Research Council
NBS	Nepal Biodiversity Strategy
NBSC	National Biodiversity Steering Committee
NBSIP	Nepal Biodiversity Strategy Implementation Plan
NCCBC	National Coordination Committee for Biodiversity Conservation
NCRPs	National Commodity Research Programs
NGO	Non-Government Organization
NPC	National Planning commission

NSB	National Seed Board
NSC	National Seed Company
NSP	National Seed Policy
PGR	Plant Genetic Resource
PGRFA	Plant Genetic Resources for Food and Agriculture
PGRS	Plant Genetic Resources Section
PIC	Prior Informed Consent
PPB	Participatory Plant Breeding
PRA	Participatory Rural Appraisal
PTDD	participatory technology development and dissemination
PVP	Plant Variety Protection
PVS	Participatory Variety Selection
R & D	Research and Development
RARS	Regional Agriculture Research Station
RH	Relative Humidity
RRA	Rapid Rural Appraisal
SAARC	South Asia Association for Regional Cooperation
SANPGR	South Asia Network for Plant Genetic Resources
SAWTEE	South Asia Watch on Trade, Economics & Environment
SCU	Seed Certification Unit
SDC	Swiss Development cooperation
SEAN	Seed Entrepreneurs Association of Nepal
SNV	Netherland Development Organization
SQCC	Seed Quality Control Centre
SVRU	Seed/Variety Registration Unit
TK	Traditional Knowledge
TRIPS	Trade Related Aspects of Intellectual Property Rights
TU	Tribhuvan University
UNDP	United National Development Programme
UNFCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
VDCs	Village Development Committees
WTO	World Trade Organization

SECTION 1

EXECUTIVE SUMMARY

Nepal is richly endowed with numerous agricultural crops and plants. The variation in temporal, altitudinal, topographical and aspects has made agricultural such biodiversity possible (Shrestha, 2007). Hence, Nepal is a safe heaven on earth for many plant and crop species even in the events of disasters of global warming in this planet. The agro-biodiversity in the country is so immense that this needs a time series study of ten to twenty years to enumerate all the variations causal element and assessments of results. It is mainly because the cultivation, gathering from the forests, food habits and consumption vary not only by ecological belts, hamlets and ethnicity but is also due to variations with events of disasters especially during the droughts. People found to have invented and adopted consuming and growing several kinds of food items to cope with such events which are cyclical (Shrestha, 2004).

About 21% (3.2 million hectares) of the total land area of Nepal is used for cultivation and the principal crops are rice (45%), maize (20%), wheat (18%),millet (5%) and potatoes (3%), followed by sugarcane, jute, cotton, tea, barley, legumes, vegetables and fruits. Crops such as rice, rice bean, egg plant, buckwheat, soybean, foxtail millet, citrus, and mango have high genetic diversity relative to other food crops. Crop species in Nepal owe their variability to the presence of about 120 wild relatives of the commonly cultivated food plants and their proximity to cultivated areas that have been listed 60 food species (fruit, vegetables, legumes) and 54 wild relatives of food plants.

Major crops and underutilized species are grown all over the nation. Diversity exists in variety and species levels. The list of underutilized species is quite large. Available information indicates among its 60 reported species of amaranth in the world at least 11 species have been reported with cultivated types for grain, green vegetables, wild and weedy types. Nepal, being proximal to the original and secondary sources of origin of different cultivated plants, has harbored numerous wild relatives of cultivated agricultural crop plants like rice, wheat, barley, buckwheat, citrus and other fruit crops, several vegetable crops, etc. It is reported that 83 different wild relatives of 46 genera under 18 families of 36 agricultural crops exists.

There are several examples of crop variety improvement through the use of plant genetic resources in Nepal. A total of 216 improved varieties of 44 crops have been released representing cereals, legumes, oil seeds, potato, vegetables, industrial crops and forage.

The present national, regional and global Food Price Rise and Food Security Concerns have shaken the stakeholders involved in agriculture development and technology generation. The ever declining national and donor support for agriculture research and development have to be reversed. Issues of small scale farmers, ultra poor and migrating youths from rural community to urban area have to be addressed as well. This necessitates increased investment in agriculture research and development specially, in the field of sustainable use of plant genetic resources for food and agriculture.

Production of major food crops such as rice, maize and wheat has more than doubled since 1970. The total production of wheat has increased by more than 12 times compared to 1970's production. Moreover, the returns to investments to variety improvement in wheat has resulted 84% internal rate of return (IRR) from 1970 to 1992.

Nepal was exporting food upto 1980's, but in recent years Nepal is facing food deficiency. Although food production is marginally surplus, 55 of the 75 districts are categorized as food deficient. Two fifths of 3.4 million land holdings in Nepal produce enough food for less than six months. Food production in the mountains remains short of the requirement by 34-45%. In the hills, the deficit is between 15-30% (NPC 2007; UNDP 2004). The role of PGRFA for minimizing food deficit through increased in productivity is very high.

Agriculture constitutes the major share of GDP (36.1 %) and support livlihood to 65% in rural areas. Increasing agricultural productivity is critical to overall growth of the Nepalese economy and to reduction of poverty. There is an increasing interest in neglected and underutilized crop species for export and domestic markets. Interest in neglected and underutilized crop species stems from a variety of factors, including their contribution to agricultural diversification and better use of land. Use of underutilized plant species have to expanding beyond local populations in traditional ways. Traditional food crops provide many benefits to the farmers practicing the different farming systems. These crops are providing food for home consumption, making productive use of marginal land and also provide income to small farmers, entrepreneurs and local market exporter.

The existing diversity of PGRFA is endangered to decline determined by the comparative advantage of modern improved varieties to farmers' varieties. It is assumed that *in situ* as well as *ex situ* conservation of PGRFA is necessary to maintain a high level of plant genetic diversity, benefiting a sustainable agricultural development. A new approach to sustainable management of plant Genetic Resources is needed in which local, national and global action should be integrated. The approach should contain Regional exchange of Plant Genetic Resource and in National approach *in situ* and *ex situ* conservation and to increase the utilization of PGRFA. The modern tools like Biotechnology should be utilized. It is essential to change the economic incentives, and institutional and policy barriers that currently discourage the sustainable use of Plant Genetic Resources. It is also essential to correct the current policy, research related to implementation activities. Plant Genetic Resources thereby create an inertia reinforcing the industralization and commercialization of Agricultural sector.

Lack of gene bank is the greatest constraints to sustain *ex situ* plant genetic resources collection. The Government of Nepal is establishing a national gene bank under Nepal Agricultural Research Council (NARC) for *ex situ* conservation of Plant Genetic Resources for Food and Agriculture. It is also very necessary for inclusion of conservation facilities in our national commodity research programes and regional agricultural research stations. This provides rays of hopes for sustainable *ex situ* plant genetic resources collections over the next 10 years.

The government needs to prioritize Community-based Biodiversity Management (CBM) programme and Community-based Biodiversity Registration (CBR) across all regions. In particular, technical and financial support for community seed banks for seed conservation and participatory plant breeding (PPB) for seed development should be extended to all parts of the country. The national policy, legislation should encourage the benefit sharing and safeguard the Intellectual Property Right and Farmer's Right for the farmers who are conserving and managing PGR.

SECTION 2

NEPAL AND THE AGRICULTURAL SECTOR

1. Basic features

Nepal is a landlocked country located between 26°22' to 30°27 north latitude and 80°4' to 88°12' east longitude in South Asia. The country is sandwiched between India in the south, east and west and China in the north. Nepal extends over a length of 885 km from east to west and has a non-uniform width of 193 km from north to south. It has a total land area of 147 181 km^2. Nepal is predominantly a mountainous country with elevations ranging from 64 m above sea level in Kechana located in eastern Terai (southern plain area) district of Jhapa to 8 848 m at the peak of the world's highest mountain, Sagarmatha.

Administratively, Nepal is alienated into five development regions, 75 districts, 58 municipalities and 3 912 Village Development Committees (VDCs). The population was 9.4 million in 1961 which increased at the rate of 2.2 percent per annum and reached 25 million in 2001. The population in 2007 is estimated at 26 million. Per capita national income is US$ 320 in 2006 (World Bank, 2008).

2. Physiographic and climatic features

Nepal can be categorized in six classes based on land use patterns. The categories and area coverage of these land use classes comprise: (a) cultivated agricultural lands - 21%; (b) uncultivated agricultural lands - 7%; (c) forest and shrubs - 40 %; (d) grassland and pasture – 12%; (e) water – 3%; and (f) others (snow, lake, urban, roads, etc), 18 %. The physiographic and climatic features of the country are described in the following sub-sections.

3. Physiography

Nepal has three physiographic zones, namely mountain, hill and Terai (Figure 1). These physiographic zones vary widely in their proportion of land use for agricultural purposes.

- **Mountain:** It is located in >2 000 m altitude and covers an area of 51 817 km^2. Only 9 percent of the area is used for agriculture and the rest belongs to other categories. Hence, only a small proportion of the population dwells in this zone. The agriculture is livestock based with little cropping. Conditions are extreme and food deficits are common.
- **Hill:** It is located between 330-2 000 m altitudes and covers an area of 61 345 km^2. It has around 42 percent of the agricultural land. The area is characterized by high ridges and steep slopes around numerous streams giving rise to many microclimates. The Hills account for about 50 percent of the population.
- **Terai:** It is located in <330 m altitude and covers an area of 34 019 km^2. Around 66 percent of the total land is under cultivation. Since, this zone alone produces 60 percent of the total food production in the country it is known as the granary of Nepal. Hence, about 45 percent of the total population dwells in Terai. Over 33 percent of the arable land is irrigated. The Terai soils are characterized by 20 to 30 cm thick, friable, generally dark brown top soil over light yellow or brown loamy subsoil. Soils are mostly acidic, well drained, clay loams or silty loam in texture. Sandy soils occur in the lower part of Siwalik range, which vary in degree of porosity and poor slope stability. Soils of the upper part of this range have developed on either sedimentary or metamorphic rocks. In steep and very steep dissected areas, the soils are usually eroded and stony. Soils of the river valleys have developed on a series of alluvial deposits and lacustrine sediments. Soils of Hills have developed primarily on igneous and metamorphic rocks. The soils are shallow, stony and rocky. The glacial soil group is found in the Himalayan region. The nutrient content of these soils is generally poor. The soils of eastern Nepal is acidic in nature and it goes on decreasing to western Nepal with some specific exceptions.

4. Climate

The climate varies from sub-tropical to alpine within a short distance due to tremendous variation in topography and altitude (64 to 8 848 m). The altitudinal variation has resulted into occurrence of all major bioclimatic zones of the world. These factors along with direction of mountain slope have created numerous micro-environments. Alpine, cool temperate, warm temperate, subtropical and tropical climates prevail in Nepal. The snow line lies on around 2 500 m altitude in winter and 4 000 m altitude in summer. Snow rarely falls below 1 500 m altitude. Snow remains considerably longer than on south facing slopes.

The average annual rainfall is about 1 600 mm, about 80 percent of which falls between June to September. The mean annual precipitation varies from more than 6 000 mm along the southern slopes of the Annapurna Himalyan range to the central part of the country to less than 250 mm in the northern central portion near Tibetan plateau. Most of the winter rainfall occurs during December to February. Total number of rainy days varies from 24 to 181 days. Annual sunshine hours vary between 922 to 2 820 hours. The recorded maximum temperature during the summer varies from 25°C to 46°C and the recorded minimum temperature during the winter varies from -26°C to nearly freezing point in the crop growing areas. Winter, spring, summer and autumn seasons, each of three months prevails in the country.

5. Population

Nepal is ethnically diverse and is a home to several races, tribes, languages, dialects, culture and religions. There are about 59 indigenous ethnic groups of people who speak 22 languages and 96 dialects. The Nepalese people belong to Indo-Aryan and Mongol races. Hinduism and Buddhism have molded the country's cultural fabrics. Nepal's population was 5.6 million in 1911 and currently it is estimated at 26 million with an annual population growth rate of 2.25 percent (MoF, 2008, CBS, 2003). The population growth rate has been in increasing trend since the first census in 1911. The population density has also been increasing from 38 persons per square kilometer in 1911 to 157 in 2001.

6. Main farming systems

Farming systems are the combination of different farm enterprises to which the farmer allocates his resources according to his desire preference and resources available. In Nepal, farming system has been crafted by factors like physiographic, climatic, social, cultural, economic and landholding size. Mixed farming system is the most dominant one owing to subsistence nature of agriculture. It blends all basic enterprises of farming system such as cereals, legumes, oilseeds, vegetables, fruits, flowers, bee keeping, sericulture, fishery, poultry, livestock etc.

The average landholding size is 0.8 ha. These are fragmented and widely scattered. It is mainly due to land being divided among heirs as per inheritance law defined in the Civil Code of the country. The agriculture is very much segregated due to small landholding. Most of the farmers are poor with low cash income which forces them depend on their own production inputs. In other words, they hardly can afford costly external inputs required for commercial farming. In general, crop production dominates farming systems and contributes about 75% of the agricultural output.

Prevalence of climatic and physiographic variations has led to integration of different types of crop and livestock enterprises. Major components of farming system are:

- Crops
- Livestock
- Forestry
- Other enterprises (poultry, livestock, fishery, bee keeping etc.)
- Farm Household

Since, Nepal possesses diverse climate and topography different components of farm enterprises have been integrated well in different types of climate with diverse types of productions. In all, there are three types of farming systems in Nepal as described below:

6.1 Hill and valley farming system

Historically, hills have remained homeland for traditional agriculture but there has been rapid migration of people to Terai owing to high population pressure in the fragile hill ecosystem. Hills occupy 42 percent of the land area of the country. This region includes valleys and terraced slopes in hills. It has low land to man ratio as compared to Terai. It has poor and difficult to access. The soils are very fertile with high organic matter content. Broadly, the hill comprises two land types, Khet and Bari (un-irrigated upland) lands. Khet land refers to lowland which is bonded and can be flooded to grow rice. Khet land has better production potential than Bari land. In Bari land, maize based cropping pattern is popular. Finger millet is often relayed with maize. In khet land, rice-based pattern dominates.

Many types of vegetable and fruits can be grown together with cereals and pulses. Livestock and forestry are the important components of crop husbandry mainly for obtaining milk, draft power, manure and fodder. Since lands in hills are sloppy, forests save the soil from erosion and help in water conservation. Hills are getting importance due to great potential for the cultivation of for off season vegetables. It has high scope for agricultural development specially those of fruits and vegetables.

FIGURE 1
Ecological regions of Nepal

Prepared by: GIS Section, Ministry of Agriculture and Co-operation; Map source: Survey Department

6.2 Terai farming system

This region is a fertile Gangetic plain land. It has easy access. It occupies 14 percent of total land area of the country. It has the most potential land where the staple food crops such as rice, wheat and maize are grown. Cereals are also staple foods of Nepalese people. Hence, this region is considered the "bread basket" of Nepal. The important cash crops grown in this area include vegetables, pulses, oilseeds, sugarcane, tobacco, jute and potato. In addition, several tropical fruits such as mango, litchi, jack fruit, pineapple, guava, banana etc are also grown. Buffalo, cow, goat, pig, poultry, fishery and vegetables are also integrated with cereal crop cultivation. Forests are also a very important component of the farming system.

7. Crops or plant products

Nepal is richly endowed with numerous agricultural crops and plants. The variation in temporal, altitudinal, topographical and aspects has made agricultural such biodiversity possible (Shrestha, 2007). Hence, Nepal is a safe heaven on earth for many plant and crop species even in the events of disasters of global warming in the planet. The agro-biodiversity in the country is so immense that this needs a time series study of ten to twenty years to enumerate all. It is mainly because the cultivation, gathering from the forests, food habits and consumption vary not only by ecological belts, hamlets and

ethnicity but it also vary with events of disasters especially during the droughts. People were found to have invented and adopted consuming and growing several kinds of food items to cope with such events which are cyclical (Shrestha, 2004).

The meager information on the enormity of plant and crop genetic diversities in Nepal to the world and the subsistence nature of agriculture have provided least incentive and momentum to make an in-depth studies on plant genetic resources in Nepal. Although, these are least documented but the massive use of plant and crop products prevails in practice. Few of them are listed in (Annex 1). The most common plant and crop groups used in the country are cereals, pulses/legumes, spices, condiments, beverages, fruits, vegetables, fibers and cash crops (Annex 2).

8. Degree of reliance on crops or plant products for domestic use and for exports

Agriculture faces a tremendous challenge of feeding some 26 million people and of being instrumental to their prosperity. In reality, it has remained subsistence oriented with lower productivity in the region. Rapid population growth amidst a scarce fertile land has led to intense pressure on the natural resources. As a result, encroachment in the marginal lands in the hills and mountains for agricultural use and conversion of prime agricultural land into non-agricultural uses in the plains has started signaling grave environmental repercussions. Its contribution to GDP is about 36 percent. Although agriculture's share in GDP has been declining, it is still the largest single sector of the economy while its position in terms of providing livelihoods to the great majority of the population has changed little over the years.

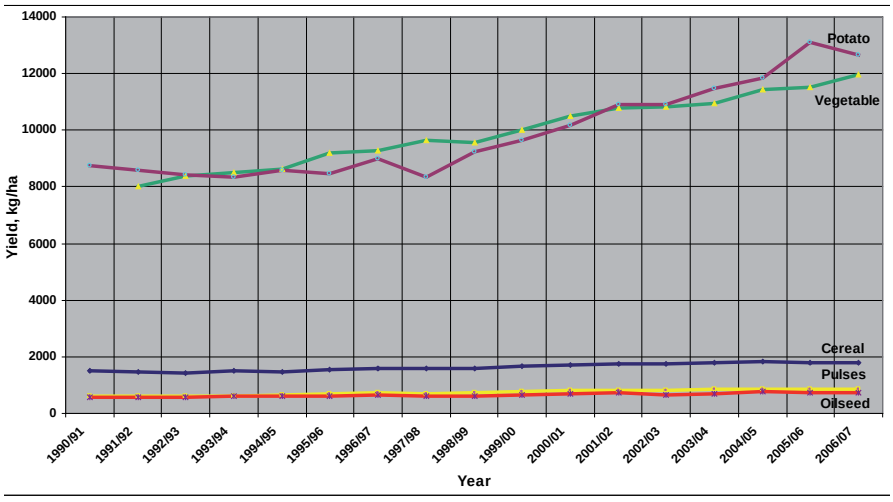
The country heavily relies on domestic production of crop or plant products. The deficit is met through imports mainly from India. About 15 agricultural commodities or products worth NRs. 13 653 200 000 were exported to India whereas 12 agricultural commodities or products worth NRs. 443 810 000 were imported from India in 2006/07 (MoAC, 2007). In addition, agricultural commodities or products are also exported and imported from overseas countries.

9. State of food security and trends

Availability of food is one of the important aspects of food security. In Nepal, there are persistently food deficit districts e.g. all districts of Karnali zone. This is the chronic food insecurity situation with high degree of vulnerability to famine and hunger. Availing food and increasing their access to food will eliminate such vulnerability. Now, food security has been considered a human rights issue in several countries of the world. Thus, food sovereignty and food security have been clearly spelt in the Interim Constitution of Nepal, 2063. It indicates the importance of food and the seriousness that the government has to put on increasing production and productivity of food and availing them to all the people. Once it is included in the judiciary law it becomes mandatory for the state to avail food for all the people.

The cereal crops (paddy, maize, wheat, millet and barely) constitute the major food items of the Nepalese people. An analysis of time series data of major food crops shows that no considerable increase in yield per unit area of cereal, pulse, oilseed, fruits and meat has been observed whereas the increase has been distinct in potato and vegetables which are emerging as commercial enterprises (Figure 2).

FIGURE 2
Yield Trend of Main Crops from 1990/91 to 2006/07



Nepal experienced food deficit till 1998/99. The country achieved positive food balance only after 2000/01 (Table 1). It is attributed mainly to consolidated approaches being taken as per APP, reforms made on policy, some efforts being made on human resource development through projects, and favorable weather conditions. Despite positive food balance in the country, 55 of the 75 districts (all mountain and hill and 2 Terai districts) were food deficit. Difficult terrain and poor road network in these ecological belts have severely constrained irrigation infrastructure development and supply of improved seeds and chemical fertilizers which are needed for increasing food production and thus attaining food security. This is attested by the low rank of such food deficit districts in terms of development indicators (SNV and ICIMOD, 2006). If such food deficit continues, the food security situation is expected to worsen further throughout the country in the years to come.

TABLE 1

Production, requirement and balance of staple food (edible cereal grain*) in Nepal

Year	Production, mt	Requirement, mt	Balance, mt
1992/93	3 292 126	3 633 724	-341 598
1993/94	3 585 112	3 723 722	-138 610
1994/95	3 397 760	3 882 915	-485 155
1995/96	3 913 878	3 948 229	-34 351
1996/97	3 972 587	4 079 135	-106 548
1997/98	4 027 349	4 178 077	-150 728
1998/99	4 097 612	4 279 491	-181 879
1999/00	4 451 939	4 383 443	68 496
2000/01	4 513 179	4 430 128	83 051
2001/02	4 543 049	4 463 027	80 022
2002/03	4 641 466	4 565 820	75 646
2003/04	4 884 371	4 671 344	213 027
2004/05	4 942 553	4 779 710	162 843
2005/06	4 869 440	4 890 993	-21 553
2006/07	4 815 284	4 995 194	-179 910

Note: Staple food or edible cereal grain includes rice, maize, wheat, millet and barley.
Source: Statistical Information on Nepalese Agriculture 2006/2007. Agri-business Promotion and Statistics Division of Ministry of Agriculture and Cooperatives, Kathmandu, Nepal, December 2007.

Paddy is the principle crop of Nepal because it occupies nearly 50 percent of the total cultivated land of the country. It contributes about 60 percent to total cereal production and 21 percent in Agriculture GDP (AGDP) (Annex 3). About 45 percent food consumption is made of this crop. More than 50 percent paddy is cultivated in rainfed condition indicating its high dependency on monsoon. Hence, the monsoon dictates the total food production in the country.

Since 2005/06, the paddy production situation in Nepal has been unfavorable due to frequent occurrence of unfavorable natural phenomena like drought, flood, landslide, hailstone, snowfall, windstorm etc. About 40 percent Terai paddy lands in eastern and central regions remained fallow due to weak rainfall (drought) during growing period and unexpected heavy rainfall during harvesting. The resultant effect was the reduction of about 0.5 million tons of rice based on the estimate of MoAC.

Maize stands in the second among the cereals and the fourth among the individual crops in terms of contribution to AGDP. Its contribution to AGDP is about 6.9 percent. It is the most important crop in terms of area and production for the hills. Seventy percent of maize is produced in the mid-hills region, eight percent in the high hill and 22 percent in Terai. Maize is the major cereal crop in the rainfed area which comprises 71 percent of the cultivated land. This also indicates that major share of agriculture production comes from rainfed land in which maize is dominant crop.

Wheat is the main winter and the third major crop. It contributes about 20 percent in total cereal grain production and 7.14 percent in AGDP. Its production also depends heavily on winter rain. Millet is an important cereal crop in the hills particularly of poor farm families who generally own relatively less fertile marginal lands. The bread or the pudding (Dhindo) made of millet flour gets digested slowly. Hence, the millet is liked by the poor people and it is considered the energy food of the poor people. The cropping intensity (around 160) and productivities of all these crops are low. This indicates a great scope for achieving food security by increasing production and productivity.

10. Brief Profile of agricultural sector

Agriculture is one of the most important sectors of Nepalese economy with considerable influence on the overall economic development of the country. It employs 66 percent of the labor force and contributes 36.1 percent to Gross Domestic Product (GDP) (MoAC, 2007). Although agriculture's share in GDP has been declining, it is still the largest single sector of the economy. Hence, this sector has a pivotal role for any attempt in raising income, alleviating widespread poverty, and uplifting living standards of the Nepalese people.

Farming is mainly of subsistence type mainly dependent on own farm inputs such as seed, manure and human and animal labor. Use of external inputs such as improved seeds, chemical fertilizers, pesticides, machineries and irrigation is very low. Only 40 percent of the cultivated area is irrigated and year round irrigated area is only 18 percent. Hence, dependency on monsoon is excessively high. The average landholding size is 0.8 ha and the yield per unit land is very low. Level of mechanization is very low due to small and scattered land holdings, poor road network, and subsistence nature of farming with low cash income. Despite several climatic and biodiversity advantages the level of commercialization is very low.

About 82 percent of the total land is allotted to food crops. The important food crops of Nepal are paddy, maize, wheat, millets and barley. Among them, the most important is paddy which occupies 50 percent of the total land devoted to food crops. About 80 percent of paddy is produced in Terai region. Maize, millet and potato are basically the hill crops. Sugarcane, jute, tobacco, tea, cotton, cardamom and fruits are the cash crops which occupy 18 percent of the total arable land. Most of these crops are produced in Terai. Lentil, pea, cowpea, soybean, green gram, black gram, chickpea, etc. are the important legume crops and mustard, rapeseed, linseed, groundnut, etc. are popular oilseed crops. In fruits, citrus, apple, walnut, mango, banana, peach, plum, pear, etc. are common. Different cole crops, cucurbits, solanaceous, legumes and leafy plants are used as vegetables. Fodder, spices and agro-forestry crops are also commonly cultivated.

11. Seed supply system

Seed supply system is not well developed because seed replacement rate is nearly 6 percent. Farmers select seeds from the crops grown for food. Exchange of seed among farmers is most popular. Since seed is both an input and a technology, the art or technique of seed production, beginning from source seed and site selection to husbandry and post-production including marketing, is crucial in terms of its quality, quantity and timely supply. Thus, it needs special consideration in terms of its supply both from domestic production and from imports. Realizing this, Government of Nepal (GoN) has executed some policy and regulatory measures to enhance seed production and supply system in the country.

National Seed Policy, 2056 (NSP) is the exclusive seed policy being enforced as per the decision made by GoN on the 3rd April 2000 to enhance crop productivity through the production, processing and effective distribution of quality seeds. The objectives of the policy are to:

- make seeds of different crops easily available in adequate quantity and quality;
- promote export through the production of quality seeds;
- make seed enterprises effective considering the existing international trade; and
- coordinate with other related institutions to protect the rights on and to continually maintain and conserve specialized genetic characteristics of Nepal's seeds.

Seed Act, 2045 was enforced on 26 October 1988 (10/07/2045 BS) and was amended on 24 January 2008 (10/10/2064 BS). The Act is not applicable for the entire country. As provisioned in the Clause 1 (1.2) of the Act, this becomes applicable only in the notified areas of the country. The Act was enacted to enhance production of different crops through the production, processing, testing and distribution of quality seeds to the people.

In the beginning, the Act was enforced only in Kathmandu, Lalitpur and Bhaktapur districts from 17 August 1998 as per the notice published in Nepal Gazette dated 14 August 1998. From the notice published in Nepal Gazette dated 14 January 2005, it was enforced from the same date to Taplejung, Panchthar, Ilam, Jhapa, Dhankuta, Morang, Sunsari, Saptari, Siraha, Dhanusha, Sarlahi, Mahotari, Rautahat, Bara, Parsa, Makwanpur, Chitwan, Nuwakot, Kaski, Nwalparasi, Rupandehi, Kapilvastu, Dang, Banke, Bardiya, Kailali, Baitadi, Darchula, Dandeldhura and Kanchanpur. The Act was enforced to increase production of different crops through the production, processing, testing and supply of high quality seeds to the general public.

As provisioned in the Act a National Seed Board has been established to advise the government to formulate and implement seed policy. The Board is authorized of regulating seed quality, approving and registering new seeds,

determining seed standards and issuing seed certificates.

Seed Regulation, 2054 was enforced on 8 January 1998 as provision made in Clause 24 of Seed Act, 2045 to implement the objectives of the Act. The Regulation has five sections, 23 clauses and nine Annexes.

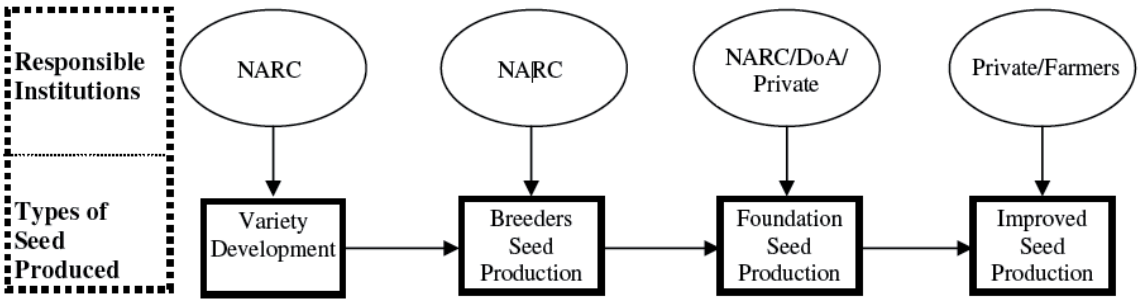
Contract Act, 2056 was enforced on 28 June 2000. The Act has 13 sections. Sections 7, 8 and 9 are most relevant for developing seed sector as a business. Section 7 relates with the contracts related to sales of commodities, Section 8 relates with contracts related to agency and Section 9 relates with transportation of commodities. These provisions are useful for developing seed as a business because agencies, sales and transportation are important apart from technical aspects of seed production. This ensures the seed producer farmers, purchase of their seeds at agreed price and at the same time it guarantees traders the supply of defined quality and quantity of seeds in a given period of time as per the contract.

The chain of variety development and seed production has been schematically presented in Figure 3. Nepal Agriculture Research Council (NARC) is mandated for developing variety and producing breeders' seeds. NARC research stations, commodity research programs, Agriculture Botany Division and Agronomy Division develop varieties and produce breeder and foundation seeds. Altogether, 248 varieties of cereals, legumes, cash crops, fruits and vegetables have been released for cultivation during 1960-2007 (NARC, 2007).

NARC, DoA, seed companies and private farms produce foundation seeds under the supervision of breeders and technical experts. Improved seeds are produced by private farms or farmers groups under the supervision of technical experts. Finally improves seeds are distributed among farmers though traders. Improved seeds are also disseminated through extension activities such as result demonstration, production demonstration, mini-kits etc.

Production of food crops has not yet been commercialized. However, vegetable seed production is emerging as a business. The government is trying to promote seed production through the implementation of policies, acts and regulations, and various program interventions such as District Seed Self-sufficiency Program and extension activities.

FIGURE 3
Variety development and seed production chain



12. Role of national and foreign private companies in seed supply

In Nepal, private seed supply sectors include seed producers, seed traders, seed distributors, and the farmers who grow and multiply seed for their own use or for sale or for local informal exchange. The formally traded sector accounts for 2-5 percent of annual seed requirement. In the vegetable seed sector, nearly half of the estimated seed requirement is commercially handled by formal channels with the private sector share estimated at four fifths.

In the past, Agriculture Inputs Corporation, a public undertaking, was engaged in supplying chemical fertilizers and seeds in the country. In 1999, GoN separated the corporation into National Seed Company Ltd. (NSC) and Agriculture Inputs Company Ltd. NSC was formally registered at Registrars' Office on 8 June 2002 under Company Act, 1996. NSC is one of the largest companies which supplies foundation and improved seeds of cereals (rice, wheat and maize), vegetables, oilseeds (rape seed), legumes (lentil and mungbean), jute and green manure (Berseem and Dhaincha) through domestic production and imports. In 2005/06 the company produced 7 000 mt. seeds of cereal crop alone (rice, wheat and maize 1 500, 5 000 and 500 mt respectively) (NSC, 2007). In addition, there are few private seed companies which mainly supply vegetable seeds through imports. One of the prominent one is Nepal Seed Company.

There is minor role of foreign companies in seed supply. There are few foreign private companies which have just started producing vegetable seeds in Nepal. The main objective of such companies is to produce seeds in Nepal for the export to other countries. The East West Company of Bangladesh is one such foreign company which is engaged in

production of vegetable seeds.

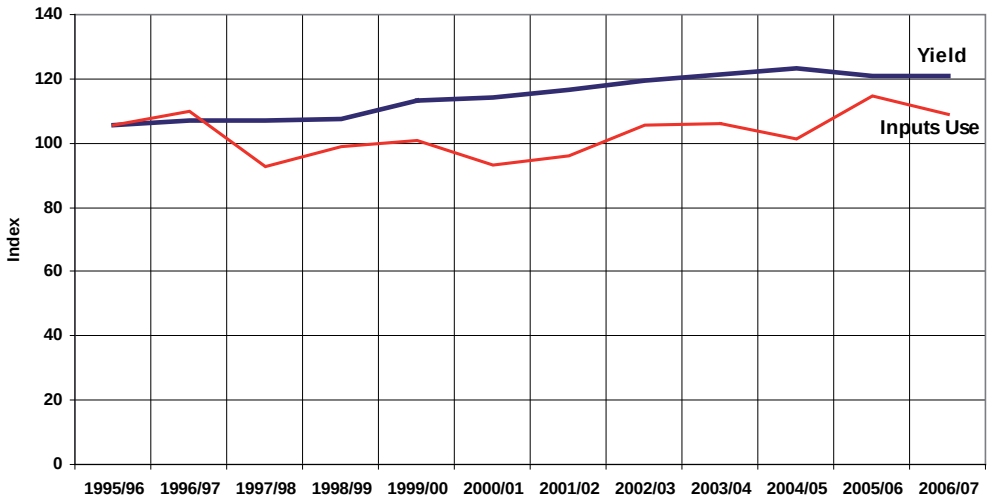
Fruit saplings are supplied through public and private farms. There are about 147 registered private nurseries which produce and sale fruit saplings. In the fiscal year 2005/06, the government farms sold 1 415 904 fruit and coffee saplings (FDD, 2007). Import of such saplings is negligible. Seed or planting material of the industrial crops such as cotton, sugarcane, tobacco and tea are handled mainly by the relevant industrial organizations.

13. Recent trends in crop or plant production and main reasons for observed changes

An attempt has been made at analyzing the time series data (1992/93 to 2006/07) of major cereal crop yields in order to analyze trends in crop and plant production in relation to use of major inputs of irrigation, chemical fertilizers and improved seeds. The index of yield and inputs has been computed for trend analysis. There has been gradual increase in the yield of cereal crops over time but such increase has not been impressive (Figure 4). The trend in the index of these inputs plotted with the trend in yield index could not show clear relationship. Hence, index of these inputs were disaggregated and were plotted with the yield index of cereal crops (Figure 5). This showed somewhat clear relationship with the increase in the yield and the major inputs being considered for analysis. Irrigation has been observed one of the important inputs for the increase in cereal crop yield. It was attested from the fact that both chemical fertilizers and improved seeds were observed same or declining but the irrigation was increasing over time. Hence, irrigation has been one of the important factors for positive trend in cereal crop yield. It calls for special attention to be paid on irrigation development in the country in order to enhance cereal crop yield.

FIGURE 4

Trend in cereal crop yield and inputs (Improved seed, chemical fertilizer and irrigation) use (1992/93- 1994/95 =100)



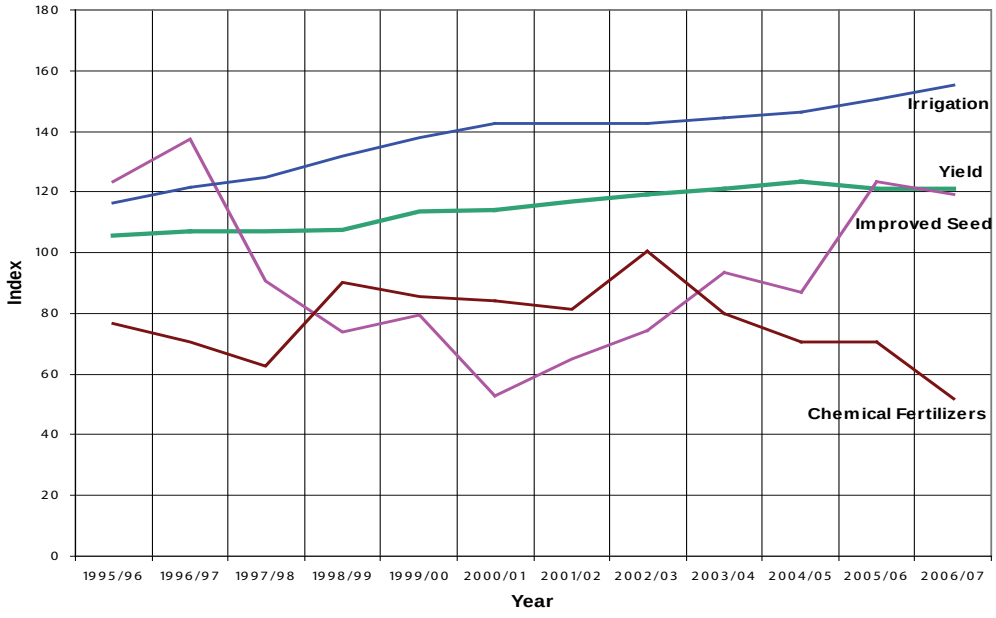
Irrigation is a critical input for crop production. The total irrigated area in the country is 1 031 137 ha which accounts for 33 percent of total cultivated area of 3 091 000 ha. Out of total irrigated land only about three percent has year round irrigation facility. It indicates considerable scope for improvement in the current status of irrigation system from seasonal to year round irrigation together with the expansion of irrigated area. Hence, considerable increase in crop yield can be achieved with the intervention in irrigation system management and expansion of irrigated area. More importantly, impressive growth in irrigated area does not match with the growth in yield (Figure 5). This indicates the need for improvement in cropping pattern, crop intensification and on-farm water management.

The total use of improved paddy, wheat and maize seeds in 2005/06 is estimated at 3 514 mt whereas that of vegetable, lentil, jute and others is 37 mt. In terms of area under these cereal crops, the improved seed covered only one percent. Hence, efforts should be made at the seed multiplication and distribution program in order to increase area under improved seed for enhancing crop productivity.

The most commonly used commercial fertilizers in Nepal are Urea, Diammonium Phosphate, Complex, Muriate of Potash, Ammonium Sulphate and Triple Superphosphate. However, their current use is only 40 kg per ha. Hence, the fertilizer deregulation policy should be revisited in order to increase farmers' access to chemical fertilizers to enhance crop productivity.

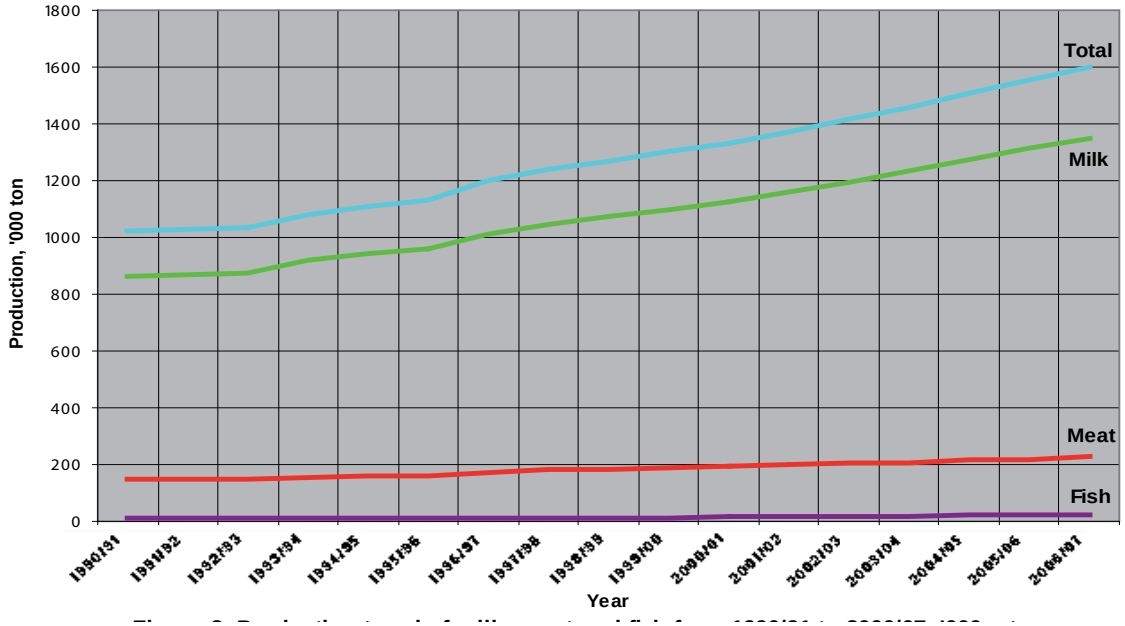
FIGURE 5

Trend in cereal crop yield and irrigation facility chemical fertilizer and improved seed uses (1992/93- 1994/95 ==100)



The trend analysis has also been done for milk, meat and fish production that constituted the main source of animal protein. Total production of these commodities has been impressive (Figure 3). Their total production in 2006/07 is estimated at 1 602 000 mt. The milk has the largest share of 84.4 percent in the total production and it was followed by meat, 14.1 percent and fish, 1.5 percent. The per capita milk, meat and fish production is estimated at 50.7, 8.5 and 0.9 kg respectively. These are emerging as commercial enterprise and as food security supplements in Nepal owing to increasing trend in fodder cultivation and stall-feeding, increasing use and availability of crop residues as fodder, increasing corn production as poultry feed, and increasing access to veterinary services.

FIGURE 6
Production trend of milk, meat and fish from 1990/91 to 2006/07, '000 mt



14. Methodology used for preparing this Country Report

The following steps were undertaken for preparation of the country report:

- The ministry of agriculture identified a focal point for contact between Nepal and FAO, Rome. A senior scientist from Nepal Agricultural research Council (NARC) was identified as the focal point for the purpose (Annex 4).
- A team of nationally available experts (11) from government and non-government organizations were identified by the focal point after interaction with Joint Secretary, Planning Division and Director, crops and horticulture research, NARC.
- Several meetings of the experts were organized to prepare a draft report.
- A national committee was established (10) to review and finalize the country report. The committee consists of representative stakeholders from GO, NGO and private sectors.
- The focal point submitted the report to NARC and then finally to the MoAC for official endorsement and submission to the FAO.

CHAPTER 1

THE STATE OF DIVERSITY

1.1 The main values of plant genetic resources

1.1.1 Importance of crops and products derived from them

The agricultural crops grown in Nepal are broadly divided into two groups; food crops and cash crops. The major food crops are paddy, maize, wheat, millets, barley, pulses and potato. Paddy, being the most important crop of Nepal, covers 55 percent of the land allotted to food crops. Cash crops occupy 18 percent of the arable land. Important cash crops include sugarcane, jute, tobacco, tea, cotton and cardamom. Most of these crops are produced in the Tarai. Legume crops grown in the country include lentil, pea, cowpea, soybean, chickpea, green gram and black gram. Mustard, rapeseed, linseed, groundnut etc. are some important oilseed crops. In fruits, citrus, apple, walnut, mango, banana, peach, plum and pear are common. Vegetable crops include cucurbits, solanaceous species such as tomato, potato, legumes and some leafy vegetables such as green mustard. Spices and agro-forestry crops are also common. About 80% of paddy is produced in the Tarai region of the country. Maize, millet and potato are basically hill crops.

1.1.2 Relative importance of the different crops and their product

About 21% (3.2 million hectares) of the total land area of Nepal is used for cultivation and the principal crops are rice (45%), maize (20%), wheat (18%),millet (5%) and potatoes (3%), followed by sugarcane, jute, cotton, tea, barley, legumes, vegetables and fruits. Crops such as rice, rice bean, egg plant, buckwheat, soybean, foxtail millet, citrus, and mango have high genetic diversity relative to other food crops. Crop species in Nepal owe their variability due to the presence of about 120 wild relatives of the commonly cultivated food plants and their proximity to cultivated areas have listed 60 food species (fruit, vegetables, legumes) and 54 wild relatives of food plants.

Nepal is endowed with natural wealth such resources are not duly used for the alleviation of poverty and misery of the people. There is widespread poverty and malnutrition in food security in many parts of the country. Nepal stands 31st in world ranking in terms of biodiversity. It is a home for 10 percent of the worlds' bird species, 2 percent (7 000 species) of the worlds' flowering plants and 5 percent (246 species) of the world's flora. Besides, about 200 species of commercially important medicinal and aromatic plants, 5 000 species of insects, 185 species of fishes, 400 species of agro-horticultural crops, 60 species of wild edible fruits and 300 species of orchids.

TABLE 2
Important crops and derived products

Important Crops	Derived Products	
	Terai	Hills
Rice	Bhat, Chiura, Bhuja, Roti	Bhat, Chiura, Cell, Jhand, Khatte
Wheat	Bread, Puri, Malpowa, nuddles	Roti, Dhindo,
Maize	Bhuja,	Dhindo, Roti, Khole
Millet	Roti	Dhindo, Raksi, Jand
Potato	Vegetable, chips, pakoda etc.	Vegetable, boiled
Citrus	Pickles,	Pickles
Mango	Pickles, ripen fruits eaten as raw	Ripen fruits eaten as raw

TABLE 3
The relative importance of different crops in different regions

Terai	Hills	Mountains
Cereals		
Rice	Maize	Maize
Wheat	Millet	Millet
Maize	Rice	Barley
Barley	Wheat	Buckwheat
Legumes		
Lentil	Soybean	Beans
Pigeon pea	Black gram	Rice beans
Chick pea	Lentil	
Black gram	Rice bean	

1.2 Diversity within and between crops

1.2.1 The state of diversity of major crops

The nation is endowed with rich diversity in cereals, grain legumes, vegetables, fruits etc. At least 4 species of wild rice named O nivara, o. rufipogon, O. granulata and O. officenalis, two wild relatives- Hygroryza aristata and leersia hexandra and several types of weedy rice O. sativa f. spontanea exist in the Himalayan Kingdom. Wild relatives of wheat are available in the hilly and mountainous region. There is a possibility of harbouring greater genetic variability of wheat because of its proximity to the secondary source of origin. Studies have revealed high tillering attribute and greater dormancy period in the traditional/ obsolete wheat varieties. Aegiolops and agropyrum species have been documented. Similarly, diversity in maize is also noteworthy. It may be attributed to the rich specific adaption of the crops in hills and mountain region. The variations in grain color, husk cover, maturity, adaptative trait to intercropping etc. are observed in farmers grown varieties. However, increased human population pressure, poverty, land degradation, environmental change, the introduction of modern cultivars and national policy have contributed to the erosion of crop genetic resources in Nepal.

In case of major crops of the country, many landraces are being lost and many of them are under threat and many endangered rare and endemic species should get due attention for effective conservation. The genetic diversity in high hill has been maintained due to specificity of landraces, undisturbed forests, remoteness etc. while in Terai area e.g. Kapilbastu and Banke districts level of genetic erosion is maximum in the major crops. Many rice landraces like Anadi, Tauli and Thapachiniya are vanishing from general cultivation. Overall diversity of major crops is decreasing trend and genetic erosion is apparently visible.

TABLE 4
Status of rice landraces in Seti River Valley

Widely grown landraces	Landraces under threat	Landraces lost over time
Jethobudho	Pakhe jhinuwa	Thimaha
Gurdi	Basaune jhinuwa	Tauli
Aanadi	Bayarni	Darmali
Panhele	Panhele jhinuwa	Germani
Gayria	Marshi	Koili
Biramphool	Gudura	Budho thakale
Ramani	Bardani	Ghote
Mansara	Batti sara	Salidhan

Widely grown landraces	Landraces under threat	Landraces lost over time
Aanpjhutte	Pokhreli jhinuwa	Jhauri
Jerneli	Pagate jhinuwa	Thapachinia
Khaltekholo	Phante silange	Bhamgera

1.2.2 State of diversity of minor crops in Nepal

Major crops and underutilized species are grown all over the nation. Diversity exists in variety and species levels. The list of underutilized species is quite large. Available information indicates among its 60 reported species of amaranth in the world at least 11 species have been reported with cultivated types for grain, green vegetables, wild and weedy types. Among 32 species of *Hordeum* species described around the sorld, only 3 species have been reported. *Hordeum vulgare* is the only cultivated species and the rest two are wild type. Covered and naked barley are commonly available and used for diverse purpose including religion use of the train by rural and urban community. Diversity in buckwheat (*Fagopyrum* sp.) and finger millet (*Eleusine* sp.) in wild and cultivated form has been described by several authors. National Hill crops Research Program and Agriculture Botany Division have undertaken research activities in there crops.

1.2.3 State of diversity of wild plants for food production in Nepal

Nepal, being proximal to the original and secondary sources of origin of different cultivated plants, has harbored numerous wild relatives of cultivated agricultural crop plants like rice, wheat, barley, buckwheat, citrus and other fruit crops, several vegetable crops, etc. It is reported that 83 different wild relatives of 46 genera under 18 families of 36 agricultural crops exists in the country.

Besides major crops, different wild species of grain legume crops were found in Nepal. In Kakani Mountain near Kathmandu valley is the forest of *Atylosia* species. Similarly, Literatures indicate that at least 4 wild species of *Atylosia*, 3 wild species of *Cicer* and 5 wild species of *Lathyrus* have been reported. These wild species are locally used as fodder & feeds, ornamental plants, etc.

Numerous wild relatives of fruit crops are found as the wild habitants in the temperate region of Nepal. At least, 9 species of *Prunus*, 3 species each of *Castanopsis, Malus, Morus, Pyrus* are mentioned as temperate wild fruit relatives in the country. It is also observed that wild mango *Mangifera sylvatica* in the Lothar forest of Chitawan district while searching for wild rice *0. granulata* during mid 1980s. Wild banana, *Musa nepalensis* is found in the lower hills of Churiya range. There is ample scope for selection of promising clones from these existing wild relatives through systematic evaluation and selection. They are the building blocks of new varieties.

Nepal already observed considerable genetic erosion of plant genetic resources due to mismanagement of developmental process. Status of wild species indicates decreasing trend because of loss of habitat. Continuous deforestation and over exploitation of natural habitats by the ever increasing population.

There are many wild relatives of cultivated plants in Nepal. But they are not properly surveyed, identified and catalogued.

Loss of diversity enhances vulnerability to pest and diseases. This is one of the most serious issues related to monoculture with uniform crop or less diversity. Insurgence of Brown Plant Hopper in districts of Terai during in 1998 and 1999 was attributed to declining rice diversity. Modern varieties like CH-45 and Mashuli were damaged by the pest.

1.2.4 Wild relatives of vegetable crops in Nepal

Nepal is a land of extreme with her geo-edapho-climatic variability. Almost all types of world climate and a wide range of bio-diversity exist. Leaving aside the vast number of micro flora, the larger plants group alone is believed to be existing as 7 thousand in species. In case of food plants, 172 families, 296 genera, 599 species and 35 sub-species are found in the country. Out of them 60 families, 155 genera, 225 species and 31 sub species are in cultivation and rest is in wild states. Out of 599 species of food plants 400 species belongs to horticultural groups of which 200 species are vegetable crops. Out of 200 only 50 species are in cultivation. The vast number of wild relatives or species are ignored or remained unknown.

Wild relatives of vegetable crops recorded in Nepal are *colocasia* (3 *spp.*), *Amaranthus* (4 *spp.*), *Chenopodum* (2 *spp.*), *Rumex* (3 *spp.*), *Pisum* (3 *spp.*), *Allum* (3 *spp.*), *Ipomoea* (5 *spp.*), *Dioscorea* (4 *spp.*), *Mentha* (3 *spp.*), *Trigonella* (2 *spp.*), *Solanum* (2 *spp.*), *Curcuma* (5 spp.). It is an irony that we are lack of awareness and attraction towards our own precious green wealth. Many of our specialists, policy makers and experts of agro-horticultural phenomena miserably fail to recognize

our indigenous crop plant resources due to lack of information, ignorance about the nutritional and economical value and lack of research work. The most important is the lack of Nepal mind. The present need of the policy maker is to give due consideration towards the collection, documentation, preservation, evaluation, maintenance, multiplication and utilization of this wild but precious wealth of nation before signing the World Trade Organization (WTO).

1.2.5 Wild relatives of fruit crops in Nepal

Wide spread diversity within a very short space has provided Nepal with about 7 000 species of flowering plants. Of the total identified 71 wild relatives of food crops under 42 genera of 28 families, 43 species are the habitants of the temperate region. Nine species of *Prunus*, 3 species each of *Catanopsis, Malus, Mores* and *Rubus* and 2 species each of *Barberies, Ficus, Hippophae, Olea, Pyrus* and *Vitis* are tabulated as temperate wild fruit relatives. Similarly, subtropical and tropical wild fruit relatives having more than one species are *Annona, Citrus, Mangifera, Musa, Foenix* and *Rhus.* Many of these wild relatives can be utilized for some purpose or others. There is ample scope for selection of promising clones from these existing wild relatives through systematic evaluation and selection. They are the building blocks of new varieties. Many of them have been already utilized as root stock in fruit plant propagation. Some of them bear inhabiting the forest of Nepal is still unknown or even if known, has hardly been explored.

In Nepal, the harvest from forests or the wild is a major source of medicine, food and nutrition for ethnic communities like Chepang, Rai, Sherpa and Gurung. The indigenous knowledge of the Rai and Sherpa communities indicate that they use 47 wild species for household consumption, 38 for fodder, 19 for medicine, 5 for religious and ceremonial purposes, 11 to make household implements, and 11 for trade as raw and processed materials.

1.2.6 Threat of genetic vulnerability

Agricultural policy of Government of Nepal (GoN) and Agricultural Research Strategy promotes deployment of diversity to reduce the threat of genetic vulnerability. The combined efforts of National Commodity Research Programs are National Seed Board have been successful in releasing location specific and wide adaptive varieties with diverse genetic background. However, the vulnerability of genetic resources in food and agricultural crops species is clearly visible in the Terai and mid hills where improved agricultural technologies are popular among farmers. A gradual disappearance of landrace/ plant species can be observed in all the following.

- Landraces of crops such as rice, maize, wheat, cabbage, cauliflower, cowpea and potato
- Native cultivated species such as *Paspalum scorbiculatum, Vigna angularis, Lathyrus sativus, Setaria italica* and *panicum miliare*
- Related wild species of cultivated crops
- Medicianal plants such as *Cinamonun, Cordiceps, Dactylorhiza, Nardostachys, Rauwolfia* and *valeriana*
- Forest trees such as *Shorea, Cedrela, Elaeocarpus, Larix, Magnolia* and *rhododendron*.

1.2.7 The trend of landraces/farmers' variety in Nepal

The diversity of Landraces is decreasing due to introduction of high yielding varieties, changing in landscape, low grain yields, lodging problem in landraces, economically less profitable, low yield potential and less responsive to chemical fertilizer.

1.3 Factors influencing the state of plant genetic diversity

1.3.1 Changes in relative importance of various crops

Relative importance of few crops namely lentil and chickpea has changed own the past 10 years. The increasing national and international demand for lentil for home consumption and cosmetic led to transformation from minor or neglected pulse crop to major pulse crops. Currently, lentil occupies nearly 60 percent of area covered by grain legume. The cultivate area of chick pea is declining largely due to botrytis. The demands of the crop remain high but are coverage is pushing the crop to minor crops.

1.3.2 Assessment of genetic erosion of PGRFA

The national programs have not assessed the genetic erosion of the plant genetic resources on regular basis. However, the data area coverage/ spread of modern varieties reported by the coordinators of the country programs are used as the indicator to assess the level genetic erosion. Baseline survey (PRA, RRA) focus group discussion and secondary date used in R & D projects are used as reference to indicate the status of the loss of diversity. Plant Genetic Resources Section in Agriculture Botany Division collects preliminary information for the purpose during survey and exploration mission. (Annex 5).

Factors of endangering the genetic diversity of local varieties:

- Introduction of modern varieties and exotic crops.
- Land conversion to industrial agriculture and urbanization.
- Deforestation and distribution of wild species habitats
- Market pressure for few preferred varieties
- Low yield potential of farmers varieties

1.4 Future needs and priorities

1.4.1 Priorities for improving understanding of the state of diversity of PGRFA

Undertake eco-geographic survey for assessing distribution of diversity

- Assessment of genetic erosion and genetic vulnerability
- Diversity assessment at molecular and phenotypic level.
- Human resource development
- Scientific database management
- Establish communication network

1.4.2 Capacity building needs to enhance assessments of the state of diversity of PGRFA

Loss of genetic diversity is the common threat to the sustainable use of plant genetic resources to meet the present needs and aspiration of future generation. Genetic erosion is apparent in the country. *Tauli, Marshi* and *Thapachiniya* the popular rice varieties of Kathmandu valley are not available in farmer's field. The spread of high yielding varieties have contributed to the gradual disappearance of landraces. While progenitors and other wild species depict the same story. *Oryza nivara* and *Oryza ruffipogon* are on the verge of extinction from *Ajigara* Tall of *Kapilvastu* district. Deforestation, land encroachment and urbanization have further increased the pace of genetic erosion. National legislation and increased awareness to safeguard the valuable assets that Mother Nature had provided to us would minimize the pace of genetic erosion.

To enhance assessments of the state of diversity of plant genetic resources including ways to better assess genetic erosion and understanding of the causes of erosion following capacity building needs to be taken.

- Institutionalization of PGR system in the nation
- Capacity development in diversity analysis, genetic erosion, taxon identification, ethno-botany etc.
- National, regional and global collaborative projects to promote bio-prospecting.

1.4.3 Priorities to better understand the roles and values of the diversity of PGRFA

It is essential to better understand the roles and values of the diversity of plant genetic resources in terms of economic, social, cultural and ecological value. Understanding the ecological services and the diverse values of the diversity would promote the conservation and sustainable use of the valuable plant genetic resources. This has remained as the major challenge for the gene bank managers to estimate economic values of genetic resources: the information often asked by policy makers and politicians.

1.4.4 Priorities to improve monitoring of genetic erosion and improve the response to observed erosion

- Develop early warning system for genetic erosion.
- Link national gene bank with community gene bank
- Creation awareness to the local communities
- Maintaining biodiversity register recognized by national legislation.
- Organize biodiversity fair on regular basis with help of extension workers
- Human resources development
- Joint regional collaborative projects.

1.4.5 Methods to analyze and assess PGRFA erosion and vulnerability

The following methods have been employed to analyze and assess plant genetic resources genetic diversity, erosion and vulnerability in the country:

- Crop based survey of plant genetic resources using participatory tools
  - Field level
  - Household level
  - PRA
  - RRA
  - Focus group discussion.
- Community biodiversity register

1.5 Obstacles to use available methods to assess PGRFA erosion and vulnerability

- Inadequate trained staff deputed in genetic resources
- In declining numbers of taxonomist
- Limited awareness on the value of genetic resources
- Lack of regional collaborative efforts to assess diversity
- Lack of national action plan for plant genetic resources

These obstacles could be overcome by:

- Collaboration and linkages at local, regional and global level
- Capacity building
- Raising awareness at community level
- Strengthening community based organizations to manage genetic resources.
- Develop and implement national action plan in plant genetic resources.

CHAPTER 2

THE STATE OF *IN SITU* MANAGEMENT

2.1 Inventories and surveys

2.1.1 Assessments and priorities

On-farm (*in situ*) conservation of landraces refers to plants and its wild relatives that are conserved in the very place where they develop their present day characteristics. It includes the conservation of entire agro-ecosystem, including cultivated crops as well as their wild and weedy relatives that may be growing in nearby areas. The conservation system describes a management process by which farmers maintain the traditional crop varieties that they develop in their local conditions and continue to manage and improve. It also empowers the farmers to exercise control over their plant genetic resources as the major biological asset and use it to improve their livelihoods. It remains a powerful strategy to integrate a farming community into the national PGR system.

2.1.2 Actions taken to improve inventories and surveys of plant genetic resources, crop-associated biodiversity and wild plants for food production

Realizing the global concern for agrobiodiversity conservation, Nepal Agricultural Research Council (NARC) and Bioversity International (Former, IPGRI) initiated the Nepal component of the global project on "Strengthening The Scientific Basis of *In Situ* Conservation of Agricultural Biodiversity" in 1997 in three eco-geographical regions Jumla (High hill), Kaski (Mid hill) and Bara (Terai) The objectives of the project were to generate understanding of farmers decision making processes for *in situ* conservation of domesticated crops along with habitats of their adaptation, strengthening national capabilities to carry out research activities in the area and enhancing the value of agrobiodiversity by direct involvement of farmers and other stakeholders. During the implementation of project, Participatory Rural Appraisal (PRA), followed by baseline surveys and diversity fairs were carried out to assess the farmer's knowledge and perspective of the amount and distribution of diversity maintained on- farm in three ecosites. Further, the Participatory Plant Breeding (PPB) program was also initiated with the aim of understanding farmers' selection criteria, encouraging and strengthening farmers' participation in variety development, and offering to farmers a wide range of material adapted to their specific natural and socio economic condition. The good practices of the *in situ* conservation program i.e. Community seed bank and community biodiversity register also played a supportive role to improve the inventories and survey of the PGRFA in Nepal. Ministry of Forestry and Soil Conservation (MoFSC) with the support of Ministry of Agriculture and Cooperatives (MoAC) have initiated to inventories and survey of PGRFA and other components of biodiversity in more than twenty districts of Nepal. A format to collect information in Biodiversity Register has been endorsed the Government of Nepal.

2.1.3 Constraints to improve inventories and surveys for plant genetic resources, crop associated biodiversity and wild plants for food production

The major constraints of improving inventories and surveys for plant genetic resources, crop associated biodiversity and wild plants for food production are: Lack of fund, inadequate efforts to use biodiversity register for the benefit of communities and nation, lack of national legislation, lack of appropriate incentive mechanism and the weak linkages of formal institutions with the community.

2.1.4 Ecological functions of crops and crop-associated biodiversity

The role of biodiversity in agricultural and natural ecosystems is to ensure food security and sustainable agricultural production through direct or indirect provision of food for humans and their livestock. Agro-ecosystems modified by

human beings, produce food, fiber and other agricultural products. These systems are often structurally and dynamically complex, and their complexity arises primarily from the interaction between socioeconomic and ecological processes.

The major ecological functions observed from crops and crop associated biodiversity are:

- Purification of air and water,
- Soil formation and fertility maintenance,
- Nutrient cycling,
- Maintaining pollination

The minor functions observed from crops and crop associated biodiversity are:

- Hydrological regulation,
- Medicinal plants for pharmaceuticals,
- Protection from harmful uv rays, etc.
- Seed dispersal and pollination,

2.1.5 Priorities for future inventories and surveys of plant genetic resources, crop-associated biodiversity and wild plants for food production

Priorities for future inventories and surveys of *in situ* plant genetic resources, crop-associated biodiversity and wild plants for food production collections over the next 10 years are:

- Registration of biodiversity in all the districts covering ethnic and ecological diversity.
- Endorsement of national legislation on access of genetic resources and benefit sharing by the constitution assembly.
- Creating a forum and/ or an institution for innovation in genetic resources and traditional knowledge.
- Capacity building.
- Generating technical and financial supports
- Providing incentives/ economic benefits to farming communities for their roles in conservation and sustainable use of PGRFA.

2.1.6 Capacity building needs and priorities to support inventory and surveys for plant genetic resources for food production

The capacity building needs and priorities of the county to support inventory and surveys for plant genetic resources, crop-associated biodiversity and wild plants for food production are:

- Strengthen documentation system and human resources form local to central levels.
- Establishing an institution to promote, use and innovation of resources and knowledge and supporting inventory and surveys initiatives.
- Sensitize and empower farming community for maintaining inventory and surveys.
- Develop a system of sharing with the community the findings of innovatory and surveys.
- Strengthen taxonomic identification skill and knowledge on wild pants.

2.2 On-farm management and improvement of plant genetic resources for food and agriculture

2.2.1 On-farm management of PGRFA in Nepal

The nation has addressed the issues of on-farm management of PGRFA by identifying good practices of conservation and sustainable use of PGRFA. These practices are being replicated in three mid and far western districts of Nepal through institutional arrangement of Ministry of forest and soil conservation and ministry of Agriculture and Cooperatives. However, realizing the level of diversity in the nation, the present effort is quite limited to mobilize stakeholders involved in conservation and use of PGRFA.

2.2.2 Incentives to promote on-farm management of PGRFA

There is no subsidy mechanisms in place to promote on-farm management of PGRFA in Nepal. But the *in situ* conservation program has built a model to link *in situ* conservation with genetic, socioeconomic and ecological benefit to farming communities. These models identify several good practices to provide benefits to farming communities through breeding and non breeding approaches.

2.2.3 National/regional forum for stakeholders involved in on-farm conservation

A national forum for stakeholders involved in on-farm conservation has been created by officially establishing the National Agrobiodiversity Conservation Committee as the apex policy body to promote conservation and sustainable use of agrobiodiversity. The committee is composed of 17 members headed by the secretary of the Ministry of Agriculture and Cooperatives. It encompasses stakeholders form GO, NGO, Private sector, academic institution and farming community.

2.2.4 On-farm participatory plant breeding programmes in Nepal

The government of Nepal has encouraged Participatory Plant Breeding (PPB) programmes. PPB is considered as a strategy to strengthen the process of on-farm conservation by encouraging farmers to continue search, select and manage local crop populations. Participatory variety selection scheme has been extensively used to promote deployment of diversity.

2.2.5 Support to develop local or small scale seed production

Seed is the basis of national food security and seed based technologies offer easiest and cheapest options of increasing crop diversity. In national context, the bulk of seeds used are farmer saved seed from previous harvest or acquired form neighbors. The seed replacement rate of quality seed of cereal crops in 2006 was 6% through formal institution system. Thereby, significant emphasis has been given to develop local or small scale seed production. Community based seed production groups and district level seed self- sufficiency program have been launched for increased access to quality seed in the farming community. Special attention has been given to address the issues of food price rise through ensuring seed security/ seed bank.

2.2.6 Additional actions support on-farm management

- Implementation of "one village, one product" programme in rural community.
- Development of markets for products originating from traditional and underutilized varieties and crops
- Changes to national policy frameworks
- Awareness activities
- Inclusion in source curriculum.

2.3 Restoring agricultural systems after disasters

2.3.1 Mechanisms to replace plant genetic resources for food and agriculture following disasters

Nepal has faced several disasters in the forms of flood, landslide, hailstones, earthquake and fire. The government of Nepal has established "National Disaster Relief Fund" and Honorable Prime Minister is the Patron of the fund. The fund has been judiciously utilized through inter ministries coordination. The Ministry of Agriculture leads the relief activities through its line agencies involved in research and development work. Normally, the modern technologies including varieties of crops and inputs are made available to the farming communities. The major emphasis is on rehabilitating the people and agriculture system in earlier state to support the food security issues and livelihood of the people. Normally, the process contributes to enhanced genetic erosion of traditional PGRFA.

2.3.2 The major constraints to establishing effective plant genetic resources disaster response mechanisms

The major constraints to establishing effective plant genetic resources disaster response mechanisms are the:

- Lack of buffer stock to supply the seed of PGRFA
- Limited awareness of need of PGRFA disaster response mechanism
- Lack of policy and institutional mechanism/ initiatives to restore PGRFA
- Insufficient fund
- Low priority for conservation of PGRFA
- Lack of system for maintaining PGRFA duplicates.

2.3.3 Needs and priorities to improve plant genetic resources disaster response mechanisms

Nepal's needs and priorities to improve plant genetic resources disaster response mechanisms are the:

Short term needs and priority:

- Establishment of buffer stock for seed including local varieties

Medium term need and priorities:

- Develop mechanism and policy to mange PGRFA in disaster period.
- Increased priority for conservation of PGRFA.
- Establish regional and international collaborations for disaster management of PGRFA

Short-Medium term needs and priority:

- Increased availability of fund to promote conservation and use of PGRFA

Long term needs and priority:

- Enhance awareness

Medium – long term needs and priorities:

- Develop infrastructure facility and human resources for maintaining duplicates of PGRFA.
- Linking national gene bank with disaster response mechanism.

2.3.4 Requirement to improve regional and international disaster response mechanisms in Nepal

To improve regional and international disaster response mechanisms are:

- Establish a Global Forum for responding to disaster situation specially FAO should promote the initiative.
- Regional country members should establish a functional forum in the regional umbrella like SAARC, since the origin and distribution of PGRFA soes not follow the rules of political boundary.
- Maintain buffer seed stock at regional level.
- Increased regional and global activities to promote conservation and sustainable use of PGRFA in disaster prone areas.

2.4 *In situ* conservation of wild crop relatives and wild plants for food production

2.4.1 The actions to encourage and support *in situ* conservation of plant genetic resources, crop-associated biodiversity and wild plants for food production

- Local seed systems are being supported by GO and NGO system
- Participatory plant breeding programmes have been initiated by GO and NGO

- Course curriculums have been developed in academic institutions.
- National Agricultural Policy, 2004 and National Agrobiodiversity Policy, 2007 that support the management and use of crop diversity in agro-ecosystems have been endorsed by government of Nepal.
- Methodologies for integrating locally adapted crop cultivars and farmer preferences into development and extension activities have been developed.

2.4.2 The limitations to *in situ* conservation of plant genetic resources, crop-associated biodiversity and wild plants for food production

- Significant changes in the land use pattern.
- Availability of seed of traditional varieties i.e. access to seed
- Developing markets for traditional crops and cultivars
- Insufficient fund for supporting informal seed supply system
- Inadequate awareness of the significance of *in situ* conservation.
- Limited PPB activities to promote use of PGRFA
- Limited biodiversity registration Initiatives.
- Lack of integration of agrobiodiversity activities in rural develop programmes.

2.4.3 Priorities and needs to enhance *in situ* conservation

- National priorities and need to enhance *in situ* conservation are:
- Enhance conservation of PGRFA through use of PPB/COB in national programmes.
- Develop incentive mechanism to farmers/ farming communities by ensuring farmers rights and benefit sharing mechanism.
- Development of regional/global partnership for on-farm conservation and sustainable use of PGRFA.
- Develop and support rural mechanism for on-farm conservation through CBM approach, maintaining/ establishing community seed bank system, creating system of agriculture development and conservation society/ cooperatives at community level etc.

2.4.4 Research priorities to support improved plant genetic resources *in situ* management

Research priority areas to support improved plant genetic resources *in situ* management are:

- Developing options of adding benefits and support biodiversity-based livelihoods
- Building local and national capacity for monitoring and assessing local crop diversity *in situ*
- Linking on-farm conservation with national gene bank activities
- Diversity assessment through molecular and biotechnological tools.
- Understanding the scientific basis of local innovation
- Diversifying the products and use of PGRFA
- Increasing market linkages of local products and local varieties.
- Generating sufficient data to authenticate the contribution of PGRFA for food security, sustainable agriculture, livelihood and economic development.

2.4.5 Priorities for policy development to support improved plant genetic resources *in situ* management

- To develop sui generis system for Plant variety protection with the aim of increasing private sectors investment in plant breeding, implement farmers rights to promote conservation and sustainable use of PGRFA and fulfilling the national commitment to implementing CBD, ITPGRFA and TRIPs agreement under WTO.
- To develop legislation for access to genetic resources and benefit sharing system for conservation and sustainable use of biodiversity.

2.4.6 Other strategic directions relevant to improving the state of *in situ* management of plant genetic resources

- Disseminating the experiences and knowledge in the local/ regional languages.
- Linking on-farm conservation and traditional food recipes and products with ecotourism/ tourism industries.
- Empowering farming communities by linking conservation and development activities through cooperatives, PPB and increased market linkages and opportunities.

2.4.7 Applied methods to achieve *in situ* management of plant genetic resources in Nepal

The following methods are identified that are essential for effective implementation of on-farm conservation programme before "best practices" can be used for policy reforms.

- Baseline surveys, diversity fair, RRA, PRA to locate ecosystem diversity, crops and community.
- Four cell analysis for rapid diversity analysis
- Community Biodiversity Register
- Community bank
- Community Biodiversity Management
- Participatory Plant Breeding for value addition of PGRFA
- Non Breeding Approaches (Market/ Local food culture.
- Linking conservation activities with development activities.

2.4.8 Obstacles to improving methods for *in situ* management of plant genetic resources

TABLE 5

Obstacles to improving methods for *in situ* management of plant genetic resources

Obstacles	Overcome the obstacles
Inadequate funding	Integrate on-farm conservation in rural development program Increased global/ regional collaboration Link with ecotourism/ tourism
Inadequate awareness at research and development institutions at local/ regional/ central levels	Inclusion of agrobiodiversity/ biodiversity fair in extension activities Dissemination of publications in local languages/ use of mass media
Accelerated use of exotic modern varieties/ chemicals for increased production and productivities	Promote genetic enhancement of local varieties Emphasize on genetic base broadening through increased support to research station based breeding activities, participatory plant breeding etc. and use traditional varieties as the female parent
Lesser numbers of plant breeders in GO/ NGO and private research and development agencies	Support human resources development with specific target on plant breeding, genetics and biotechnology.
Weak support for informal seed supply system	Increased GO support for informal seed supply system Inclusion of on-farm conservation programme in extension activities.
Limited extension of good practices in farmers fields	Integrate on-farm conservation good practices in rural development programmes Increased global/regional support for linking the good practices in rural development programmes.
Lack of national legislation	Endorse ABS legislation and PBR and FR legislation

CHAPTER 3

THE STATE OF *EX SITU* MANAGEMENT

The conservation of available variability in crop species aims at safeguarding crop diversity to meet the present needs and aspiration of future generation. The *ex situ* management includes the field gene bank, storage of orthodox/recalcitrant seeds and vegetatively propagated germplasm in gene bank facilities with ultra-low temperature, *in vitro* conservation and cryopreservation techniques.

National Commodity Research Programmes maintains landraces in field and grow them every year. It is possible to continue the process with limited number of collections. However, handling of large number of collections requires modern facilities to conserve the variability. A national facility to conserve the crop diversity is the need of the present time.

3.1 Sustaining and expanding *ex situ* collections

3.1.1 Plant exploration and collection

The foothills of the Himalayas harbor high levels of genetic, species and ecosystem diversity. N.I. Vavilov's contributions in diversity prompted several biologists, naturalists, adventurists, travelers and plant hunters to collect germplasm from Nepal Plant exploration and germplasm collection (crop specific and multi-crop collection) missions have also been regularly organized at national level. Passport data are collected by using the standard format developed either by Agriculture Botany Division (ABD) for our national purpose or as per the requirements of the particular mission.

Initially IBPGR (IPGRI) and IRRI were involved to collect the germplasm of different cultivated crops and their wild relatives. Later on, Japan provided support for plant exploration. International gene bank like IRRI, Philippines conserved 2 545 accession and NIAS, Japan conserved 2 030 accessions of rice germplasm collected from Nepal. In addition to the international exploration missions, NARC also regularly collected the crop plant genetic resources since 1986. The process was slowed down because of the deteriorating security situation. However, limited activities were carried out through linkage and coordination with farming communities and eco-regionally based agriculture research stations.

The seed repository (prefabricated facility with 20 sq.m. of space, 5^0C and 45% RH) of plant genetic resources section preserved 10 781 accessions of the orthodox seeds collected from different regions of the country. Sustaining *ex situ* collection was really a challenge because of declining resources allocation and irregular electricity supply. A proposal was developed by NARC to establish a national gene bank for long/ short term conservation of PGRFA. The Government of Nepal has endorsed the proposal in 2007/08. The facility is designed to sustain *ex situ* PGR collection.

3.1.2 Constraints to sustaining *ex situ* plant genetic resources collections

- Insufficient trained staff
- Irregular electricity supply
- Limited resource availability for conservation activity
- Lack of national facility for safety duplication
- Weak commodity research programs from conservation perspective
- Lack of field gene bank for horticultural crops/ clonally propagation crops.

Lack of gene bank is the greatest constraints to sustain *ex situ* plant genetic resources collection. Beside this, lack of funding, insufficient staff, lack of training, and insufficient equipment irregular electricity supply and national facility for safety duplication would be the major constraints for the purpose. Now, the Government of Nepal is establishing a national gene bank under Nepal Agricultural Research Council (NARC) for *ex situ* conservation of plant genetic resources for food and agriculture. It is also very necessary for inclusion of conservation facilities in our national commodity research program and regional agricultural research stations. This provides rays of hopes for sustainable *ex situ* plant genetic resources collections over the next 10 years.

3.1.3 Botanical garden and the its role to conserve PGRFA

The Government of Nepal (GoN) has established 9 botanical gardens and conservatories in different bioclimatic zones with focus on landscape development for education and research, aesthetic and recreational purposes. Nationally listed endangered and threatened plant species are also conserved *ex situ* with high priority in botanical gardens. The botanical gardens and conservatories have maintained few wild and some edible plant species and wild relatives of cultivated/ domesticated plant genetic resources for food and agriculture.

3.1.4 Constraints to expanding plant genetic resources *ex situ* collections

The expected major constraints to expanding plant genetic resources *ex situ* collection will be inadequate funds and trained human resources, lack of taxonomist rapid pace of genetic erosion, insufficient equipment and lack of implementation plan especially field gene banks for expanding PGR *ex situ* collections.

3.1.5 Priorities for sustaining and expanding *ex situ* plant genetic resources collections

Priorities for sustaining and expanding *ex situ* plant genetic resources collections over the next 10 years will be:

- Collection
  - Niche specific and demand driven collection
  - Marginalized/under utilized crops and wild PGRFA: Millets, buckwheat, amaranths, colocasia etc.
  - Vegetable crops – beans, cowpea, okra etc.
  - Oilseeds – linseed, mustard, yellow mustard etc.
  - Fruits- field gene banks for citrus, jackfruit etc.
  - Roots, tuber crops
- Establishing facility for safety duplication
- Development of cryo-preservation facility in national gene bank
- Documentation
- Utilization
  - Genetic enhancement
  - Base broadening
- Capacity building (Infrastructure and human resources)
- Generating technical and financial supports

3.1.6 Safety duplications for unique accessions

Nepal has not yet established safety duplication for unique accessions of plant genetic resources. Though, it is one of the priority areas for *ex situ* plant genetic resources conservation. Regarding this, Nepal needs to finalize the implementation plan for safety duplication in international gene banks based on the articles of International Treaties on Plant Genetic Resources for Food and agriculture (PGRFA) and/ or create facility for safety duplication in the high Himalayas with technical and financial support from donors.

3.1.7 Documentation of *ex situ* PGR collections and its priorities and needs to complete documentation

Documentation of *ex situ* plant genetic resources collections has been initiated and passport data of 10 781 accessions have been documented in MS Excel programme. Though, a better system needs to be developed for documentation of *ex situ* plant genetic resources collections. Scientific documentation of *ex situ* plant genetic resources will be the major priority. To complete this task we need a documentation expert and facility to establish the complete documentation system and provide training for the staff with the responsibility of day to day task for documentation.

3.1.8 Research priority to expand and improve *ex situ* plant genetic resources conservation

- Enhance conservation through use
- Assess low cost conservation technology under controlled temperature condition.
- Develop cost effective drying technique (low temperature and low humidity drying)
- Select cheap and quality packaging materials for long term conservation.
- Development of trained manpower to undertake research on conservation activities
- Development of protocols for diversity assessment using molecular techniques.
- Develop electricity saving mechanism to reduce cost of conservation.
- Develop techniques and protocols for *in vitro* conservation especially for clonally propagated crops and crops with recalcitrant seeds.

3.1.9 Cooperative arrangements to enhance *ex situ* plant genetic resources conservation

- Conservation:
  - FAO provided TCP facility for designing the proposed National Gene Bank in 2007 and the Government of Nepal is establishing a national gene bank with its own limited resources.
  - Past collections are being conserved in several institutions, agricultural centre and friendly collection.

TABLE 6
Collection and preservation of germplasm in gene bank

SN	Crop catagories	No. of species	No. of accessions
1	Cereals	11	4 715
2	Millets	06	0977
3	Pseudo cereals	03	0383
4	Pulses	22	3357
5	Oilseeds	10	0640
6	Vegetables	20	0603
7	Spices	10	0075
8	Fibre crops	03	0011
9	Miscellaneous	05	0020
	Total	**90**	**10 781**

3.1.10 Management practices to prevent genetic erosion in collections during regeneration

During regeneration of plant genetic resources the following management practices were employed to prevent genetic erosion:

- Growing large population
- Timely rejuvenation
- Monitoring of viability/ germination test of the seed
- Collecting representative sample of the accession
- Special care adopted during harvesting, threshing, cleaning, packing and leveling of the seed.

3.1.11 Priorities for maintaining viability and preventing genetic erosion

- Provide back up facility for regular electricity supply
- Monitoring viability on regular basis
- Rejuvenation of accessions.
- Institutional capacity building for human resources and facilities.

3.1.12 Priorities for regional and international cooperation for maintaining viability and preventing genetic erosion

Priorities for regional and international cooperation will be:

- Support for strengthening the gene bank.
- Capacity building of human resources.
- Joint proposal development.
- Exchange visits for enhancing and sharing technical knowledge/ visiting scientist/experts.

3.2 Planned and targeted collecting

3.2.1 PGR collecting activities to improve *ex situ* plant genetic resources coverage

TABLE 7
International collaboration in plant exploration and germplasm collection over the past 10 years in Nepal

Year	Exploration group	Primary purpose
1998	IRRI/Nepal	Wild rice
1999	Germany/Nepal	Wild rice (2 times)
1999	IRRI/Nepal	Wild rice
1999	NIAR (NIAS)-Japan/Nepal	Buckwheat
1999	Japan, Sweden/Nepal	Wheat/Barley
2000	NIAS-Japan/Nepal	Buckwheat

TABLE 8
National Exploration and Collection of Germplasm

Year	Exploration team	Primary Purposes
1995/96	SR Gupta, DB Thapa, T. Katsumoto & RP Paudel	Different species of multi food crops
1996	SR Gupta, DB Thapa, HP Subedi & RP Paudel	Wild and cultivated rice species
1996/97	SR Gupta, DN Mandal, ML Vaidya, & Representative from NRRP	Different species of multi food crops
1997	SR Gupta and DB Thapa	Wild rice species
1997/98	SR Gupta, DN Mandal, & Representative from NWRP	Different species of multi food crops
1998/99	SR Gupta and DN Mandal	Assessment of genetic erosion of food crop species
1999	SR Gupta, KD Subedi & YM Bhattarai	Wheat species
1999/00	SR Gupta, SK Shrestha, A. Priyadarshi & DM Dongol	Different species of cereal crops
2007	Agriculture Botany Division, Nepal	Finger millet

3.2.2 Major gaps in *ex situ* plant genetic resources collections

Major gaps exist in national *ex situ* plant genetic resources collections and holdings in genetic seed house.

Minor crops and underutilized species are poorly represented in the present collection. Similarly, limited efforts have been assigned to vegetable species, fruit species, forage species, condiments, wild plants and wild relative collections. Besides crop categories, the remote areas/ inaccessible areas have been poorly represented in the existing collections. Sporadic efforts have been made but not adequate to cover the level of diversity that the nation possesses. A systematic plan to collect diversity has not been yet developed.

3.2.3 Constraints to undertaking collecting missions

Limited financial resources availability, inadequate technical manpower, lack of taxonomist, lack of national collecting plans, knowledge on extent of genetic erosion and lacks of diversity distribution map are the greatest constraints for undertaking collecting missions to overcome gaps and address priority needs.

3.2.4 Collecting priorities and needs for major PGRFA

The collecting priorities and needs for major and minor crops, underutilized species, forages, wild plants and their wild relatives are:

- Niche specific and demand driven collection
- Minor/marginalized/under utilized crops and wild PGRFA: Millets, buckwheat, amaranths, colocasia etc.
- Forage species – berseem, clover, jai etc.
- Wild plant and their relatives – rice, fruits, vegetables, medicinal plants etc.
- Collecting in mountains and high hills.

3.2.5 Research needs and priorities in relation to enhancing collecting of PGRFA

- **Eco geographical survey to assess distribution of diversity**
  - Equipment needs: GPS, Laptop (Passport data collection and information management)
- **Plant exploration and collecting mission**
  - Plant collection and exploration equipment: Binocular, Camera, Vehicle etc.
- **Maintenance of inventory systematic documentation system**
  - Computer desktop
  - Printer
- **Trained manpower good knowledge of taxonomy**

3.3 Assessment of major *ex situ* needs

3.3.1 Priority needs and measures of Nepal

- Sharing the burden of the costs of conservation
- Low cost conservation technologies
- Improved germplasm management
- Filling gaps in collections
- Global regeneration efforts
- Develop pathogen-tested collections
- Complete safety duplication

3.3.2 Other strategic directions relevant to improving the state of *ex situ* management

National level

- Identify focal point for facilitated exchange of germplasm based on the principle of multilateral access and sharing of benefits
- Develop plan for implementation of ITPGRFA.
- Develop functional National Plant Genetic Resources System for conservation and sustainable use of PGRFA.
  - Establish National Plant Genetic Resources Centre and depute necessary manpower in the centre.
  - Initiate conservation of active samples in national commodity research programme, RARS, ARS in NARC and Farm/Station under department of agriculture.
  - Develop national facility for safety duplication in the High Himalayas to low cost conservation system in the SAARC region.

- Activate National Agrobiodiversity Conservation Committee and link with National Biodiversity Steering Committee for effective policy/guidelines implementation.

Regional level

- Establish functional cooperation and linkages between and among the PGR centers located in this region
- Sharing of information system and exchange of germplasm
- Support long term and short term training initiatives
- Exchange visits of scientist be encouraged.

Global level

- Share the burden of cost of conservation specially for the least developed countries.
- Provide the technical and financial support for improved germplasm management and modernization of the national plant genetic resources centre.
- Training supports for LACs.

3.3.3 Methods for *ex situ* conservation of plant genetic resources in your country

- Genetic seed house in Agriculture Botany Division and field gene banks particularly for some fruit crop species are being employed for *ex situ* conservation of plant genetic resources in the nation.
- Gene bank facility for long term conservation is being established along *in vitro* conservation facility and diversity assessment laboratory in Horticulture Research Centre in NARC and DoA.

3.3.4 Obstacles to obtaining and using available *ex situ* methods for conserving plant genetic resources

Obstacles exist in obtaining and using available *ex situ* methods for conserving plant genetic resources, which are:

- Inadequate number of trained manpower
- Availability of ageing equipments that needs heavy maintenance on regular basis.
- Lack of back up facility for electricity and irregular electricity supply.
- Inadequate funds for maintenance of the equipments.

To overcome these obstacles there should be:

- Crop based experts for characterization either by recruitment or by providing training
- Scientific documentation system of PGR
- A good conservation facility for conservation of PGR
- Technical experts for gene bank management.
- Judicious availability of financial resources
- Increased deputation of scientist, technical officers and supporting technical staff.

CHAPTER 4

THE STATE OF USE

The conservation of crop genetic resources is meaningful only if they are properly characterized and evaluated to assess the extent of diversity and the variability is utilized for the betterment of mankind. Landraces exhibit extreme variation in agro morphological traits, resistance to biotic and abiotic stresses and adaptation. National Crops Research Programs and Agriculture Botany Division have utilized the crop resources for crop improvement programs. A total of 216 varieties of 44 different crops along with complete package of practices have been released and registered since 1960. Out of 216 food crops varieties released by National Seed Board, 32 were developed by local selection directly and 11 were developed by the hybridization of local and exotic germplasm. Many other landraces are being used to developed food crop varieties.

4.1 Distribution of plant genetic resources

4.1.1 Mechanisms to record the distribution of samples of conserved plant genetic resources to breeding programmes

Conserved germplasm has to be properly distributed to promote the use of genetic resources. National Commodity Research Programmes are the main users of these valuable genetic resources (Annex-VI). Plant Genetic Resources Section (PGRS) has mechanism to record the distribution of samples of conserved plant genetic resources to breeding programmes. Commodity research programmes in major crops are using the distributed accessions in national breeding programmes depending upon the availability of plant breeders.

4.2 Utilization and enhancing the use of plant genetic resources

4.2.1 Recent improvements in crop production through the use of particular varieties that demonstrate the contribution of plant genetic resources

Improved varieties of rice, maize and wheat cover 85 percent, 86 percent and 96 percent respectively of the cultivated areas. There are several examples of crop variety improvement through the use of plant genetic resources in Nepal. A total of 216 improved varieties of 44 crops have been released representing cereals, legumes, oil seeds, potato, vegetables, industrial crops and forage. Table 9 below describes the details of variety development through the use plant genetic resources in Nepal. Among the listed varieties in the table 9, more than 10 have been released during 2007-2008. Presently only 14 percent of local landraces in rice, 42 percent in maize and none of them in wheat are utilized in crop improvement programmes and are released for general cultivation. This information shows that presently very limited amount of local genetic resources are used in improvement of major food crops, despite the huge potentials that exist in the country. Varietal development and their dissemination efforts made in the past had resulted very attractive rate of returns in Nepal. The improved crop varieties of rice, maize and wheat have a greater impact on increased farm yields. The rice productivity has been increased from 1 760 kg per hectare in 1972 to 2 860 kg per hectare in 2004, wheat yield from 900 kg per hectare in 1 972 to 2 152 kg per hectare in 2008 while maize yields have crossed 2090 kg per hectare in 2007. Improved varieties of rice cover >86.4 percent, maize >88.2 percent and wheat 96.3 percent of total cropped area of perspective crops.

TABLE 9
List of the crops and the varieties released/registered officially in Nepal

S. No	Crop	No of released varieties	No of varieties registered	No of varieties denotified	S. No	Crop	No of released varieties	No of varieties registered	No varieties denotified
Cereals					**Vegetables**				
1	Rice	56		12	22	Potato	6		
2	Maize	19		7	23	Cauliflower	3		
3	Wheat	30		13	24	Radish	4		2
4	Finger millet	3			25	Turnip	1		
5	Barley	6			26	Onion	1		
Legumes					27	Broad leaf mustard	4		
6	Soybean	8		1	28	Tomato	4		
7	Lentil	8			29	Carrot	1		
8	Chick pea	6		1	30	Cabbage	1		
9	Pigeonpea	2			31	Yard long bean	2		
10	Mung bean	3			32	Pea	2		
11	Cowpea	3			33	Bean	2		
12	Black gram	1			34	*Capsicum frutescence*	1		
Oilseed crop					35	*Capsicum annum*	**1**		
13	Ground nut	6			36	Squash	1		
14	Rapeseed	6		1	37	Sponge gourd	1		
15	Broad leaf mustard	2			38	Swisschard	1		
16	Sesame	2			39	Cucumber	1		
Industrial crop					40	Bitter gourd	**1**		
17	Tobacco	1			41	Okra	1		
18	Cotton	1			42	Spinach	1		
					43	Brinjal	1		
19	Sugarcane	4			**Forage**				
20	Jute	2			43	Oat	2		
21	Ginger	1			44	Total	216	2	35

Source: Bhatta and Bajracharya, 2008.

4.2.2 Landrace enhancement: an economic incentive to support use of farmers varieties

There are meagre examples that demonstrate social, economic and environmental benefits from the use of local crop diversity. The participatory landrace enhancement programme of *Jethobudho* (JB) population from Pokhara Valley has demonstrated the value of on-farm conservation of traditional variety. The case study tested the hypothesis that economic incentive is a low-cost strategy to support on-farm conservation than other means of conservation. Results reveal that there are economic and social benefits from landrace enhancement to farming community. The variety has been officially released by the National Seed Board.

The farming communities maintaining the source of materials are maintaining source seed production and receiving the economic benefits and social recognition as the pioneer farmers promoting the conservation and sustainable use of PGRFA.

4.2.3 Outcomes

Overall performance of Jethobudho (JB)

A total of 260 randomly selected JB growing farmers from Pokhara valley participated in participatory variety evaluation of improved JB with their own local JB during 2003 and 2005. Table 2 shows overall performance of six selected lines.

Figure 1 of Annex VII illustrate the comparative performance of the improved JB with local JB in most of the preferred traits.

TABLE 10

Comparative performance of selected *Jethobudho* accessions in Kaski

Accessions	Source of materials	Address	Milling recovery %	Plant height (cm)	Grain yield t ha^{-1}	Straw yield t ha^{-1}	Organoleptic weightage
JB-T-010-025/5	Dhan Bdr. Karki	Lekhnath Sisuwa	71.2	178.4	2.95	13.41	427.5
JB-T-023-030/25	Meghnath Subedi	Lekhnath-8, Sisuwa	71.2	171.5	2.96	12.9	465.0
JB-T-103-237/12	Ganga Giri	Kaskikot-7, Pame,	68.8	174.3	3.35	14.0	427.5
JB-T-105-238/5	Man Bdr. Sunar	Kaskikot-6, Pame,	72.9	178.1	3.40	14.6	427.5
JB-T-147-296/6	Kedar Pd. Kafle	Pokhara-17 Biruwa	70.9	177.5	2.83	12.7	420.0
JB-T-168-316/3	Bhim Pd. Baral	Pokhara-7, Maswar	77.2	179.4	2.87	12.7	450.0
Average			72.03				436.25
LSD at *0.05*				8.58	0.88	2.46	
CV %				2.7	16.2	10.6	

Gains in quality traits

JB rice is known for its quality and consumers are willing to pay the premium price (74 percent higher price than *Mansuli* rice). Baseline study indicated that 21 percent of farmers from Begnas village maintained JB for its superior post-harvest qualities, productivity and price stability over other common landrace. Authentic JB rice when cooked has superior softness, flakiness, aroma and better taste as indicated by consumer preference ranking survey. Variability in quality is the main concerns of consumers and market entrepreneurs for JB rice marketing.

FIGURE 1 OF ANNEX VII:

Participatory variety selection resulted in better understanding and farmers acceptance for enhanced materials based on various agronomic characters

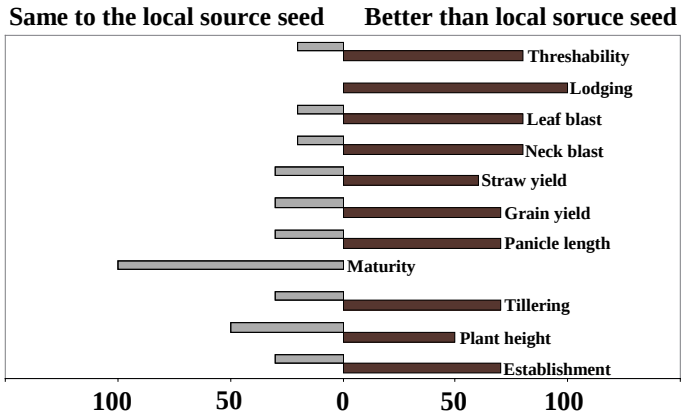
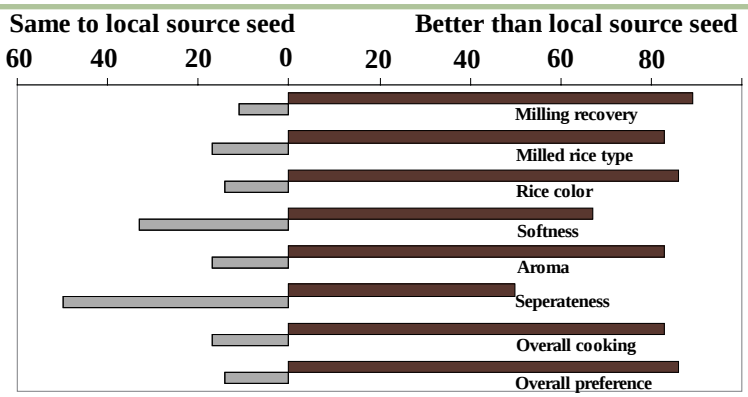


FIGURE 2
Farmers' perception on post harvest quality traits colleted using HLQ in PVS trials in Pokhara valley in 2003



The enhanced materials were highly preferred for post harvest quality traits, by the farmers (Figure 2). Selected JB had more than 72 percent milling recovery with a maximum range of 79 percent. It was also found that *Jethobudho* landrace meets international standard and has a potential to be marketed in Arabian markets because of its special quality traits that Arabian consumers prefer.

Community based seed production (CBSP)

In order to share benefits of JB landrace development with large number of farmers, community based seed production (CBSP) was initiated with diverse stakeholders for *Jethobudho* landraces. It aims to strengthen healthy seed system adapted to ensure the sustained supply of seed of enhanced landraces to the farming communities. The project established a link between community seed producers with seed entrepreneurs and district self reliance seed production programme for social, economic and institutional sustainability. The system has now produced breeder seed and truthfully labeled seeds for marketing and distribution. The private sectors, especially rice millers and merchants, have special interest on enhanced *Jethobudho* for marketing thereby contributing conservation through utilization. They are willing to pay higher price NPRs 1 500 per *muri* (70 kg husked rice) for enhanced JB compared to local JB (NPRs 1 200).

Variety release and recognition of custodians

National Variety Release and Registration Committee of National Seed Board visited to assess the performance of *Jethobudho* in farmers' fields in Pokhara valley and released the variety as the output of participatory landrace enhancement.

4.2.4 Learning and emerging issues

Participatory landrace enhancement is a quick method (7 years) for demonstrating value of on-farm conservation to community and policy makers. National partners have initiated germplasm enhancement work in rice landraces (such as *Jhinuwa, Kala Namak, Ganjale Masino* and *Lalka Basmati*) and also fingermillet populations of *Kalo Dalle* and *Samdhi Kodo* in Kaski valley.

Creating market incentives for conservation and exchange of selected population are current challenges for PPB team. There is need for developing provision of geographic indicator (GI) for landraces such as *Jethobudho,* and incentives ensured through GI should go to the custodian farmers. At the community level, it is essential to link farmers with the market (private sectors), as quickest way to generate income from their local products.

4.2.5 Major constraints in improved use of plant genetic resources

- Lack of characterization and evaluation of conserved germplasm
- Lack of integration between conservation and utilization programme
- Insufficient capacity for plant breeding (Personnel fund, training etc.)

- Inadequate documentation of useful information on the conserved germplasm
- Insufficient equipment
- Lack of proper facilities for conservation of germplams

Following activities have been undertaken to enhance the use of plant genetic resources:

- **Strengthened capacities and improved training in plant breedin.**
  Several plant breeders have received advanced degree and medium term training from USA, UK, India and other countries and also from IARCs such as CIMMYT, Mexico, IRRI, Philippines, ICARDA, and ICRISAT etc. However, there is acute shortage of young plant breeders due to retirement of experienced breeders and there is no lateral entry in the recent past.
- **Increased collaboration among researchers, breeders, gene bank managers and farmers to better integrate conservation and use of plant genetic resources.**
  Breeders are directly involved in characterization and evaluation of PGRFA. This has created a conducive environment to use PGRFA in national breeding programmes. Further, with the establishment of national gene bank, it is expected that collaboration among researchers and gene bank managers will further strengthened.
- **Increased pre-breeding activities, particularly to enhance base-broadening programmes.**

4.2.6 Improved the regulatory and policy frame works

National Seed Act and Regulation encourage the use of PGR. Participatory data have been accepted and it is mandatory to include farmer's acceptance in Variety Release Format. This indicates the favorable policy regime to promote conservation and sustainable use of PGRFA. The above mentioned activities are current priorities for Nepal and there is urgent need to be further strengthen and implement them.

4.2.7 Characterization and evaluation of germplasm

Systematic characterization and evaluation of collected/ preserved germplasm enhance the use of genetic resources by plant breeders and other scientists. Descriptors published by IPGRI are normally on agro-morphological characters. Besides, Agriculture Botany Division and National Commodity Research Programs (NCRPs) are also involved in this process. Altogether 4 151 accessions were characterized before 1999 and by now the number have reached to 5 662 (Table 11).

TABLE 11
Characterization and evaluation of Nepalese germplasm

S. No.	Crops	No. of Accession								
		Before 2000	2001	2002	2003	2004	2005	2006	2007	Grand Total
1.	Barley	972	78	146	-	-	-	-	-	1 196
2.	Broad bean	35	127	-	-	-	-	-	-	162
3.	Buckwheat	507	-	93	-	-	-	-	-	600
4.	Chickpea	250	-	-	-	-	-	-	-	250
5.	Cowpea	72	-	-	-	-	-	-	-	72
6.	Finger millet	718	-	97	100	50	-	-	-	965
7.	Grain Amaranths	76	-	-	-	-	-	-	-	76
8.	Lathyrus	87	-	-	-	-	-	-	50	137
9.	Lentil	146	-	-	50	100	100	100	50	546
10.	Mungbean	53	-	-	-	-	-	-	-	53
11.	Pigeonpea	227	-	-	-	-	-	-	-	227
12.	Rice	1 331	140	148	200	50	100	100	100	2 119
13.	Soybean	230	-	81	-	-	-	-	-	311
14.	Taro	48	-	-	-	-	-	-	-	48
Total		**4 752**	**345**	**565**	**350**	**200**	**200**	**200**	**200**	**6 812**

Molecular techniques (Isozyme, RAPD and Microsatelite) are also being used to characterize the selected species of crops in recently established biotechnology lab. Some scientific papers have been published in different literatures. Characterization and evaluation for disease/insect resistance, drought, biotic and abiotic traits have not been undertaken.

4.2.8 Priorities for promoting characterization and evaluation

- Generating financial support for characterization
- Involve multi disciplinary team for characterization and evaluation
- Identify hot spot for characterization and evaluation
- Sharing the information and maintaining website.

4.2 9 Collections in gene bank

A total of 10 781 accessions of 90 crop species of orthodox seeds have been collected through various national and international collection missions and preserved in the genetic seed house of Agriculture Botany Division at Khumaltar having floor area of about 20m^2 with 5^{0}C and 45 percent relative humidity (Table 12).

TABLE 12
Collection and preservation of germplasm in gene bank

SN	Crop catagories	No. of species	No. of accessions
1	Cereals	11	4 715
2	Millets	06	0977
3	Pseudo cereals	03	0383
4	Pulses	22	3357
5	Oilseeds	10	0640
6	Vegetables	20	0603
7	Spices	10	0075
8	Fibre crops	03	0011
9	Miscellaneous	05	0020
	Total	**90**	**10 781**

Nepal has not maintained core collections in genetic seed house, since the nation does not possess the long term conservation facility. Recently, the government of Nepal is supporting the construction of gene bank with long term conservation facilities. After the establishment of facility, the core collection concept will be introduced in the gene bank. To promote the use of collection held in gene bank, it is imperative to have strong breeding programmes. However, Crop specific plant breeding goals have been developed by commodity research programme. In general, it aims at enhancing food security and poverty alleviation by increasing quantity and quality of agriculture production through the use of improved varieties. Country's plant breeding capacity is not very strong and effective because of following reasons:

- declining plant breeders due to retirement
- lack of modern facilities
- lack of advanced training to young breeders

4.2.10 Future research priorities to enhance use of plant genetic resources for food and agriculture

- Identify crop specific farmers preferred traits and useful traits for plant breeders.
- Assess diversity at phenotypic and molecular levels.
- Generate information on responses to biotic and abiotic stresses.

4.2.11 Major constraints to achieving diversification of crop production and broadening diversity in crops

Diversification of crop production

Government policy is conducive to the diversification of crop production. Crop diversification project has been launched and the commodity research programmes are seriously involved in deployment of diversity in the farming system. However, marketing system greatly promotes the uniformity. The effect is apparently visible by the spread of market driven few popular varieties in farmer's fields.

4.2.12 Future needs and priorities to reduce genetic vulnerability

The strategy to address genetic vulnerability has been formulated at commodity level, in major crops such as rice, wheat, and maize. Broadening of the genetic base of available Germplasm for disease resistance, yield enhancing traits, abiotic stresses tolerance etc. has been incorporated in crop improvement initiatives. R and D system has been putting its effort in deployment of diversity. Participatory Variety Selection and Participatory Plant Breeding is gaining wider support at national level. However, there is a greater need of increased recruitments of plant breeders and supporting team, strengthen biotechnology laboratory and use modern tools and techniques of plant breeding, capacity building of plant breeders and increased investment in plant breeding in government and non government sector.

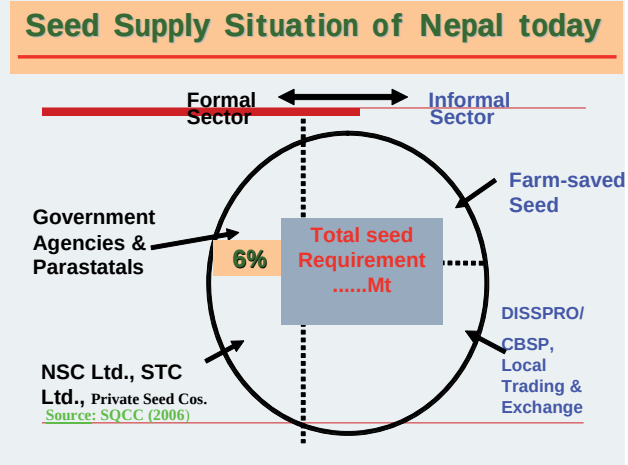
4.3 Seed supply systems and the role of markets

4.3.1 Seed production and distribution

Seed production and distribution, especially the source seed (breeder and foundation) is a public sector function. Production and distribution of other seeds such as certified and improved seeds are undertaken by both the public and private sectors, separately and also in public-private partnership.

Public sector organizations involved in seed production and distribution include Nepal Agricultural research Council, NARC (especially for breeder and foundation seeds), District Agriculture Development Offices under the Department of Agriculture, and National Seed Company. Private sectors include contract farmers and farmers' groups, NGOs, seed companies, agro-vets etc.

Both sectors are involved as shown in the following figure.



4.3.2. Seed production and distribution a constraint to the availability of good quality seed of a wide range of plant varieties

There are constraints on production and distribution of seed in general. Till 2001 production and distribution of certified and improved seed along with chemical fertilizer and pesticides was taken care by the then Agriculture Inputs Corporation. By realizing the importance of quality seed in terms of production and distribution the Government of Nepal established National Seed Company in 2002 as a sole organization in public sector.

The Seed Quality Control Centre (SQCC) was strengthened by establishing two important units such as Seed Certification Unit (SCU) and Seed/Variety Registration Unit (SVRU) in 2002. The major functions of SCU include field inspection, issuing of certification tags and seed certification and monitoring of certification. As per the provision of Seed Act 1988, seed certification in Nepal is voluntary, but truthful labelling is compulsory. Similarly, the major functions

of SVRU include registration and updating of varieties, DUS, grow-out test, registration of imported/exported seeds, and monitoring and inspection of seed market.

Earlier, seed certification work as a whole used to be controlled by the Central Seed Testing Laboratory. To widen the seed certification work in the country the Regional Seed Testing Laboratories are given the mandate of seed certification within the respective regions.

District seed self-sufficiency programme (DISSPRO) was started with 15 districts in 2003, which has now has extended to more than 50 districts. DISSPRO is a programme run by respective District Agriculture Development Offices (DADO) involving groups of seed growers within the command districts. DADO provides necessary technical supports, seed bins in subsidized price and also coordinates for chanalizing markets.

Over the last 10 years, several private seed companies have emerged as potential seed enterprises. Also, many agro-vets all over the country are involved in seed business, particularly seed marketing. A few NGOs and INGOs are also directly or indirectly getting involved in production and distribution of quality seed in their project areas.

Regarding integration of plant genetic resources, plant breeding and seed systems, participatory variety selection (PVS) and participatory plant breeding (PPB) involving farmers and other stakeholders have started in the country in the past 10 years. This has promoted selection and adoption of wide range of genetic materials by farmers themselves.

At national level, Government has created a "National Seed Board" (NSB) that implements the seed production and distribution system at national level in major crops. Seed Quality Control Center (SQCC) under the ministry of agriculture is a legal authority for seed quality control business in the country and it has regional networking too. Recently govt. has opened privatization of seed business and there are number of private seed companies operating in the country including one govt. supported National Seed Company (NSC). Despite this, the seed replacement rate in major food crops such as rice, maize and wheat is in the proximity of 6 percent.

4.3.3 Priorities to improve seed production and distribution over the next 10 years

- Facilitate the local seed growers' groups, community-based seed production (especially in the hills and mountain districts), involve cooperatives in seed production and distribution by providing technical supports and training.
- Involve private seed companies in production and distribution of improved seed as per the national demand in terms of variety and quantity.
- Reorganize DISSPRO for effective management and sustainability.
- Expand network and capacity of the National Seed Company to strengthen formal seed sector for assured quality seed production, distribution and marketing.
- Enforce Seed Act and Regulations in true sense.
- Strengthen research and development capability in seed sector.
  - Produce enough source (BS/FS) seeds at commodity level of demanded crop varieties.
  - Monitor the management of subsequent categories of seed production
  - Procurement of large quantity of seed through private companies
  - Provision of buffer stock

4.3.4 Major constraints in making seeds of new varieties available in the market place

- Publicity of new varieties is very much limited. Majority of farmers are small farm holders and they are illiterates. Lack of adequate information on newly released varieties makes farmers less confidence in adopting them.
- There is small quantity of seed available at the time of release, it takes time to produce large amount of seed for distribution. New variety's seed dissemination is slow (slow variety replacement). This is due to lack of awareness among farming communities, the newly released variety takes time to cover substantial area.
- Lack of legislation on Plant Breeders Rights.
- Geographic remoteness of the country is a major physical constraint responsible for poor road links in the hilly districts and adversely affects the seed distribution system.
- It is a general practice that a new variety is recommended for a wider domain, but the domain may have different micro-environments. There is a chance of failure of a new variety due to micro-climate variations within a short range.

4.3.5 Location of the market (domestic versus international) affect the use of plant genetic resources

Location of the market plays a significant role promoting the use of plant genetic resources. Urban market has induced commercialization that promotes the uniformity in the farming system. Rural communities specially, in remote areas are devoid of urban market and dependent on local plant genetic resources for food and agriculture. The food security and livelihood concerns of rural community are addressed by the high level of available diversity in the form of wild and cultivable PGRFA.

4.4 Measures to support development of new markets for local varieties and diversity rich products

Initiatives on on-farm conservation and home garden management of plant genetic resources for food and agriculture have led to support development of new market for local varieties and diversity rich products under the leadership of rural communities in Kaski and Bara districts. Agriculture Cooperatives and Agriculture Development and Conservation Society are involved in establishing market linkages and product diversification of PGRFA including underutilized crop species (finger millet, buckwheat)

However, limited efforts are underway from GO, NGO and Private Sectors to develop markets for local varieties and diversity rich products.

4.4.1 Constraints in attempting to increase markets for local varieties and diversity-rich products

- Changing food habits of the people: A shift from traditional food to western/ eastern fast food.
- Inadequate availability of local varieties and diversity rich products in market.
- Lack of systematic effort to promote new markets for local and diversity rich products.
- Inadequate awareness of diversity rich products in human nutrition and health.
- Inadequate investment in market promotion of local varieties and their products.

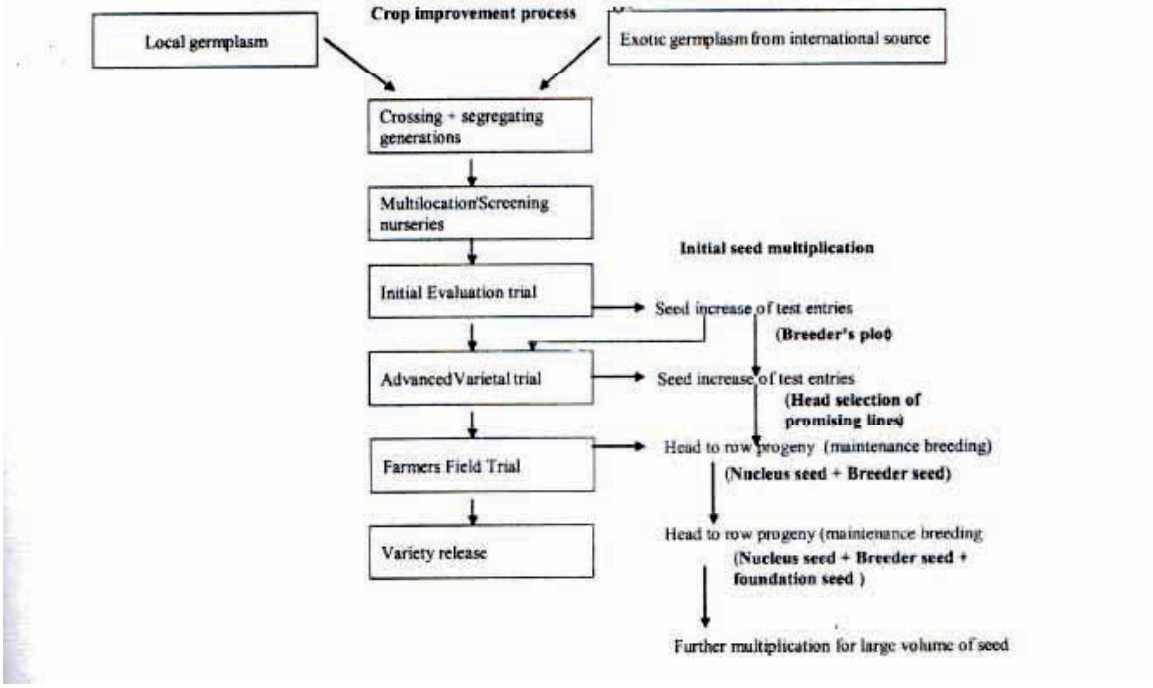
4.4.2 Strategies to better link small-scale producers with markets – local and export markets

Efforts have been made to link small-scale farmers with market, especially local markets. Small scale farmers are supported through cooperatives and saving credit schemes. The government of Nepal has initiated concentrated effort to promote development and alleviate poverty, especially at rural community. For international market, it is limited to few vegetable seed like radish and some others. The approaches adopted are briefly stated below:

- **Contract farmers:** Seed companies largely produce their seeds by contracting farmers individually or in groups. Number of seed companies is increasing with its volume of operation in the country. They have been expanding their markets by linking agrovets located all over the country as better outlets.
- **Community-based seed production (CBSP):** CBSP is basically organized in remote hilly areas to meet the seed demand within the districts. The CBSP largely supported by Hill Maize Research Programme (HMRP) under the SDC assistance is expanding in many hill districts.
- **District Seed Self-sufficiency Program (DISSPRO):** DISSPRO is technically supported by District Agriculture Development Office (DADO) with subsidy for small infrastructure like seed bins. Under this program, small scale seed producers are better linked with markets within and even outside the district with the direct involvement of respective DADO, who keeps and provides information on seed demand and supply for the district.
- **Cooperative farming:** Cooperative farming has been practiced in the country for a long time. However, it was not effective in the past due to lack of Government policy and program. The Government is now putting efforts on making cooperative farming viable and functional. In the current fiscal year, there is a program of constructing ten modern seed godowns of different capacities in order to expand the commercial seed market involving private sector.

To improve the state the plant genetic resources it is imperative to enhance investment in agricultural research and development. According to the world development report, 2008 "investment in agricultural research has paid off handsomely, delivering an average rate of return of 43 percent in 700 projects evaluated in developing countries." This indicates an urgency at national, regional and global level to encourage collaborative projects at regional level in the form of shuttle breeding, increased donor support for sustainable use of plant genetic resources and augmented of investment in human resource development to generate professional plant breeders and multidisciplinary team in crop research programs.

A typical flow chart in varietal development and initial seed increase in maintenance breeding process (source: Chand and Bhatta, 2001)



4.4.3 State of crop improvement programme

The state of national crop improvement programme can be best characterized as the basic formal sector crop improvement programme with capacity of germplasm identification and evaluation. In major crops improvement programmes, moderate facilities to improve crop varieties exist, these are devoid of advanced breeding techniques such as molecular based breeding methodologies and other modern technologies for lab research. Few non-government organization and private seed companies Seed Entrepreneurs Association of Nepal (SEAN) are also involved in crop improvement initiatives.

Rice, wheat, maize, grain legumes, oil seeds, sugarcane, potato etc. have benefited from past variety improvement programs in the country. Following table indicates the number crops benefited from variety improvement programs in Nepal.

TABLE 13
No. of varieties released and notified by NSB

SN	Crop	Number of varieties released
BS	Cereals	114
FS	Legumes/Pulses	31
BS	Oil seed crops	16
FS	Industrial crops	9
BS	Vegetables	44
FS	Forage crops	2
	Total	**216**

4.4.4 Crop improvement contributed to food security

In major food crops such as rice, maize and wheat the production has more than doubled since 1970. In wheat the total production has increased by more than 12 times compared to 1970's production. More over, the returns to investments to variety improvement in wheat has resulted 84 percent internal rate of return (IRR) since 1970 to 1992. The table below showed how major crops have contributed to food security in the country.

TABLE 14
Area, production and yield of major cereals over 27 years

Crop	Area (ha)	Production (MT)	Yield (kg/ha)	% MV area
Rice				
1980	12 64 840	2 464 000	1 932	
2007	1 549 447 (22.5%)	4 209 279 (70.8%)	2 717 (40.6%) (29 kg/ha/year)	87%
Maize				
1980	457 000	743 000	1 629	
2007	870 401 90.5%	1 819 925 145%	2 091 (28.4%) (17 kg/ha/year)	86%
Wheat				
1980	392 000	477 000	1 218	43%
2007	726 664 85.4%	1 515 139 217.6%	2 085 (71.2%) (32.5 kg/ha/year)	96%

TABLE 15
Breeder and foundation of rice, wheat and maize produced in research farm and stations in last five years period (2002/03- 2007/08)

Crop	Seed class	02/03 (mt)	03/04 (mt)	04/05 (mt)	05/06 (mt)	06/07 (mt)	07/08 (mt)	Seed demand for 07/08
Rice	BS	25.42	7.57	11.24	7.84	5.09	7.7	12.6
	FS	400.00	446.00	408.20	295.20	254.02	309.80	177.9
Wheat	BS	10.00	24.64	22.60	17.66	20.69	22.8	32.6
	FS	300.00	100.00	85.39	103.98	127.31	106.2	218.9
Maize	BS	3.85	2.14	0.55	4.83	1.92	3.9	0.12
	FS	7.45	58.97	48.83	35.05	60.11	46.3	23.06

4.4.5 Breeding programmes developed to increase crop resistance to pests and diseases

In all major food crops, such as rice, maize, wheat, potato, grain legumes etc., one of the breeding objectives is to breed crop varieties resistance to diseases and pest.

4.4.6 Implementation of participatory crop improvement programmes

Recent initiative taken by NARC in technology dissemination include participatory technology development and dissemination (PTDD), farmer participatory varietal trail- PVS (mother baby trails) in which farmer managed participatory research (FAMPAR) trials are conducted along with intensive farmer- researcher interaction during genotype selection, participatory plant breeding (PPB). These concepts help farmers not only in technology testing/ verification but also offer basket of choices to farmers and takes less time in dissemination. Other initiatives taken are print media such as booklets, leaflets, posters, fact sheets, news papers, FM radios, television and more recently telephone and mobile cell phones are also common in technology dissemination.

4.4.7 Significant changes in the use of plant genetic resources

The present national, regional and global Food Price Rise and Food Security Concerns have shaken the stakeholders involved in agriculture development and technology generation. The ever declining national and donor support for agriculture research and development have to be reversed. Issues of small scale farmers, ultra poors and migrating youths from rural community to urban area have to be addressed as well. This necessitates increased investment in agriculture research and development specially, in the field of sustainable use of plant genetic resources for food and agriculture.

4.4.8 Methods employed for plant breeding

- **In self pollinated crops:**
  - Pedigree method- during 1970s to mid 1980s (cumbersome, more time, space and resources needed)
  - Modified pedigree bulk system since 1980 on-ward –still continued in many crop programs (time saving, less resources compared to pure pedigree system)
  - More recently the selected bulk system of handling breeding population has been incorporated which is more resource efficient and leads higher genetic gains in-terms of grain yield.
  - Multilocation evaluation in the form of replicated yield trials, screening nurseries for biotic and abiotic and on-farm adaptive trials are common.
- **In open pollinated crops such as maize:**
  - Mass selection
  - Stratified mass selection
  - Modified Ear to Row selection
  - Half sib
  - S1 progeny selection
  - Multilocation evaluation in the form of replicated
  - Yield trials, biotic and abiotic screening nurseries and on-farm trials

4.4.9 Methods for utilization of plant genetic resources for food and agriculture through plant breeding

The national research system is putting its efforts in enhancing the yield potential through resource efficient breeding tools. Selected bulk system of breeding self pollinated crops such as in wheat has 3.3 percent higher genetic gains in yield over modified pedigree bulk method. This method is 50 percent and 25 percent more resource efficient than classical pedigree and modified pedigree bulk system. Similarly, Alpha-lattice designs with two main blocks (replications) can save up to 50 percent cost of handling coordinated varietal trial with 200 percent more experimental efficiency over RCBD with four replications. National Wheat Research Programme has been using both of these techniques in the plant breeding research. Biotechnology Unit has also been working in anther culture to induce doubled haploids in rice and embryo rescue techniques in inter-species crosses.

CHAPTER 5

THE STATE OF NATIONAL PROGRAMME, TRAINING NEEDS AND LEGISLATION

Developing national policies, strategies, working policy, plans and programs are vital obligations of the parties in the Convention on Biological Diversity (CBD, 1992). Attaining conservation, promotion and sustainable use of biological diversity (plant genetic resources and the animal genetic resources) to protect environment, self-sufficiency in food production, income generation and off-farm development, promoting agro-based industries and conserving forest for betterment of livelihood are apparent features of the state policy related to genetic resources management.

5.1 National programme

After being a party in the Convention on Biological Diversity, 1992 (Nov. 23, 1993) and a member in the FAO Commission on Plant Genetic Resources, Nepal organized a national workshop on plant genetic resources conservation, management and use in November 1994 to assess status of plant genetic resources and suggest future plan of actions for their conservation. The workshop recommended the need of establishing a national plant resources system and a national coordination committee for the conservation, management and sustainable use of plant genetic resources. Following which, the National Agriculture Biodiversity Conservation Committee representing relevant sectarian government and non-government organizations and academic institutions was formed under the secretary in the Ministry of Agriculture in 2000. The committee ratified later by Agro-biodiversity Policy (2007) forms a thematic sub-committee (as per Nepal Biodiversity Strategy, 2002) to the National Biodiversity Coordination Committee headed by the minister for forest and soil conservation for mainstreaming all biodiversity programs in the country. National Agro-biodiversity Conservation Committee has now been organizing regular meetings to guide the agricultural sector in sustainable use and conservation of local genetic resources and knowledge through formulation of relevant policies and strategies. The committee has grown to full-fledged working condition with authority and mandate on managing peoples' access to and sharing of benefits arising due to diverse genetic resources in the country and associated traditional knowledge.

Ministry of Agriculture and Cooperatives organized a 'national workshop on agro biodiversity conservation' on 15th July, 2003. Based on the recommendation of the workshop, National Agriculture Policy, 2004 laid priority on conservation and utilization of agro biodiversity through encouraging *in situ* conservation of genetic resources and promoting conservation oriented farming system. This emphasized the need, and led to the formulation and ratification of Agro-biodiversity Policy, 2007 for the country that has addresses of the various stakeholders' rights on access to agro-genetic resources and roles on their conservation, promotion and sustainable utilization. The priority programs identified by the policy include scientific studies, research, extension and other programs for conservation, maintenance and sustainable use of agro-biodiversity. The policy has yet to be expanded with details of working policy especially on *in situ* and *ex situ* conservation and utilization of biodiversity, benefits sharing and bio-safety.

A national workshop on 'learning from community biodiversity registrar in Nepal' organized by Ministry of Agriculture and Cooperatives in collaboration with Nepal Agriculture Research Council and NGOs involved in plant genetic resources conservation on 27-28th Oct., 2005 emphasized need of community level programs for registering plant/animal genetic resources and associated knowledge and proper approaches/methods for such documentation. Community level management of biodiversity and monitoring of genetic erosion, strengthening local capacity in biodiversity management and establishing community rights on access to and equitable sharing of benefits due to genetic resources were also recommended. Ministry of Agriculture and Cooperatives (Gender Equity and Environment Division) allocated budget for community level biodiversity registration and documentation in three districts in the f.y.2004/2005 representing three ecological regions in the country namely high mountain (Mustang), middle mountain (Tanahun) and the plain (Sunsari). District agricultural and livestock service offices in the districts implemented the program to make the farming communities aware of importance of agro-biodiversity, genetic resources and traditional knowledge conservation and their community level registration and documentation.

The tenth plan (2002-2007) containing some goals and targets related to biodiversity conservation provided opportunity to formulate programs on maintaining habitats, reducing population decline of important species and community participated ecotourism.

Community participated development of some varieties and conservation technologies in rice and wheat, initiation of *in situ* conservation program such as community seed banks programs and institutionalization of crop selection and fertilization system are some achievements in the tenth plan period.

The three-year interim plan (2007/08-2009/10) has completely adopted the agro-biodiversity conservation objectives and strategies set by Agro-biodiversity Policy (2007), which has coverage of major issues regarding conservation, promotion and sustainable use of agro-biodiversity and related traditional knowledge through research, development and institutional arrangement for establishing community and public ownership on such resources. It includes registration and documentation of the resources, regulatory mechanisms for the resource conservation, promotion and utilization, farmers and state ownership on such resources and access to the benefits from the resources. Conserving agriculture, pasture-land and animal bio-biodiversity in 10 selective districts each and establishing a gene bank have been major programs emphasized in the plan.

5.2 Training

Staff deployed in plant genetic resources activities is not adequate. They have not been trained in conservation, gene bank management, seed health, molecular characterization, community biodiversity registration and documentation. Therefore, Gender Equity and Environment Division in the Ministry of Agriculture and Cooperatives and directorates of trainings in the departments of agriculture and livestock services have jointly been organizing trainings on biodiversity conservation, promotion and utilization in order to develop technical work force in different disciplines trained on national agro-genetic resources system. *In situ* Program (NARC), LI-BIRD, IUCN and Ministry of Forest and Soil Conservation have been supporting the program with required resource persons.

Institute of Agriculture and Animal Science, Rampur and Himalayan College of Agricultural Science and Technology, Bhaktapur have included PGRFA in course curriculum. Similarly, Department of Botany, Kirtipur has initiated Master degree course in Biodiversity and Environment Management in collaboration with Norwegian University. The course includes a brief introduction of agro-biodiversity along with international treaties and agreements related to biodiversity.

Literature review of various institutions indicates the needs and priorities to strengthen national capacity in education and training in the field of PGRFA:

- Trainers training / short course training
- Strengthening laboratory facilities
- Collaborative projects to facilitate exchange of professional/students for exchange and training outside the country
- Establish University of Agriculture and Animal Sciences

5.3 National legislation

5.3.1 Agricultural Policies and Legislations

Agriculture Perspective Plan (1995)

Agriculture sector has been recognized the largest source for broad based growth, which is to be achieved through effective implementation of the 20-year Agriculture Perspective Plan (APP) launched in 1997. The APP stresses for priority inputs (irrigation, agricultural roads, fertilizer and agricultural technology) to achieve priority outputs (increased production of fruits, vegetables, livestock, forestry and promotion of agri-business), in the process increasing both the level of resource availability and the efficiency of resource use (APP, 1995). The Plan has become a key strategy to alleviate poverty and enhance food security since the Ninth Plan (1997-2002) period.

National Agricultural Policy (2004)

The National Agricultural Policy (2004) outlines policy frameworks for achieving APP targets. The goal is to conserve, promote and utilize the natural resources, environment and biodiversity. In achieving such, the policy has strategies to adopt conservation oriented farming system and encourage *in situ* conservation of biodiversity.

Plant Protection Act (1972)

This is a pioneer legislation aimed at protection of plant species in Nepal. It is specifically enacted to regulate and control the epidemics of plant diseases and spread of crop pests through plants and plant products. Section 3 in the Act (i) provides the government with the authority of prohibiting import of any plant or plant produce from any country without prior consent, (ii) specifying necessary conditions to transport any plant or plant produce from one district to another within the country (internal plant quarantine) and (iii) specifying the responsibilities/authority of quarantine stations, checkpoints and laboratories for inspection and treatment of the plant and plant produce.

Seed Act (1988)

It is enacted to support production and distribution of quality seeds to increase crop yield, which has established a National Seed Board to advise the government to formulate and implement seed policy. The Board is authorized of regulating seed quality, approving and registering new seeds, determining seed standards and issuing seed certificates.

National Agro-biodiversity Policy (2007)

It addresses conservation, promotion and utilization of agro-genetic resources and community and state rights on them. The priority programs identified by the policy include scientific studies, research, extension and biodiversity registration and documentation. The policy also includes a working policy on *in situ* conservation, *ex situ* conservation, agro-biodiversity utilization, benefit sharing and biosafety. Under the policy, National Agricultural Research Council, National Seed Board, and District Agricultural Offices are adopting various strategies for *in situ* and *ex situ* conservation of agro-biodiversity (NPC/UNDP, 2005).

Nepal Biodiversity Strategy (2002)

The Nepal Biodiversity Strategy (NBS) is an important strategy in implementing the CBD and serves as an overall framework for the conservation and sustainable use of national biodiversity and biological resources in the country. The strategy reflects the national commitment to adopt a more holistic approach in conservation of biodiversity and sustainable use of biological resources through implementation of a number of cross-sectoral as well as sector-wise national biodiversity strategies for the management of habitat, species and genetic diversity in the country.

Nepal Biodiversity Strategy Implementation Plan (2006-2010)

The Nepal Biodiversity Strategy Implementation Plan (NBSIP) is a framework to materialize the vision of the NBS into practical actions for effective conservation of biodiversity and sustainable use of biological resources. The overall goal of the Plan is to contribute towards achieving the NBS objectives for biodiversity conservation, maintenance of ecological processes and systems, and equitable sharing of the benefits accrued. The Plan has recommended the following priority project concepts and implementation arrangements for successful implementation of the national biodiversity conservation strategies discussed earlier (GoN-MFSC, 2006a).

Biosafety Guidelines (2005)

The Biosafety Guidelines, framed by the Ministry of Forest and Soil Conservation in 2005, aim at balancing biodiversity conservation and public health-related concerns with the development of biotechnology in the country. The guidelines have paid specific attention to the Genetically Modified Organisms (GMOs) and their derivatives rather than the molecules and methods applied in assessing the potential risk posed by GMO. The guidelines has a provision of releasing GMO step by step only after assessing the potential adverse effects it causes and making sure that it will not have adverse effects on human health and the environment.

National Biosafety Policy (2007)

National Biosafety Policy has been framed with the objectives of protecting biodiversity, human health and the environment from adverse effects of research and development activities of modern biotechnology. This is an outcome of the government's realization of the significance of biosafety in conservation of biological diversity and safeguarding human health.

National Clean Development Mechanism of the Kyoto Protocol (2007)

Nepal signed the United Nations Framework Convention on Climate Change (UNFCC) on 12 June 1992, ratified it in 1994 and the Convention entered into force in the country on 31 July 1994. Under the Protocol, the Government of Nepal has developed a number of criteria and indicators for environmental protection and sustainable development. Some of the

indicators that are directly related to biodiversity are: (i) maintaining sustainability of local ecological functions, and (ii) maintaining genetic, species, and ecosystem diversity and not permitting any genetic erosion (GON-MOEST, 2007).

5.3.2 Formulation of national legislation

Nepal has formulated the following legislations:

- Access to Genetic Resources and Benefit Sharing (draft)
- Plant Breeders Rights and Farmers Rights (draft).

In the present era of globalization and liberalization of economy, it has been extremely complex to harmonize international treaties and agreements in national perspective. Regular multi-stakeholders' consultation on diverse issues related to conservation and sustainable use of PGRFA would help develop legislation that matches the national interest and international commitment. Global Policy Initiatives are essential to facilitate developing countries, like Nepal, in the process.

5.4 Information system

National Information Management Systems have not been developed to support efforts to sustainably use, develop and conserve plant genetic resources because of the growing nature of PGR organization. The Government of Nepal has initiated the construction of National Gene Bank with full financial support from national treasury. In the infancy stage, International Programme should extend full cooperation to establish national information management system in terms of human resources and infrastructure development.

5.5 Public awareness

Public awareness of the roles and values of plant genetic resources is at the satisfactory level. The concerted efforts from the government and non-government organizations involved in research and development system have led to application of participatory tools including the use of mass media, (radio and television programmes) national workshops /seminars in diverse locations, publications, biodiversity fair, interaction programmes, etc. for creating enhanced awareness of the issue. Demonstrating benefits from on-farm conservation to farming communities have paved the ways for attracting related stakeholders ranging from policy makers, politicians to farming communities. Financial incentives/ subsidy system is not in place for the conservation and sustainable use of PGRFA. The major emphasis is on value addition of PGRFA through breeding and non-breeding approaches to deliver economic, social and environmental benefits to farming communites and the nation.

CHAPTER 6

THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

Nepal has an array of cooperation and collaboration with international and regional organizations/ institutes since the beginning of research and development activities in the filed of plant genetic resources for food and agriculture. International Agriculture research Centres (Bioversity International, IRRI, CIMMYT, ICRISAT, ICARDA, AURDC, etc.)and FAO have been crucial in promotion of conservation and sustainable use of plant genetic resources since the adoption of the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and the World Trade Organization, Plant Genetic Resources has attract increasing attention in regional/ international fora, government and non- government organization and academic research. this has resulted into immense awareness of conservation and use of plant genetic resources. A number of reasons account for this development: the alarming loss of genetic recourses increasing patents in life form and disregard for traditional knowledge, restriction on exchange of germplasm, multi-lateral trading system, benefit sharing etc. The subject matter may further gain importance because of the recent food security concerns, rising prices and the global financial crisis. Economist argue that failure in economic front promotes the loss of genetic resources and traditional knowledge associated with the valuable resources. This justifies increased regional and international collaboration in the field of plant genetic Resources for food and agriculture.

Nepal is one of the member countries of South Asia Association for Regional Cooperation (SAARC). It provides an inter-governmental forum to discuss on diverse sectors including agriculture development, food security and exchange technology/ information. Recent meeting in 2008 has identified several areas for joint collaborative projects like Zero energy, yellow rust and stem rust (Ug99) disease of wheat, seed production, processing and packaging fruits, capacity building needs etc. Research scientists from the region have developed a project on "shuttle breeding in pulses" to be launched in Bangladesh, Bhutan, India and Nepal. It is expected that implementation of the project would enhance the exchange of germplasm and elite lines/ varieties among participating member countries. the exchange of varieties/ germplasms has been largely reduced after in CBD and the advent of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreement).

Nepal is also the member of South Asia Network for Plant Genetic Resources (SANPGR). The network pursues four objectives to:

- Assist countries to assess and meets their needs for conservation of PGR and to strengthen link with the users of PGR;
- Build international collaboration in the conservation and use of PGR;
- Develop and promotes improved strategies and technologies for pgr and integrated methods of conservation;
- Provide on information service to inform members of both practical and scientific developments in the field.

The SANPGR has been very effective in the exchange of information, development of South Asia strategy for global diversity trust, arranging short term trainings, crop specific collaborative projects on sesame, finger millet, etc. have been launched, however, the exchange of germplasm/elite lines/ varieties is still the limitation in the region since the inception of the network. The network has been facilitated by the Bioversity International.

National needs and priorities to strengthening international network for plant genetic resources are:

- Support national gene bank under construction for securing the collection in long term conservation facility
- Strengthen training of trainers, provide specific short course training and long course training.
- Facilitated access to germplasm and/or elite lines/varieties through shuttle breeding approach in the network member countries.
- Develop joint collaborative project o minor crops/neglected underutilized species.
- Implement complementary conservation activities to link gene bank with community seed banks/farming communities.

6.1 International programmes

6.1.1 On-farm conservation of PGRFA

"Strengthening the scientific basis of *in situ* conservation of agricultural biodiversity on-farm" is one of the most beneficial programme for plant genetic resources in the country. The project was designed jointly by, Nepal Agricultural Research Council (NARC), Local Initiatives for Biodiversity, Research and Development (LIBIRD) and Bioversity International (former IPGRI). The government of the Netherland and IDRC were the main funding organization

Sustainable management of agrobiodiversity on-farm results in from the continued support of farmers and their local institutions. The Nepal component of global *in situ* agrobiodiversity conservation project has developed innovative community based crop genetic resource management methods, tools and good practices for on-farm conservation which have been increasingly adopted in other *in situ* projects at the global level. These include approaches and tools of community management of crop genetic resources such as community biodiversity register (CBR), Biodiversity Fair, Participatory Plant Breeding (PBB). Strengthening local seed networks, and value addition and market linkage methods. These innovative community based approaches can be used for the effective management and sustainable use of crop genetic resources in the community as well as linking with the improvement of livelihood of rural poor. These are also the means and strategies to document, protect and develop sense of ownership, enhance farmers' access to diverse genetic resources as well as their sustainable use for future prosperity of mankind.

6.1.2 Genetic Resources Policy Initiative

A global Genetic Resources Policy Initiative (GRPI) has been launched in Nepal since early 2003. The project aims to strengthen the capacity of developing countries to design comprehensive policy framework for genetic resources. The project was designed in 3M (Multi-stakeholder, Multi-Sectoral and Multi disciplinary0 approach. The project employed mainly 3 approached: Policy awareness, action research and capacity building in integrating GRPI in national development. All together 21 stakeholders comprises GO, NGO, Private sectors, Seed entrepreneur and farming community were involved as task force of the project. The Bioversity International was the implementing agency of the project.

6.1.3 Identification of national PGRFA issues

The national multi-stakeholder workshop identified PGRFA issues, coordinating institutions and accordingly second phase proposal was developed in line with these prioritized issues.

6.1.4 Policy influence

GRPI activities were designed in line with national policy documents like the Tenth Development Plant, Agriculture Prospective Plan and Nepal Biodiversity Strategy. The inclusion of nationally recognized programmes and policies in GRPI has increased the inputs in national policy and legislation documents. Ministry of Agriculture and Cooperatives (MoAC) invited the GRPI-Nepal/ *In situ* Conservation Team to provide technical input and invited to draft national agrobiodiversity policy. The main objective of the National Agrobiodiversity Policy is the conservation and sustainable utilization of PGRFA and traditional knowledge to meet the present needs and aspiration of the future generation for future generations. In addition, the GRPI-Nepal project provided technical inputs to develop Sui Generis system for Plant Variety Protection and intellectual Property Rights (draft legislation). The project also provided the technical and other supports to organize several formal/informal interaction meetings/ workshop on ITPGRFA, farmers' rights and farmers' empowerment and GR policy issues, as the result the International Treaty on Plant Genetic Resources for Food and Agriculture has been endorsed by the parliament on 2nd January 2007 and the government of Nepal endorsed the National agrobiodiversity Policy on 5 March 2007. The NABCC has been initiated the task to prepare working strategy of National Agrobiodiversity Policy. The GRPI-Nepal provided necessary technical inputs to prepare bio safety framework of Nepal.

6.1.5 Capacity building

A set of activities has been carried out to enhance capacity of national stakeholders such as researchers, extension workers, private entrepreneurs and community base organizations by creating awareness and orienting them in genetic resource policy issues.

With the expertise of GRPI-Nepal team in the preparation of course curriculum, Tribhuvan University (TU) has initiated M. Sc. course in Environment and Biodiversity Management from 2008 agrobiodiversity and international treaties and agreement have been included in the course and Bio safety has also been included in the M. Sc. bio tech program in Tribhuvan University science and technology department.

6.1.6 Global rust initiatives

Steam rust, a devastating wheat disease is a possible threat in future for wheat growing countries in south Asia. The virulent race noted as UG 99 emerged from Uganda and now observed in Asia. Global Rust Initiatives with the support of CIMMYT is screening wheat germplasm in Kenya for identifying the source of resistance. Nepalese germplasm is showing promises to cope with the new challenge: genotypes namely ' WK 1627', 'WK 1628', 'WK 1639' and 'WK 1644'. this kind of joint collaborative project in the need of the day to promote the exchange of germplasm for addressing the issues of food security.

6.2 Needs and priorities for future international collaboration

6.2.1 Understanding state of diversity

- Collaborative projects on integrated PGR activities
- Human resource development
- Scientific database management
- Establish communication network

6.2.2 Enhancing *in situ* management

Areas to support improved plant genetic resources *in situ* management are:

- Empowering farming communities through value addition
- Linking on-farm conservation with national gene bank activities
- Diversity assessment. and promoting local innovation
- Diversifying the products and use of PGRFA for increasing market linkages
- Support dissemination of good practices for on-farm conservation and home garden diversity

6.2.3 Enhancing *ex situ* management

- Development of trained manpower to undertake research on conservation activities
- Development of protocols for diversity assessment using molecular techniques
- Develop electricity saving mechanism to reduce cost of conservation

6.2.4 Enhancing use of plant genetic resources

- Capacity building in plant breeding and biotechnology
- Support characterization and evaluation activities
- Collaborative projects on pre-breeding

6.2.5 Enhancing training needs and legislation

- strengthen training of trainers, provide specific short course training and long course training.
- Harmonization of international treaties and agreements in national perspective

6.2.6 Enhancing information management and early warning system on plant genetic resources

- Capacity building in information management and early warning system

6.2.7 Participation in international agreements, treaties, conventions, or trade agreements

- Nepal has ratified the CBD in 1993:
- Member of WTO, 2004:
- ITPGRFA, 2007
- GPA (Nepal was a party to Global Technical Conference), 1996

With the adoption of the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and the World Trade Organization, Plant Genetic Resources has created awareness of significance of conservation and sustainable use of PGRFA in government and non- government organization, community based organizations/ farming communities, academic institution and private sectors. This has led to development of national policy on agro biodiversity, inclusion of agro biodiversity in periodical plans and course curriculum and increased investment in the sector. However, the exchange of germplasm has not been facilitated because of sensitivity of ownership and IPRs.

CHAPTER 7

ACCESS TO PLANT GENETIC RESOURCES FOR FOOD OF BENEFITS DERIVED FROM THEIR USE, AND FARMERS' RIGHTS

7.1 Access to plant genetic resources

7.1.1 International agreements

Nepal signed the Convention on Biological Diversity (CBD) on 12 June 1992, ratified it on 15 September 1993, and became a party to the convention on 21 February 1994. Nepal also ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) on 2 January 2007. The Ministry of Forests and Soil Conservation (MoFSC) has been serving as the national focal point for the implementation of the CBD at the national level and the Ministry of Agriculture and Cooperatives (MoAC) as for the ITPGRFA.

In addition to these two international instruments, on 22 August 2007, Nepal also ratified the Convention on Indigenous and Tribal Peoples (No. 169) adopted by the International Labour Organization (ILO) in 1989. And, with the objective of expanding the opportunities for a meaningful and beneficial integration into the world economy and the multilateral trading system, Nepal also became a member of the World Trade Organization (WTO) on 23 April 2004. Nepal's commitment in the WTO includes the implementation of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), including the enforcement of a *sui generis* system of Plant Variety Protection (PVP) that protects the rights of plant breeders as well as "relevant stakeholders" such as farmers.

While the Ministry of Industry (MoI) is the focal point to coordinate the implementation of WTO agreements, the MoAC is tasked with the role of devising the national PVP and farmers' rights law.

7.1.2 Developed or modified national legislation and policies or taken other action in terms of providing access to plant genetic resources within the country and sharing of benefits derived from their use

The Government of Nepal - in its various policies, including the periodic national development plans - has expressed its commitment to the protection and management of biological diversity on a sustainable basis for the benefit of Nepal's present and future generations and for the global community as a whole.

With regard to the protection and promotion of agricultural biodiversity, the government, in its Three-Year Interim Development Plan (2007/08–2009/10), plans to support conservation, promotion and sustainable utilisation of agricultural resources by preparing an inventory of agricultural biodiversity; protect and promote traditional knowledge, skills, research, technology use and practices of farmers; and make arrangements for the equitable and judicious distribution of opportunities and benefits generated by the access and utilisation of agricultural genetic resources and materials.

7.1.3 Policies and legislation

The Nepal Biodiversity Strategy (NBS) had been approved in 2002 and its Implementation Action Plan in 2006. The NBS provides an operational planning framework for the conservation of biodiversity, the maintenance of ecological processes and systems and the equitable sharing of benefits. Similarly, draft bill on Access to Genetic Resources and Benefit Sharing (AGRBS) was prepared in 2002, following which a series of consultations with concerned stakeholder groups, including the groups of local and indigenous communities at the national and local levels have been concluded. The bill has not, however, been approved for implementation, and is expected to be enacted in 2009.

This legislation deals with rules and regulations concerning access to genetic resources and sharing of benefits arising out of the commercial use of genetic resources and associated TK. The bill also deals with prior informed consent (PIC) procedures, in addition to requiring the authority and the third party to conduct public hearing with the concerned stakeholders for obtaining PIC for access and bioprospecting.

Likewise, with the vision of promoting the conservation and sustainable use of agricultural genetic resources/materials and associated traditional knowledge (TK), and encouraging the participation of concerned stakeholders in both the processes, a National Agro-Biodiversity Policy has also been formulated in 2007. The Policy also intends to develop options for a fair and equitable sharing of benefits arising from the access and use of agricultural genetic resources and materials.

Besides these, several policies relevant to the implementation of the CBD have been introduced, for example, Herbs and Non-Timber Forest Product Policy 2004, Agriculture Policy 2004, and Biotechnology Policy 2006 and national agro-biodiversity policy, 2007.

7.1.4 Institutional arrangements

National Coordination Committee for Biodiversity Conservation (NCCBC) has been formed under the chairmanship of Honorable Vice-Chairperson of the National Planning Commission with 22 other members. NCCBC is composed of the following committees.

- National Biodiversity Steering Committee (NBSC) under the chairmanship of the Secretary of the MoFSC.
- National Agro-Biodiversity Steering Committee (NABSC) under the chairmanship of the Secretary of the MoAC (This committee deals with cultivated/domesticated crop related biodiversity).
- Biodiversity Registration Coordination Committee (BRCC) under the coordination of the Honorable Member (Agriculture) of the National Planning Commission.

7.1.5 Management action to maintain or enhance access to plant genetic resources located outside the country

The Government of Nepal as well as National Agriculture Research Council (NARC) has concluded some bilateral agreements and institutional contracts for facilitating access to plant genetic resources among the parties. However, these agreements and contracts have not been able to facilitate access, since gaining access to plant genetic resources is becoming more difficult over the past 10 years.

7.1.6 Difficulties in maintaining or enhancing access to plant genetic resources located outside the country

In view of the emerging concerns associated with benefit sharing, intellectual property rights, farmers' rights and biopiracy, complexities have arisen in undertaking management actions that are important for the maintenance and enhancement of access to plant genetic resources outside the country.

Contracting parties have even seen a kind of situation in which both parties do not respond to each other's enquiries concerned with access to specific plant genetic resources. This has not only obstructed the conservation efforts, but has also adversely affected agriculture research required for supporting the agriculture, food security and development goals of the country. A list of restrictions over access to certain plant genetic resources is provided in Annex VIII. Plant genetic resources for Food and Agriculture have not been included for restriction.

7.2 Fair and equitable sharing of the benefits of the use of plant genetic resources

7.2.1 Benefits arising from the use of PGR in the country and mechanisms for sharing benefits derived from the use of PGR

The AGRBS bill provisions for access and benefit sharing mechanism within Nepal, creating a monetary mechanism of benefit sharing among the government, the authority that implements the ABS law, and local and indigenous communities.

According to the mechanism, if the government is the owner of the resources, 50 percent of the benefits will be shared with the government, 30 percent with the authority and 20 percent with the communities. Similarly, if the local and indigenous communities are the owners of the resources, 51 percent of the benefits will be shared with them, 29 percent with the authority and 20 percent with the government.

In addition, the bill also provisions that out of the benefits received by the owners, 20 percent of the received benefits will have to be shared with local government institution for investment in the conservation and development of biodiversity.

7.2.2 Obstacles to achieving or enhancing the fair and equitable sharing of the benefits of the use of genetic resources

The major obstacles to achieving or enhancing the fair and equitable sharing of the benefits derived from the use of genetic resources are: lack of information about the use, value and importance of genetic resources, bioprospecting and breeding among stakeholders at large; lack of appropriate documentation and registration of resources (for example, identifying the multiple owners in different districts); limited institutional arrangements required to facilitate access, PIC as well as benefit sharing at both government and community levels; and the lack of dispute settlement mechanism at the community level.

The sharing of non-monetary benefits might also contribute to create confusions as it would be difficult to fairly and equitably share the benefits among the government, the authority, and the communities.

7.2.3 Importance of maintaining or enhancing access to plant genetic resources and benefit sharing

Maintenance and enhancement of access to plant genetic resources as well as benefit sharing requires adequate and effective arrangements at three levels: policy, institutional and practice. The strategic directions in this regard will have to be prepared in consideration of national and local issues, such as with regard to creating a linkage among the government, private sector, communities and civil society, including media for wider sensitization as well as implementation of rules and regulations concerning the ABS mechanism.

The enhancement of the capacity of government as well as community institutions, for example, for developing skills and ideas on the registration of biological and genetic resources, and associated TK; management and mobilization of the benefit sharing (genetic resources) fund; and negotiations for mutually agreed terms is also critical.

Without institutional arrangements at the national and local level, identifying both the concerned government and community institutions, it will be complicated to maintain or enhance access to plant genetic resources and benefit sharing.

7.3 Implementation of Farmers' Rights

7.3.1 International agreements relevant to the implementation of Farmers' Rights

Nepal ratified the ITPGRFA on 2 January 2007, and is committed to implement provisions to facilitate access to plant genetic resources for food and agriculture as well as devise a national mechanism to protect farmers' rights, some of which are also dealt in the Treaty.

The Government of Nepal has also expressed its commitment to provide protection to plant varieties through breeders' rights during the country's accession to the WTO. In its commitment, the government has mentioned that it would devise *sui generis* PVP system that does not authorize patents on plant varieties but guarantees the rights of breeders as well as "relevant stakeholders" such as farmers.

7.3.2 Developed or modified national legislation and policies to achieve or enhance the implementation of Farmers' Rights

Following the ratification of the ITPGRFA, MoAC and NARC have been working to identify policy options and mechanisms to protect farmers' rights related to plant genetic resources for food and agriculture. The government has prepared a bill for enforcing a national mechanism to protect farmers' rights.

Some civil society organizations such as South Asia Watch on Trade, Economics & Environment (SAWTEE), Local Initiatives for Biodiversity, Research and Development (LI-BIRD) and Forum for Protection of Public Interest (PRO PUBLIC) have also been working with the MoAC and NARC to identify options and mechanisms to protect farmers' rights under the PVP system. The PVP bill has already been prepared by the MoAC.

The significance of protecting farmers' rights in Nepal needs to be understood from the fact that Nepalese farmers have not merely been contributing to farming and agricultural biodiversity conservation as guardians and custodians of plant genetic resources but, as breeders, have also developed several varieties that are crucial for agricultural biodiversity and food security.

7.3.3 Obstacles to achieving or enhancing the implementation of Farmers' Rights

The major obstacle to implement farmers' rights is to find the policy, institutional and practical mechanisms and approaches to balance the rights of breeders and farmers. The judicious use of or promotion of biotechnology is crucial in this process, and importantly, there should also be a mechanism that advances traditional agricultural systems and practices, for example, with regard to protection to farmers' varieties as unique forms of intellectual property rights. It is also important to note that intellectual property rights are a tool that can support agriculture development through the creation of ideas, knowledge and innovations in the agricultural sector but, to a great extent, they may also affect the traditional patterns of farming and livelihood of farmers.

Thus, intellectual property regime needs to be tailored to the conditions within Nepal, keeping in view the specific development needs and priorities in the agricultural sector. The goal should be to provide incentives for seed sector development through intellectual property rights such as trademarks, trade secrets and plant breeders' rights but such incentives should not create unnecessary limitations on the practices and livelihoods of farmers.

CHAPTER 8

THE CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

8.1 The need for a PGRFA management system

PGR are some of the major biological assets available to the resource poor farmers that can be harnessed for sustainable production and improve livelihood options. Conservation of Plant Genetic Resources is essential for maintaining the variation and gene complexes for current and future crop improvements and meet needs in response to an ever-changing environment and circumstances.

PGR are not only valuable to farmers of today but these also be potentially could valuable to future generation of farmers, professional breeders and consumer elsewhere. The value of PGR lies in their evolutionary potential and future use in plant breeding. The challenge now is how to capture this public value and manage for sustainable use and eliminate danger of being extinct. From an economic perspective, in the changing local and global context, there is a need to develop management system based on methods to identify and predict genetic resources of high private and public value in order to devise lease-cost policy instruments to support on-farm conservation of crop plants in a particular area. Because the social benefits of conserving PGR are often intangible, widely spread and not fully reflected in market prices, the benefit of conserving evolutionary potential are not reflected fully in financial cost-benefit analysis.

Plant Genetic Resources are essential to the nation as well as to the world for the following functions:

- Sustainable production of food and other agricultural products, including providing the building blocks for the evolution of deliberate breeding of useful new crop varieties.
- Biological support to production via. soil biota, pollinators, and predators
- Wide services provided by agro-ecosystems, such as landscape protection, soil protection and health, water cycle and quality, air quality that contributes to the sustainability of environment.

The most common methods of conservation *ex situ* have been complemented through *in situ* conservation at household level in recent decades. However, the introduction of exotic and modern crop varieties is causing problems in conservation of PGR *in situ* at household level. Therefore, Community seed banking is one of the emerging and suitable alternative methods for *in situ* crop conservation which is found very effective in the Kachorwa of Bara distircts. A community seed bank consists of network of the local people, organized for the purpose of seed production, use and marketing of the local genetic resource for conservation. This is a method of *in situ* conservation of crop genetic resources where people maintain the genetic diversity on-farm by cooperating to establish the seed network. Establishment of demonstration block, seed production block and ensuring seed availability according to the demand of the public is the major activity in community seed banking. The community led seed bank needs to be supported by community based biodiversity management (CBM) and Community Biodiversity Register (CBR) that are community-led participatory approach to *in situ* conservation of agro-diversity on-farm by strengthening capacity of farming communities in mobilizing local knowledge and expertise, resources and local institutions. These approaches are very helpful to develop the better understanding of status and values of their biodiversity assists, and use this resulting information to develop sustainable conservation strategies at the local level.

8.2 Contribution to sustainable agriculture

Sustainable means keeping efforts or things continuously. This is the development without destruction. It is to meet the needs of present without compromising the ability of future generations to meet their own needs. Therefore, sustainable Agriculture means production of Agricultural commodities with appropriate soil, water and pest (harmful insects, parasites, disease etc) management and without exerting any negative effects in the soil, environment and human health. So that, all basic requirements of Population and in the future will be fulfilled. Organic agriculture or natural farming may be considered as synonyms of sustainable agriculture. The sustainable agriculture should have the following criteria:

- Ecologically sound: i.e. that should use, maintain and minimize the losses of natural resources (Crops, animals, organisms or biodiversity etc)
- Economically viable: pay sufficient return to investment and provide self-sufficiency.
- Technically feasible: Such that all people of the society have the opportunity to test and adopt the technologies easily.
- Socially acceptable: Such that agricultural development activities or efforts should be acceptable to the communities or the ultimate users.

Traditionally, agriculture in Nepal was depended upon local natural resources such as recycling of organic matters, using diverse types of agro-biodiversity, long fallow-period, no tilling in steep slope and so on, which were self sustaining and environmentally friendly, provided crop density is not too high. These practices still exist in large part of hill farming systems. Though there is less output or income in areas of such practices, there is no major challenges for the declining soil fertility and economic viability challenges to sustainable agriculture have increased in areas with agriculture development interventions which have been concentrated in terai, valleys end in other accessible areas. The major agricultural problems in Nepal that challenges the sustainability are as follows.

- Excessive use of external inputs
- Declining of soil fertility
- Less attractive agriculture production enterprise for farmers.
- Increased poverty and heavy pressure on land.
- Lack of awareness of organic products
- Lack of sustainable orientation in development interventions.

This has come to mean the use of biological relationships within the farm agro-ecosystem to reduce reliance on external inputs and improve productivity, and is clearly an approach of direct relevance to using agricultural biodiversity for sustainable livelihoods. Farmers in traditional systems already rely heavily on Integrated Crop Management Approaches, because of economic and practical barriers to accessing agro-chemicals, but the industrial-type agricultural systems it is only recently that farmers and scientists have come to realize the value of these approaches. Integrated Pest Management (IPM) is perhaps the best known Integrated Crop Management approach, using better management of pest-predator relationships to reduce reliance on chemical pesticides and increase productivity. In addition, this whole system approach can also be used to improve crop nutrient management, by managing below ground biodiversity, including plant root architecture, rhizobia and soil biota, etc.

In Nepal home gardens and farm land is one of the major driving forces behind the development of agricultural sector, and on-farm maintenance of agricultural biodiversity. Nepalese farmers widely practice mixed farming, which involves a high interdependence between crop production, livestock rearing, and use of tree resources from community forests and/or farm-managed trees. They have intricate knowledge about the nature, production management and use value of a wide range of plant species. They extensively use such traditional knowledge (TK) to maintain and develop a wide range of varieties of desired traits that address their diverse needs.

For contribution to Sustainable Agriculture the appropriate management of PGRFA should be done. In Nepal different Participatory approaches have been adopted for contributing the sustainable use of PGRFA for example: the landrace *Jethobudo* which was about to be eroded from the farmers' field has been enhanced through participatory method with farmers initiatives of NGO and Public Research System. Now, the improved *Jethobudo* is cultivated by large numbers of farmers.

BOX 1
Landrace enhancement: A case study of JethoBudo

The Convention on Biological Diversity (CBD) has recognized the continued maintenance of traditional varieties *in situ* as an essential component of sustainable agricultural development (FAO, 1998). Landraces or farmers' traditional cultivars are important biological resources for resource poor farmers to ensure sustainable production and improve livelihood options. This is the foundation upon which plant breeding depends for the creation of new varieties and, therefore, landraces have a critical public value for global food security.

Participatory landrace enhancement and selection is one of the on-farm management strategies for searching, selecting, maintaining and exchanging economically valued rice varieties. The on-farm conservation method used with the locally popular rice landrace *Jethobudo* was studied by NARC, LIBIRD and Bioversity International (formally IPGRI) in the Pokhara valley of Kaski District. The study aims to find out whether some farmer-preferred economic traits *of Jethobudo l*andrace population could be enhanced and also to see whether landraces of economic value could be conserved per se by enhancing some economic traits, and whether community-based seed production system can integrate incentive mechanisms for custodian farmers or a farming community for promoting on-farm conservation.

From 338 seed sample*s of Jethobudo rice* landrace collected in 1999 from the seven mivto niches, diversity was assessed for consumer-preferred post harvest traits during the 2000 and 2001 seasons. Significant variations in market traits were found in the studied populations. In 2006, six most preferred populati*ons of Jethobudo rice* were selected for quality traits and variety was released by the National Seed Board of Nepal under the name o*f "Pokhareli Jethobudo" in 200*6. Community based seed producer groups multiply foundation and truthfully label seeds and market through extension, private and NGOs outlets to generate income.

Plant genetic resources provide various goods and services which has great contributions to sustainable agriculture and livelihood improvements. The value of the goods and service may be direct value or indirect value. For sustainable use of PGR over-exploitation of resources should be decreased and should ensure continued provision of genetic resources by incentives and fair and equitable sharing of benefit derived for the stakeholders who manage the PGR.

8.3 Contribution to food security

In Nepal, many mountainous and hilly regions are fully dependent on PGRFA besides major food crop like Rice, Wheat and Maize. Nepal though was exporting food mainly rice upto 1980's, but in recent years it is facing food deficiency mainly due to increasing population. Although food production is marginally surplus, 55 of the 75 districts are categorized as food deficient. Two fifths of 3.4 million land holdings in Nepal produce enough food for less than six months. Food production in the mountains remains short of the requirement by 34-45%. In the hills, the deficit is between 15-30%. The high hills district like Humla, Jumla, Mugu etc are facing food deficient and are mainly dependent on minor cereals like Millet and other underutilized crops.

Different local landraces and improved cultivars are grown in the Country. The rate of variety change is very low and a limited number of varieties are being popular after release and other unpopular varieties are wiping out. Only a small portion of farmers use improved seed of different food and horticultural crops through formal seed supply system. About 90% of farmers' seed of major crops are met through informal seed system in Nepal and this proportion is much higher in case of locally grown or in neglected crops. Access to improve seeds and plant Genetic Resources is vital for the food security and sustainable development. Studies show that the inadequate access to the high quality genetic resources, seeds and knowledge are major constraints faced by the rural and the poor farmers.

In Nepal, due to its high agro-ecological diversity an important reservoir of genetic resources also occur which can be utilized for solving the diversity problem of global food deficiency. If the country fails to undertake effective measures to address the loss of Plant Genetic resource, it would not only make farmers more vulnerable but would also worsen the situation of food security. For Least Developed country like Nepal, such loss of Plant Genetic Resource is also a major concern from the viewpoint of poverty reduction, rural development and ecological balance. The government should, therefore, pay increased attention towards implementing the measures that promote the conservation of Plant Genetic Resources and its sustainable use.

Nepal Demographic and Health Survey, 2006 reported that about 49.3 percent children below 5 years were affected by stunting (short of their age), which can be a sign for early chromic under nutrition. The survey also found that 38.6 percent of the children were under weight in 2006. which is an indicator of acute malnutrition in the nation. It is clear that Nepal needs to increase its food and agricultural production to fulfill the demand of its malnutrition children and food deficiency in which plant Genetic Resources play important role.

A case study revealed that the contribution of landraces for food security is significantly important in Nepal. Dependence on landraces for food security is significantly higher in marginal environments (100%) compared to high production potential system (17%). Social seed networks were found to be a secure source of locally adapted seed. Since local landraces are the only secured assets available to resource-poor farmers for sustaining their livelihood and managing vulnerability, access to and control over such resources are a critical policy issue.

BOX 2
Community Seed Bank

From the past study and experience the reliable and effective option for Biodiversity conservation in Nepal is Community Seed Bank for enhancing local seed security in Bara District of Nepal. The management program was started by the Community Biodiversity Register group which was renamed as the Agriculture, Development and Conservation Society (ADCS) in the support of on-farm conservation program through NARC, LIBIRD and Bioversity International. Later GEF also supported the ADCS for diversifying the activities of Community Seed Bank. Besides National and International Organizations, Local Women groups, Local authority, Non-Members and local elite individuals also support physically and goods for the construction of seed bank. Now, members of ADCS contribute voluntarily to the management of stored seed.

In Kanchorwa, Nepal, Farmers experienced rapid loss of rice landraces along with a significant decrease in the area under cultivation in a short span of time. This could have been due to several reasons; But the study team identified a threefold factor responsible for this accelerated process. First, access of farmers to better options improved varieties second, lack of quality seeds and availability of cultivation practices, and the third was certain government policies that served as disincentives to landraces growers.

The main operation systems of the community seed bank in Bara district include collection and identification of all available seeds of landraces. The collected seed were stored by using locally available seed storage materials. The collected seeds are distributed based on the traditional *Dedha* system. In this system, after harvest the farmers will pay back 150% of source seed from where they had barrowed. The collected and stored seed are continuously improved through selection by maintaining diversity block and participatory plant breeding.

To date, 60 landraces of rice, 5 of sponge gourd, 3 of pigeon pea and 2 of finger millet seeds have been collected and stored in the seed house and this number is increasing. A series of elite varieties namely- Kachorwa-4, Kachorwa-5, Kachorwa-11 and Kachorwa-17 have been developed. These varieties possess high yielding attributes along with farmers preferred traits.

The community seed bank is leading to sustainable local seed security. It fulfills the community's requirement for quality landrace seed and helps to increase farmers' access to quality seed as a means of conserving local crop diversity to maintain on-farm. The study found the level of awareness of community people on conservation of PGRFA and capacity of Community based organization has been enhanced after establishment of community seed bank at Kachorwa. An initial effort of this approach has shown the encouraging results in on-farm conservation of agricultural biodiversity and hence a partnership between plant breeding program, agriculture development agencies and community seed bank need to be developed for better utilization of local crop landraces conserved at community seed bank.

8.4 Contribution to economic development

Economists identify various categories of the values of Plant Genetic Resources. However, the economic valuation of many aspects of PGR remains problematic. Direct uses of PGR include a range of products which provide dietary diversity and make important nutritional contributions (Provision of minerals, vitamins and protein; hunger crops). They include:

- Consumptive uses: goods that do not appear in national economic statistics, but which local people need (e.g. medicinal plants, wild vegetables, building material), can be valued at the cost of market alternatives.
- Productive uses (goods sold in commercial markets) and conventionally valued at the net price at the point of sale. Additionally, the PGR can generate improvements in yields through plant breeding.

Indirect uses of Plant Genetic Resources include production effects such as adaptation to lower input conditions; specific adaptation (intra-farm and inter farm); reduction of risk; potential for high biological production; and having a range of varieties and species with complementary agro-ecological requirements. Some scientists have also identified PGR as 'Portfolio value' whereby losses due to the complete failure of a particular crop are compensated for by the yield of other crops.

The 'Option value' of biodiversity is the potential of PGR to provide economic benefit to human society in the future.

- Insurance value: insurance against future adverse conditions, as needs are constantly changing and because genetic resources may later prove to provide useful characteristics, for example resistance to new disease or adaptability to changed climatic conditions; and
- Exploration value: Plant Genetic Resources represents a treasure chest of potentially valuable but as yet unknown resources.
- 'Non-Use' value include the Existence value (for biological communities, or areas of scenic beauty) this is often valued in crude terms at the amount people willing to pay to prevent a species from going extinct or an area being developed.

There is the inevitability of conflicts between the vastly differing interests of diverse stakeholders in Plant genetic resources, exacerbated by their dramatically different degrees of effective voice and market power. There is a need to promote mechanisms that return a fair proportion of benefits to the stakeholders who manage PGR at the local level. Additionally, non-market uses of PGR (for example, the provision of ecosystem services and functions) require public support to ensure their continued provision.

The private and public breeders, who provide modern varieties, are utilizing PGRFA as raw material for their breeding activities (material value). Besides utilizing the material value for the short and medium-term perspective, breeding companies are also interested in the long-term perspective of the heritable value of genetically coded information. Development of seeds and biodiversity will create market for Local PGR. Similarly use of marketable and underutilized species need to be promoted.

8.4.1 Market incentives for conservation of PGRFA

Many people are challenging the notion of on-farm conservation of agro-diversity by arguing that it implies substantial costs to farmers and society in term of other opportunities foregone. At the same time, some scientists have demonstrated the success of conserving unique biodiversity through market promotion. In principle, market options are the least expensive instruments for pursuing on-farm conservation since when markets function well; there is no need for public interventions such as direct producer subsidies. Realizing these facts, efforts were made to link agro-biodiversity with its niche market in order to explore market promotional activities that make biodiversity rich farming system profitable at market economy and to understand how market incentives could support on-farm conservation of agro-biodiversity.

8.4.2 Increased farm income

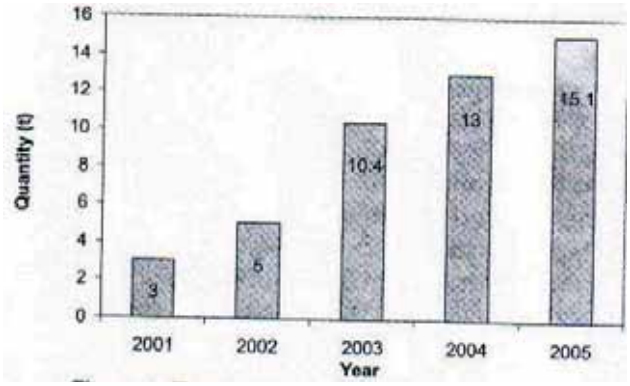
Marketing local biodiversity is coming up as an emerging option of income generation to support the livelihood of all categories of farmers. Linking biodiversity with market has encouraged farmers to generate cash income not only from local crops but also to internalize market for most of their farm commodities. Farmers who use to grow most of the crops only for household consumption has now started selling some of the products (raw, processed and value added) in market thereby supplementing to their household income. It was found that some local agricultural products produced around Pokhara valley have special qualities that make them more promising for getting premium price. For example, *Jethobudho* and Pahenle rice of Pokhara valley, the *Khari* and *Hatipau* variety of taro produced in Serabenshi and Begnas,

Butter Bean produced in Amalachaur and Black gram and Cowpea produced in many areas of Tanahu district including Serabenshi are very popular among consumers. This special product quality makes consumers willing to pay even slightly higher prices and farmers are getting higher prices of these crops which helped for their continued production.

8.4.3 New product development

Consumers in urban areas, particularly the young generation, increasingly look for the taste of novel and exotic foods. Therefore, developing the products for niche market and consumers from the local crops was one of the strategies taken for their market promotion. Different private entrepreneurs were encouraged to develop range of products and test them in market with the technical support of food expert. As a result, some of the private companies such as Annapurna Bakery, Khudahar Khaja, Pokhara Commercial Womens' Group, Digo foods are preparing different food items from finger millet and buckwheat. Similarly, some entrepreneurs like Sital Agro-products, Srijanashil Women's Groups are involved in marketing of local agricultural products. This has increased the demand of local crops in market which has been an incentive to farmers for continued production of such crops thus contributing to on-farm conservation. For example, development and marketing of different products form finger millet has increased the demand of finger millet in Pokhara valley for last few years (Fig. 1).

FIGURE 1
Trend of finger millet supply by SitalAgro-products in Pokhara



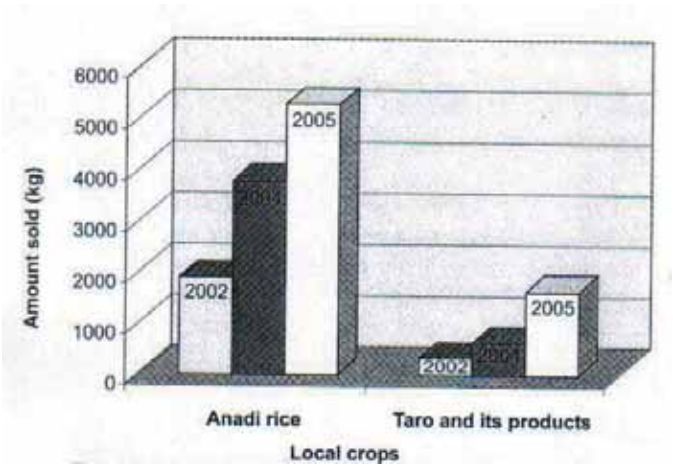
Furthermore, the demand of the products derived from local crops is also increasing in Pokhara valley due to increased awareness on health and nutrition. There is also scope for introducing these local crops based products to schools. It is expected that the demand of the local agricultural products in Pokhara will further increase in future and this will be the motivating factor for farmers for their continued production. This will not only contribute to the livelihood of farmers but also help conserve agricultural biodiversity on-farm.

8.4.4 Linkage and market chain development

Farmers are producing range of local crops from generation. They also have generation long knowledge and skill in preparing different value added products from the local crops. For example farmers were preparing *maseura, tandra, gava, gundruk* on their own for home consumption. Tapping these local skills and knowledge, farmers' capacity was increased for quality production and scattered from of production was consolidated for market promotion.

A number of market channels have been developed for marketing local crops and their products around Pokhara Valley. In some cases, farmers themselves sell their products during their leisure time of farming. Further, there are some persons (*dokes*) in Pokhara and nearby villages who collect the local products from producers, bring them to the market and sell in bulk to the entrepreneurs and also to the consumers through door to door delivery systems. The entrepreneurs finally market these products through different market outlets. Shital Agro-products, Srijanashil Women's Group, Anapurna Bakery, Kundahar Khaja, Madhav's Café, Digo foods are some of the micro-entrepreneurs involved in processing and marketing of local crops and their products at different scale in Pokhara. In this way, farmers' products are coming to market through different marketing system contributing to the household income of farmers which has been incentives for growing diversity of crops. As a result of increased market access the area under different crops such as perilla, bean, cowpea, taro, anadi rice etc. has been increased in some villages around Pokhara valley (Fig. 2).

FIGURE 2
Annual transaction of Anadi rice and Taro from 2002to 2005 by Pratigya Cooperative



8.5 Contribution to poverty alleviation

Poverty and unemployment are widespread in Nepal. A large majority of people experience food deficit. Agriculture represents the major share of GDP (36.1 %) and provides livelihood more than 65% of population living in rural areas. Agricultural Productivity is very low ($ 140 per agricultural worker) by international standards. Even though land productivity is higher (at $ 649 per hector of agriculture land), the small land holdings size (about 0.9 ha) implies that household income is also low. Since vast majority of the population depends on agriculture for their livelihood and most of this population is in poverty.

BOX 3
Commercialization and Marketing Process of Local PGRFA

The study on underutilized local PGRFA was conducted by ABTRACO, market survey in Kathmandu valley and less urbanized Tansen -a town in mid hills was done for various local PGR Products that included also the products of Local species belonging to Neglected and Underutilized species such as *Maseura*, Buckwheat flour, Finger millet flour, *Gundruk*, Soybean, Horsegram, Perilla, Sesame, Rice bean, Cowpea, Bhang, Blackgram, Timur, Jimmu, and Ash gourd.

The number of consumers buying local products from the stores and wholesalers ranged from 5 to 500 per week in Kathmandu valley. Reasons for buying these products are because of the assumed medicinal value of such products and also as new exotic items for foreigners. Most of the stores expressed their interest to deal with these products. They also reported that exportable markets of such products are India, Japan, Israel and USA. The study reported that there are high possibilities of promoting value addition enterprises for some of the selected local PGRFA like Buckwheat, Millet, Taro, Sesame, Ricebean, Yam, Perilla, Horsegram etc.

This shows that the demand of local PGRFA is increasing and the market channel is rising which will be the mild stone for the management of the local PGRFA and that will ultimately generated employments and incomes of the local farmers.

The existing diversity of PGRFA is endangered to decline determined by the competitive advantage of modern to farmers' varieties. It is assumed that *in situ* as well as *ex situ* conservation of PGRFA is necessary to maintain a high level of plant genetic diversity, benefiting a sustainable agricultural development. Although there are significant costs involved in the conservation efforts.

A new approach to sustainable management of plant Genetic Resources is needed in which local, national and global action should be integrated. This involves:

- Cross-sectoral action
- a combination of policy and area-based approaches
- a decentralized knowledge-intensive approach to technology development where farmers are full participants in the process;
- strengthening of local institutions
- a high degree of policy input into arrangements for managing and sharing PGR because of the significant differences in biodiversity between people, countries and regions.

It is essential to change the economic incentives, and institutional and policy barriers that currently discourage the sustainable use of Plant Genetic Resources

The government should prioritize Community-based Biodiversity Management (CBM) programme across all regions. In particular, technical and financial support for community seed banks for seed conservation and Participatory Plant Breeding (PPB) for seed development should be extended to all parts of the country. These activities can play an instrumental role in strengthening traditional agricultural systems and promoting their sustainable use for the benefit of farmers as well as society. However, the government should implement such programmes keeping in view the need to protect the plant genetic resources.

ANNEX 1

IMPORTANT MINOR FOOD CROPS OF NEPAL

S. No.	Local Name	English Name	Scientific Name
1	**Grains:**		
	Phapar	Buckwheat	*Fagopyrum eculentum*
	Jain	Hog millet	*Avendabyzantina* sp.
	Jaun	Barley	*Hordeum vulgare*
	Uwa	Uwa	*Andorogen sorghum*
	Kagano	Foxtail/Italian millet	*Setaria italica*
	Bajra	Bajra	*Pennisetum typhoideum*
	Junelo	Jowar	*Sorghum vulgare*
	Chino	Ragi	*Panicummiiaceum* sp.
2	**Pulses:**		
	Mash	Blackgram	*Phaseolus mungo*
	Gahat	Horse gram	*Dulichos biflorus*
	Mung	Green gram	*Phaeolus aurevs*
	Rahar	Red gram/Pigeon pea	*Cajanus cajan*
	Masyang/Gurans	Month beans	*Phaseolus aconitifolius*
	Chana	Bengal gram/Chickpea	*Cicer arientinum*
	Khesari	Khesari	*Lathyrus ativus*
	Matar/Keraun	Garden pea	*Pisum sativum*
	Bakulla	Broad bean/Horse bean	*Vicia faba*
	Bodi	Cow pea	*Vigna sinensis*
	Simi	Filed bean	*Doclichos lablab*
	Rajma	French bean	*Phaeolus vulgaris*
	Bhatamas	Soybean	*Glycine max*
3	**Green Vegetables:**		
	Lunde	Amaranth	*Amaranthus spinosus*
	Chaulain	Araikeerai	*Amaranthus tristis*
	Bethe	Bethe	*Chenopodium album*
	Chukandar	Beet green	*Beta vulgaris*
	Chana ko saag	Bengal gram leaves	*Cicer arientinum*
	Lauka ko munto	Bottle guard leaves	*Lagenaria vulgaris*
	Bakulla simi ko saag	Broad bean leaves	*Brassical oleraceavar*
	Ganjar ko saag	Carrot leaves	*Brasical oleracea*
	Celery saag	Celery	*Apium gravelen*
	Karkalo ko saag	Colocacia leaves	*Colocacia antiquoxum*
	Hariyo dhaniya	Coriander leaves	*Coriendrum sativum*
	Bodi ko saag	Cowpea leaves	*Vigna catiang*
	Sajihan ko saag	Drumstick leaves	*Moringa oleifera*
	Methi ko saag	Fenugreek leaves	*Trigonella foenum*
	Chamsur ko saag	Garden cress	*Lepidium sativum*
	Chariamilo	Garnden sorrel	*Oxalee corniculata*
	Lasun ko saag	Garlic leaves	*Alium sativum*
	Kheshari ko saag	Kheshari eaves	*Lathyrus sativus*
	Gyath govi ko saag	Knolkol greens	*Brassicae oleraceae*
	Koiralo ko saag	Cink bauhinia	*Bauhinia purpurea*

S. No.	Local Name	English Name	Scientific Name
	Salad/Miri ko saag	Lettuce	*Lactucasativa* sp.
	Latte ko saag	Love-lies bleeding	*Amaranthus caudatus*
	Poi saag	Poi saag	*Basella rubra*
	Padina/Babari	Mint	*Mentha spicata*
	Tori ko saag	Mustard leaves	*Brassica campestris*
	Nundhikki ko saag	Kitchen garden purslane	*Portulaca oleraceae*
	Patuwa ko saag	Patuwa leaves	*Corchorus capsularis*
	Aalu ko saag	Potao leaves	*Solanum tubersum*
	Pharsi ko munto	Pumpkin leaves	*Cucurbita maxima*
	Mula ko saag	Radish leaves	*Raphanus satuvus*
	Rayo ko saag	Rape leaves	*Brassica napu*
	Kusum ko saag	Sunflower leaves	*Carthamu tinctorius*
	Palaungo ko saag	Spinach leaves	*Spinacia oleraceae*
	Bhatmas ko saag	Soybean green	*Glycine max*
	Sskarkhand ko saag	Sweet potao greens	*Ipomoea batatus*
	Iamali ko saag	Tamarind greens	*Tamarindus indicus*
	Salgam ko saag	Turnip green	*Brassica rapa*
	Sim ko saag	Water cress	*Naturtium officinale*
	Golbhenda	Tomato	*Lycopersicon esculentum*
	Rukh tamatar	Tree tomato	*Cyphomandra betacca*
	Chyau	Mushroom	
	Kubhindo	Ashgourd	*Benicasa hispida*
	Lauka	Bottlegourd	*Lagenaria vulgaris*
	Tito karela	Bittergourd	*Momordica charartia*
	Bhanta	Brinjal	*Solanum melongena*
	Chhyapi	Leek	*Allium porrum*
	Bakulla simi	Broad bean	*Vicia faba*
	Cauli	Cauliflower	*Brassica olereceae*
	Squish	Cho-cho marrow	*Scchium edule*
	Jhuppe simi	Clester bean	*Cyamopi tetragonoloba*
	Karkalo ko danth	Colocacia stem	*Colocasia autiquorum*
	Hariyo bodi	Green cowpea	*Vigna catjan*
	Kakro	Cucumber	*Cucumis sativus*
	Asare simi	Double bean	*Faba vulgaris*
	Sajihan	Drum stick	*Moringa oleitra*
	Hiude simi	Field bean	*Dolichos lablab*
	Simi	French bean	*Phaseolus vulgaris*
	Bhende khursani	Giant chilly	*Capsicum annum*
	Kathar	Jack fruit	*Artocarpus heterophyllu*
	Gyanth govi	Knolkhol	*Brassica oleraceae*
	Ramtoriya	Ladys finger	*Abelmoschus esculentus*
	Badahar	Lakooch	*Artocaropus lakoocha*
	Kamal ko danth	Lotus stem	*Nelumbium nelumbo*
	Kancho aanp	Green mango	*Mangifera indica*
	Pyaj ko danth	Onion stalk	*Allium cepa*
	Pyaj	Onion	*Allium cepa*
	Kancho mewa	Green papapya	*Carica papaya*
	Parwal	Parwar	*Trichosanthes dioca*
	Keraun	Pea	*Pisum sativum*
	Rato simi	Pink bean	*Phaseolus* sp.
	Kera ko bungo	Banana flower	*Musa sapientum*
	Kera ko danth	Banana stem	*Musa sapientum*
	Kancho Kera	Green banana	*Musa sapientum*

S. No.	Local Name	English Name	Scientific Name
	Pharsi	Pumpkin	*Cucurbita moxima*
	Pharsi ko phool	Pumpkin flower	*Cucurbita moxima*
	Pharsi ko munta	Pumpkin leave	*Cucurbita moxima*
	Rayo ko duku	Rape plant stem	*Brassica napus*
	Rahar ko kosha	Green redgram	*Cajanus cajan*
	Ghiraunla	Ridgegourd	*Luffa acutangula*
	Sanai ko phool	Sunhemp flower	*Cortalaria juncea*
	Simal ko phool	Silk cotton flower	*Bombax malbarium*
	Chichinda	Snakgourd	*Trichoanthes anguina*
	Palungo ko danth	Spinach stalk	*Spinacia oleraceae*
	Tante/Tarware simi	Sword bean	*Canvalia gladiata*
	Tinda	Tinda	*Citrullus vulgaris*
	Golbheda	Tomato	*Lycopersicon esculentum*
	Kurilo		
	Kamal ko phool	Water lily	*Wymphaea nouchali*
	Singada/Pani phal	Water chestnut	*Pastalum sorobiculatum*
	Koiralo	Mountain ebony	*Bauhinia variegata*
	Kavro	Banyan	*Ficus virens*
	Neem ko saag	Neem leaves (tender)	*Azadirachta indica*
	Bans ko Tama	Bamboo tender shoot	*Bambusa arundinacea*
	Hattibad/Kettuke ko Tama		
4	**Roots and Tubers:**		
	Kera ko jara	Banana rhizome	*Musa paradisica*
	Chukandar	Beet root	*Beta vulgaris*
	Ganjar	Carrot	*Dacus carota*
	Pindalu	Colocacia	*Colaria antiquerum*
	Lasun	Garlic	*Allium sativum*
	Ghar Tarul	Yam	*Dioscora* sp.
	Ban Tarul	Wild yam	*Dioscorea versicolor*
	Githa		
	Vyakur		
	Kamal ko jara/Serakhi	Lotus root	*Nelumbium nelumbo*
	Haledo	Mango Ginger	*Cacuma amada*
	Pyaj	Onion	*Allium cepa*
	Aalu	Potato	*Solanum tuberosum*
	Mula	Radish	*Raphanus sativus*
	Sakarkhanda	Sweet potato	*Ipomoea batatus*
	Salgam	Turnip	*Brassica rapa*
	Ole	Yam elephant	*Amorphopharlus campanulatus*
5	**Nuts and Oilseeds:**		
	Simta	Chilgoza	*Pinus gerardiana*
	Katuns	Chest nut	*Castranopsis hystrix*
	Okhar	Walnut	*Jaglans regia*
	Til	Gingelly seed	*Sesamum indicum*
	Kalo Til	Niger seed	*Guizotia abyssinica*
	Badam	Groundnut	*Arachis hypogaea*
	Aalas	Linseed	*Linum usitetissimum*
	Tori	Mustard seed	*Brassica nigra*
	Suryamukhi phool	Sunflower seed	*Helianthus annuas*
	Kusum phool	Safflower	*Carthamus tinctorius*
	Nariwal	Coconut	*Cocos nucifera*

S. No.	Local Name	English Name	Scientific Name
6	**Condiment and Spices:**		
	Timur		
	Jwano	Omum	*Trachyspermum ammi*
	Hing	Asafoetida	*Ferula foetide*
	Sonph	Aniseed	
	Khursani	Chilly	*Capsicum annuum*
	Lasun	Garlic	*Allium sativum*
	Besar	Turmeric	*Curcuma domestica*
	Dhaniya	Coriander	*Coriandrum sativum*
	Aduwa	Ginger	*Zingiber officinale*
	Alainchi	Cardamom	*Elettaria cardamomum*
	Tejpat	Bay leaf	*Cinammon* sp.
	Methi	Fenugreek	*Trigonella foenum*
	Marich	Pepper	*Piper nigrum*
	Kagati ko bokra	Lime peel	*Citrus wedica*
	Jaipatri	Mace	*Myritica fragrance*
	Jaiphal	Nutmeg	*Myritica fragrance*
	Bhakamilo	Bhakimilo	*Rhus javanica*
	Lwang	Cloves	*Eugenia caryophylla*
	Jeera	Cumin	*Cuminum cyminum*
7	**Fruits:**		
	Bedu		
	Khanayo	Banyan tree fig	*Ficus begalensis*
	Ainselu	Himalayan yellow raspberry	*Rubus ellipticus*
	Katuns	Chest nut	*Castranopsis hystrix*
	Kaphal	Berry	*Myrica esculenta*
	Chutro		*Berberis* sp.
	Ghangharoo	Fire thorn	*Pyracantha crenulata*
	Guyanlo		
	Khjura	Date	*Phoenix* sp.
	Ganeulee		
	Amala	Amala	*Phyllanthus emblica*
	Damaru		
	Chiuri	Bassia	*Bassia butyracea* *Madhuca butyracea*
	Bhalayo		
	Darim	Pomegranate	*Punica granatum*
	Bel	Wood apple	*Limonia acidissima*
	Mel/Mayal	Wild pear	*Pyrus pashia*
	Naspati	Pear	*Randia aliginosa*
	Kera	Banana	*Musa paradisiaca*
	Mewa	Papaya	*Carica papaya*
	Lapsi	Lopsi	*Choerospondias axillaris*
	Syau	Apple	*Malus syvestris*
	Khurpani	Apricot	*Prunus armeniaca*
	Bans ko phal	Bamboo fruit	*Bambusa arundinacea*
	Neem ko phal	Neem fruit	*Melia azadirachta*
	Bayar	Zizyphus/Chinese date	*Zizyphus jujube* *Zizyphus mauritiana*
	Hade bayar	Aribel	*Zizyphus incurva*
	Satibayar	Satibaya	*Rhus parviflora*
	Angur	Grape	*Vitus vinifera*
	Amba	Guava	*Psiidium guajava*

S. No.	Local Name	English Name	Scientific Name
	Rukh katahar	Jackfruit	*Arcocarpus heterophyllus*
	Jamun	Jambu	*Syzygium cumini*
	Gulab jamun	Rose apple	*Syzgium zambos*
	Kusum	Kusum fruit	*Schleichera tijuga*
	Badahar	Lakucha	*Artocarpus lakoocha*
	Nibuwa	Lemon	*Citrus limon*
	Jyamir		
	Kagati	Lime	*Citrus auratnifolia*
	Mausam	Sweet lime	*Citrus sinensis*
	Bhogate	Pummelo	*Citrus maxiena*
	Kaljyamir		
	Bimiro		
	Athannni		
	Dowanni		
	Lichi	Litchi	*Nephelium litchi*
	Loquat	Loquat	*Eriobotray japonica*
	Kimbu	Mulberry	*Morus alba*
	Mahuwa	Mahuwa	*Bassia langifolia*
	Aanp	Mango	*Mangifera indica*
	Kharbuja	Muskmelon	*Cucumis melo*
	Tarbuja	Watermelon	*Citrullus vulgaris*
	Mewa	Papaya	*Carica papaya*
	Katahar	Pineapple	*Ananus comosus*
	Anar	Pomogranate	*Punica granatum*
	Haluwabed	Persimmmon	*Diospyros kaki*
	Suntala	Organge	*Citrus aurantium*
	Aaru	Peach	*Amygdatis persica*
	Aarubakhada	Plum	*Prunus domestica*
	Peepal ko phal	Ficus fruit	*Ficus religiosa*
	Seetahal/Saripha	Seetaphal	*Annona squamosa*
	Bhui kaphal	Strawberry	*Fragaria vesca*
	Okhar	Walnut	*Juglans regia*
	Kimbu	Mulberry	*Morus alba*
	Fishes:		
	Katle machha	Katla	*Catla catla*
	Bam machha	Bam	*Mastocembellus armatus*
	Sahar machha		
	Mungri machha	Magur	*Clarias batrachus*
	Jhinge machha	Prawan	*Penaeu* sp.
8	Rahoo machha	Rahoo	*Labeo rohita*
	Singhi machha	Singhi	*Saccobvanchus fossils*
	Tengra machha	Tengra	*Mystus vitattus*
	Hilsa	Hilsa	*Clupea ilisha*
	Jalakapur		
	Nadi ko machha	Rainbow trout	
	Gangata	Crab	*Paratephusa spinigera*
	Flesh Foods:		
	Boka/Bakhra/Khasi	Goat meat	*Capra hyrchusb*
9	Bheda	Sheep meat	
	Ranga	Buffalo meat	*Balbus busbolis*
	Kukhura	Fowl	*Gallus bankiva murghi*

S. No.	Local Name	English Name	Scientific Name
	Hans	Duck meat	*Anas platyrhyncha*
	Bagedi	Finch	*Fringillidoe* sp.
	Battain	Qual meat	
	Parewa	Pigeon	*Columbalivia intermedia*
	Sungur	Pork	*Sus cristatus wagemer*
	Sano chiplekira	Small snail	*Viviparus bengalensis*
	Thulo chiplekira	Big snail	*Pilaglobosa* sp.
	Kachhuwa	Turtle meat	*Lissemys punctata*
	Harin	Venisan/Deer meat	*Antelope cervicapralinn*
	Kaleej		
	Teetra		
	Chyakhura		
	Dhukur		
	Bhyakur		
	Milk and Milk Products:		
	Aama ko dhudh	Human milk	
	Gai ko dhudh	Cow milk	
	Bhainsi ko dhudh	Buffalo milk	
	Bakhri ko dhudh	Goat milk	
	Dahi	Yoghurt	
10	Mahi	Butter milk	
	Gaale/Chenna		
	Khuwa		
	Chhurpi/Dudhkhuwa		
	Cheese		
	Dhulo dhudh	Powder milk	
	Makk		
	Fats and Edible Oils:		
	Makkhan/Nauni	Butter	
	Gai ko ghyu	Cow ghee	
	Bhainsi ko ghyu	Buffalo ghee	
11	Chiuri ko ghyu	Hydrogenated oil	
	Tori ko tel	Mustard oil	
	Bhtamas ko tel	Soybean oil	
	Suryamukhi ko tel	Sunflower oil	
	Boso	Animal fat	
	Miscelaneous Foods:		
	Maha	Honey	
	Supari	Arecanut	*Areca catechu*
	Pan ko pat	Betel leaves	*Piper betle*
	Ookhu	Sugarcane	*Saccharum officinarum*
12	Nariwal	Coconut	*Cocos nucifera*
	Badam ko pina	Groundnut cake	*Arachis hypogaea*
	Gundruk	Gundruk	*Brassica* sp.
	Katahar ko biyan	Jack fruit seed	*Artocarpus interidfolio*
	Sakkhar/Gun	Jaggery	
	Mahuwa	Mahuwa flower	*Bassia latifolia*

Source: Collected and compiled by Dr. Shiddi Ganesh Shrestha, Kathmandu, Nepal. Email: shiddis@yahoo.com.

ANNEX 2

IMPORTANT MAJOR CROPS GROWN IN NEPAL

S. No.	Local Name	English Name	Scientific Name
1	**Cereal Crops:**		
	Dhan	Paddy	*Oryza sativa*
	Makai	Maize	*Zea mays*
	Kodo	Millet	*Eleusine coracana*
	Gahun	Wheat	*Triticum aestivum*
	Jaun	Barley	*Hordeum vulgarae*
2	**Cash Crops:**		
	Tel Bali	Oilseed	-
	Aaloo	Potato	*Solanum tubersosum*
	Tambaku	Tobacco	*Nicotiana tabacum*
	Ookhu	Sugarcane	*Saccharum officinaium*
	Jute	Jute	*Corchorus capsularis*
3	**Pulse Crops:**		
	Masuro	Lentil	*Lens esculenta*
	Arahar	Pigeon Pea	*Cajanus cajan*
	Mash	Black Gram	*Phaseolus mungo*
	Gahat	Horse Gram	*Dolichos biflorus*
	Mung Bean	Green Gram	*Phaelos arvens*
	Bhatmas	Soybean	*Glycine max*
	Bodi	Cow Pea	*Vigna catjang*
	Simi	Field Bean	*Dolichos lablab*
	Matar Keraun	Garden Pea	*Pisum sativum*
	Chana	Chick Pea	Cicer arientum
4	**Other Crops:**		
	Phalphul	Fruits	-
	Tarkari	Vegetables	-
	Haldo/Besar	Turmeric	*Curcuma domessica*
	Aduwa	Zinger	*Zingiber officinale*
	Alainchi	Cardamom	*Elettaria cardamomum*
	Chiya	Tea	*Camellia* spp.
	Kapas	Cotton	*Gossypium* spp.

ANNEX 3

COMPONENTS OF AGRICULTURE GROSS DOMESTIC PRODUCT

S. No.	Agriculture Commodities	Weight, %
1	**Cereal and other crops**	49.41
	Paddy	20.75
	Maize	6.88
	Wheat	7.14
	Millet	1.37
	Barley	0.22
	Potato	4.67
	Sugarcane	1.24
	Jute	0.17
	Tobacco	0.06
	Soybeans	0.19
	Pulses	4.42
	Others	2.29
2	**Vegetables and Nursery**	9.71
	Vegetables	9.7
	Others	0.01
3	**Fruits and Spices**	7.04
	Orange	0.97
	Mango	1.56
	Banana	0.40
	Apple	0.42
	Spice	1.79
	Tea	0.05
	Others	1.85
4	**Domestic Animals and Dairy**	23.25
	Buff (Buffalo Meat)	4.42
	Mutton (Goat Meat)	3.24
	Milk	12.36
	Others	3.23
5	**Other Animal Farming**	2.43
	Pork (Pig Meat)	0.50
	Poultry Meat	0.67
	Eggs	0.81
	Hides and Skin	0.36
	Others	0.10
6	**Forest Products**	8.07

Source: Selected Indicators of Nepalese Agriculture and Population, 2008. Agri-business Promotion and Statistics Division of Ministry of Agriculture and Cooperatives, Kathmandu, Nepal.

ANNEX 4

NATIONAL COMMITTEE MEMBERS

List of personnel involved in the preparation of country report

SN	National Committee Members	Role
1.	Secretary, Ministry of Agriculture and Cooperatives (MoAC)	Chairperson
2.	Executive Director, Nepal Agricultural Research Council (NARC)	Member
3.	Member Secretary, National Agrobiodiversity Conservation Committee (NABC)	Member
4.	Joint Secretary (Planning Division), MoAC	Member
5.	Director General, Department of Agriculture (DoA)	Member
6.	Director, Crops and Horticulture, NARC	Member Secretary
7.	Deputy Director General (Planning and Human Resource), DoA	Member
8.	Representative, ICIMOD	Member
9.	Representative, Seed Entrepreneur	Member
10.	Representative, CEPRED (INGO)	Member
Focal Point:		
Dr. Madhusudan Prasad Upadhyay, Senior Scientist, NARC		
Working team members:		
1.	Mr. Jagdish Chandra Gautam, ED, ABTRACO	
2.	Mr. Kamlesh Adhikari, Program Director, SAWTEE	
3.	Dr. Deep Mani Pokharel, Under Secretary, NABCC, MoAc	
4.	Dr. Siddhi Ganesh Shrestha, Under Secreatry, MoAC	
5.	Mr. Ashok Mudwari, Chief, Agriculture Botany Division, NARC	
6.	Mr. Madan Raj Bhatta, Chief, NWRP, NARC	
7.	Mr. Salik Ram Gupta, Senior Technical Officer, ABD, NARC	
8.	Mr. Surendra Kumar Shrestha, Officer, GRPI-Nepal	
9.	Mr. Chandra Bahadur Shrestha, Expert, Seed	
10.	Mr. Sushil Raj Subedi, Progam Officer, ABTRACO	
11.	Dr. Madhusudan Prasad Upadhyay, Senior Scientist, NARC	
Advisor:		
Mr. Suresh Kumar Verma, Joint Secretary, MoAC		

ANNEX 5

FARMERS' LANDRACES AND IMPROVED VARIETIES IN 3 ECO-SITES SURVEYED IN 1999 AND 2003

Crop/Site	Base line survey, 1999	Monitoring survey, 2003
Rice		
Talium N, 21 Lost, 13 New, 2	Boyo Dhan (Pakhe), Darime, Dhan, Jadan Dhan, Jumli Local, Kalo Dhan, Kalo Marshi, Lahare Dhan, Majhaula Marshi, Mahele, Mehele and Darime Dhan, Patle Dhan, Ratanpuri, Rato Dhan, Rato Marshi, Rato and Seto Marshi, Rato and Kalo Marshi, Seto Local, Seto Marshi, Seto Seed, Sijalalya	Boyo Dhan (Pakhe), **Chandanath-1, Chandanath-3,** Jumli Local, Kalo Marshi, Majhaula Marshi, Rato Dhan, Rato Marshi, Seto Local, Seto Marshi
Begnas N, 69 Lost, 29 New, 14	Anga, Barmali, Basmati, Bayarni, Bayarni Jhinuwa, Bichara Ghaiya, Biramphul, CH-45, Chobo, Dhave Jarneli, Ekle, Gauriya, Ghaiya, Gurdi, Gurdi Ghaiya, Jarneli, Jetho Budho, Jhauri, Jhinuwa, Jhinuwa Basmati, Jhinuwa Ghaiya, Jhyali Rato Ghaiya, Jire Ghaiya, Juge Bayarni, Kalo Bayarni, Kalo Gurdi, Kalo Jhinuwa, Kalo Tude Jhinuwa, Kanajire Ghaiya, Kanchi Mansuli, Kathe Gurdi, Katuse Ghaiya, Kaude, Kaude Anadi, Kunchali Ghaiya, Lahare Ghaiya, Lahare Gurdi, Lame, Madhese, Mala, Manamuri, Mansara, Mansuli, Masino Ghaiya, Masino Jhinuwa, Naltume, Naulo Madhese, Pahenle, Pakhe Jarneli, Pakhe Ramani, Radha, Radha-7, Radha-9, Ramani, Rate, Rato Anadi, Rato Ghaiya, Sano Gurdi, Sano Madhese, Seto Anadi, Seto Bayarni, Seto Ghaiya, Seto Gurdi, Seto Jhinuwa, Tende, Thapachini, Thulo Gurdi, Thulo Madhese, Tude Jhinuwa,	**Anadi**, Adheri Jhinuwa, Anga, Bale, Basmati, **Basmati Jhinuwa,** Bayarni, Bichara Ghaiya, Biramphul, CH-45, **Chaite**, Chiniya Marshi, Chote, **Darmali**, Dhabe, Dhabe Jarneli, Ekle, Gauriya, **Janaki**, Jarneli, **Jarneli Rato, Jate Ghaiya,** Jetho Budo, **Jhauri**, Jhinuwa, Jhinuwa Ghaiya, Kalo Jhinuwa, **Kandani Dande Jhinuwa,** Kathe Gurdi, Kaude, Madhise, **Makwanpure, Malaysia,** Mana Muri, Mansara, Mansuli, Naltumme, **Pahele,** Pakhe Jarneli, Pakhe Jhinuwa, Pani Barmeli, Radha 7, Radha 9, Ramani, **Rampur Mansuli,** Rate, Rato Anadi, **Sabitri**, Seto Anadi, Seto Jhinuwa, Tarkaya Jhinuwa, Thulo Gurdi, Tunde, **Tunde Marshi**
Kachorwa N, 53 Lost, 10 New, 12	China-4, Anadi, Anga, Ashanni, Basmati, Basmati Lalka, Batsar, Bhathi, CH-45, Chandina, Dadha-5, Dipahiya, Dudhisaro, Dudhraj, Ekahatar, Faram, Gajargaul, Ghuthani, Jaya, Jiri, Karma, Kataush, Kheraha, Kunchali Mansuli, Lajhi, Lalka Farm, Lalka Katika, Latongad, Mallika, Mansara, Mansari, Masula, Masuli, Masura, Meghdut, Mutmur, Muturi, Nakhi, Nakhi Saro, Nat Masuriya, Net Masuli, Philips, Rango, Ratrani, Sabitri, Sarho, Sathi, Satraj, Sokan, Sona Masuli, Sotwa, Television, Usha	**Amaghouj**, Anga, Ashanni, Batsar, **BG-1442**, Bhadaiya Basmati, Bhadaiya Masula, Bhatti, CH-45, China-4, Chandina, Chhatraj, Dipahiya, Dudhraj, Ekahattar, Ghaiya, Ghuthani, **Harinker, Hybrid Rice**, **Jagarnathiya,** Jaya, Jiri, **Kanchi Masuli**, Kanchi Nani, **Kariya Kamod**, Karma, Katush, Khehra, Lajhi, Lal Tenger, Lalka Basmati, Madhumala, Mallika, Masula, Mutmur, Nakhisharo, Nat Masuli (Sona Masula, Swarna), **Pakhar**, **Parewa Pankha,** Philips, **Punjabi**, Radha-5,, Rampur Masuli, Rango, **Rani Pankaj**, Sabitri, **Sano Masuli, Sarju 52,** Sathi, **Shilhat, Sobha Masuli**, Sokan (Gajjargoul, Sotwa), Television, Ujjarka, (Lalka Kartika, Faram), Usha
Finger millet		
Talium N, 12 Lost, 6 New, 0	Auli Kalo Kodo, Auli Kodo, Auli Rato Kodo, Dabli Kodo, Dabli Rato, Dalle, Jumli Kodo, Kalo Kodo, Kangcho Kodo, Murli Kodo, Rato Kodo, Seto Kodo	Dabli Kodo, Dabli Rato, Dalle, Kalo Kodo, Murli Kodo, Rato Kodo
Begnas N, 24 Lost, 13 New, 1	Arghumle Kodo, Asoje Kodo, Dalle, Dudhe Dalle, Dedhe Kodo, Dudhe Seto, Hetaude, Hetaude Seto, Jhyape, Kalo, Kalo Dalle, Kalo Jhyape, Kartike, Kukur Kane, Laphre, Majhthane Dalle, Mansire Jhyape, Rato Jhaype, Samdhi Kodo, Seto, Seto Dalle, Seto Jhyape, Thulo Kodo, Thulo Kalo	Dalle, Dudhe Dalle, Hetaude, Jhyape, Kalo, Kalo Jhyape, Laphre, **Madi Pare**, Samdhi Kodo, Seto Dalle
Kachorwa N, 6 Lost, 4 New, 0	Jhalariya, Jhalaro, Local, Muna (Mahamuna), Muturiya, Satputiya	Jhalariya**,** Muna (Mahamuna)
Barley		
Talium N, 5 Lost, 2 New, 0	Chawali, Gharelu Jau, Lekali (Pahabai), Lekhali Takulo, Takullo Pahabai	Chawali, Lekali, Takullo Pahabai
Buckwheat		
Talium N, 6 Lost, 2 New, 0	Batule, Bhadule, Mithe Phaper, Murali, Tilkhude, Tite Phaper	Bhadule, Mithe Phaper, Tilkhude, Tite Phaper

Crop/Site	Base line survey, 1999	Monitoring survey, 2003
Cucumber		
Talium N, 10 Lost, 8 New, 0	Auli, Auli Panhelo, Jalgi Kankro, Jumli Local, Jumli Seto, Jumli Panhelo, Junli Rato, Lamo Thulo, Sano (Jumli Sano), Thulo Kankro	Auli Panhelo, Jumli Local
Begnas N, 15 Lost, 8 New, 10	Bhaktapir Local, Chaite, Chhoto, Dalle, Dalle Bhunte, Bhunte, Ghiu Kankro, Hariyo, Kalo Kankro, Khir Kankro, Lamcho Thulo, Madale, Madhyan Pahenlo, Seto Dalle, Seto Local	Bhaktapir Local, **Bikase Seto**, Chaite, **Chhoto Hariyo, Chhoto Local**, **Chhoto Seto**, Dalle, **Dude, Hariyo Thulo, Khir Kankro, Lamo Local**, Madale, **Madhale Seto, Patalo Lamo, Sano Seto, Seto Ghiu, Seto Khir Kankro**
Kachorwa N, 4 Lost, 0 New, 1	Baisakha, Balma, Balma Harihar, Hariyo	Baisakha, Balma, Balma Harihar, Hariyo, **Many Indian Hybrids**
Sponge gourd		
Begnas N, 15 Lost, 5 New, 5	Chhoto, Hariyo, Hariyo Chhoto, Hariyo Lamo, Hariyo Dalle, Hariyo Madhyam, Hariyo Basaune, Kalo Chhoto, Kalo Lamo, Seto, Seto Bose, Seto Chhoto, Seto Lamo, Seto Madhyam, Seto Dharse	**Bose**, Chhoto, **Chhoto Madyam**, **Dalle**, **Dalle Seto,** Hariyo Chhoto, Hariyo Lamo, Kalo Chhoto, Kalo Lamo, **Pusa Chillo, Seto Bikase**, Seto Bose, Seto Chhoto,Seto Lamo
Kachorwa N, 16 Lost, 10 New, 3	Balma, Baisakha, Basmati, Bhadaiya, Dudhi, Galphuli, Galphuli Hariyo, Galphuli Seto, Ghiuwa, Hariyo Lamo, Hariyo Local, Muturiya, Seto Lamo, Tagwa, Seto Tagwa, Ujala (Uja/Ujarka)	Baisakha, Basmati, Bhadaiya, Galphuli Hariyo, Galphuli Seto (Ujarka Galphuli), **Lamka,** Lamka Ujarka**,** Railo, Tagwa (Ujarka Tagwa)
Taro		
Begnas N, 24 Lost, 16 New, 2	Chhaure, Dalle, Dudhe Karkalo, Hattipau Pidalu, Juke, Kalo Karkalo, Kalo Pindalu, Khajure Rato Pidalu, Khari Pidalu, Khujure Seto, Lahure Karkalo, Rato, Rato Khari, Rato Lamo, Rato Mukhe Pidalu, Rato Panchamukhe Pidalu, Rato Pidalu, Satmukhe, Seto Karkalo, Seto Lahure, Seto Pidalu, Seto Mukhe, Thado, Thado Rato Mukhe	**Dudhe Seto**, Dalle, Dudhe Karkalo, Hattipau Pidalu, Kalo Pidalu, Khujure Rato Pidalu, Khari Pidalu, Lahure Karkalo, **Panchamukhe,** Rato Pidalu, Rato Mukhe Pidalu
Pigeon pea		
Kachorwa N, 5 Lost, 3 New, 1	Chanki, Pajawa, Rato Local, Seto Local, Sthaniya Mins	Chanki**, Maghi (Rampur Rahar-1)**, Pajawa

ANNEX 6

DISTRIBUTION OF LOCAL GERMPLASM AND USE IN BREEDING PROGRAMMES

SN	Crops	No. of accessions	Research Programme/Institute	Purpose
1	Rice	51	IAAS, Rampur, Chitwan	Root knot nematode disease screening
		700	NRRP, Hardinath, Dhanusa	Rejuvenation and characterization
		16	ARS, Pakhribas, Dhankuta	Research
		25	NRRP, Hardinath, Dhanusa	Aromatic rice research
2	Green gram	28	IAAS, Rampur, Chitwan	Research
3	Wheat	100	IAAS, Rampur, Chitwan	Drought/ heat stress tolerance
		390	Plant Pathology Division	Disease screening Research
		15	Wheat unit, ABD	Research
4	Buckwheat	126	HCRP, Kabre, Dolkha	Research
		138	Hill crop unit, ABD	Research
		188	HCRP, Kabre, Dolkha	Research
		50	Biotechnology Unit, (BK Joshi)	Research
5	Amaranths	46	HCRP, Kabre, Dolkha	Research
6	Finger millet	30	HCRP, Kabre, Dolkha	Research
7	Rice bean	50	FOSRIN Project (Dr. J. Bajracharya)	Research
8	Barley	277	HCRP, Kabre, Dolkha	Research
9	Jute	204	JRP, Itahari, Sunsari	Rejuvenation of lost germplasm
	Total	**492**		

ANNEX 7

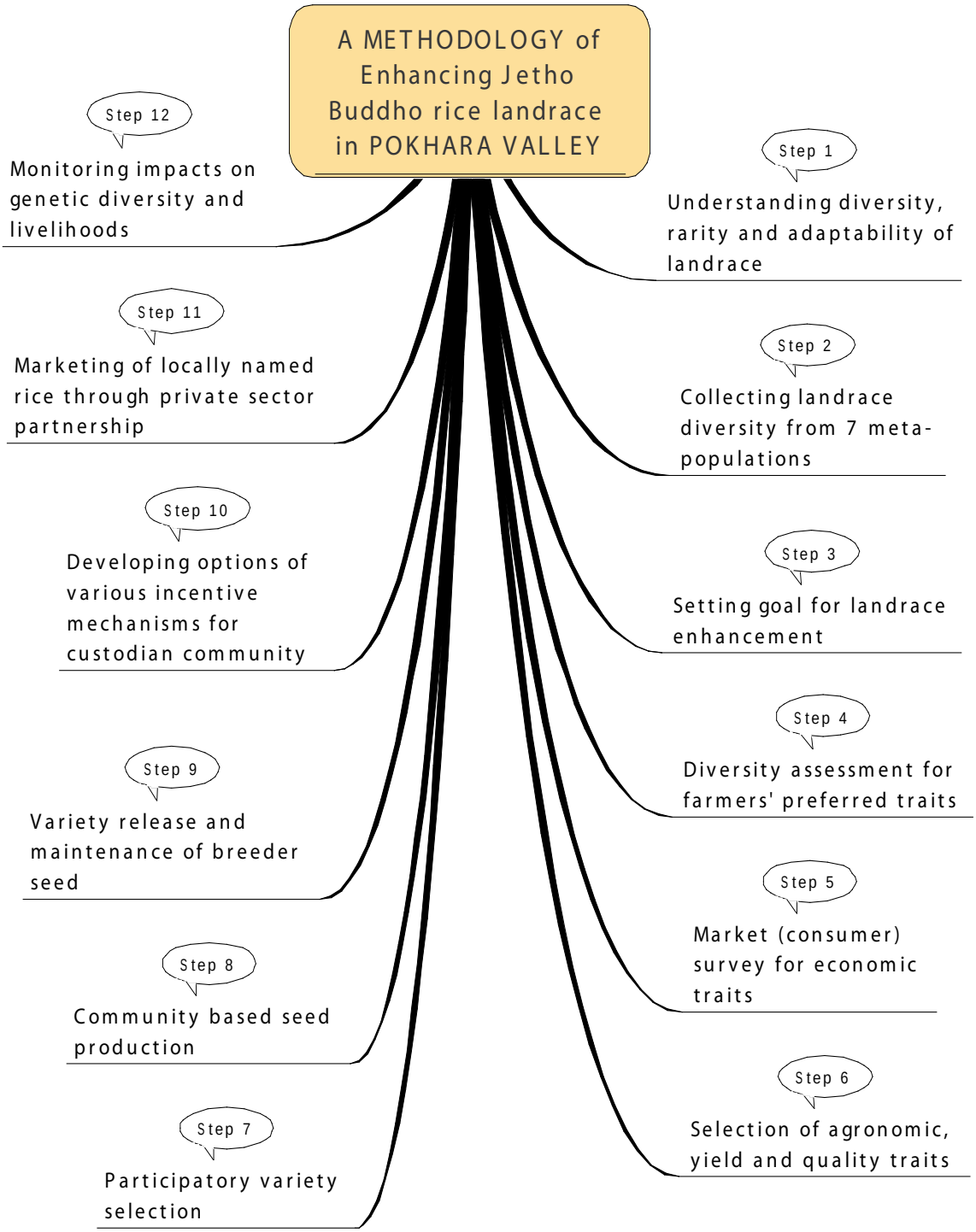
UTILIZATION OF LANDRACES IN VARIETAL IMPROVEMENT PROGRAMMES

Crop	Variety/Strain	Parents	Main character	Released Yr
Rice	- Khumal-2 - Khumal-4 - Palung-2 - Chhomrong local - Khumal-5 Machhapuchhre-3 - Pokharilo Jethobudho - Khumal-8	Jerneli/Kn-16-361-BLK-2-8 IR 28/Pokhreli Masino BG94-2/Pokhreli Masino Local selection Pokhreli Masino/ Kn-IB-361-BLK-2-6 Fuji102/Chhommrong Jethobudho Jumli Marshi" / "IR-36"	Fine grain " " Cold Tolerance Fine grain Cold tolerance Aromatic fine Small grain	1987 1987 1987 1991 1990 1990 2006 2007
Maize	- Hetauda comp - Makalu-2 - Manakamana-1 - Rampur-2 - Ganesh-2- - Arun- 1 - Rampur-1 - Ganesh-1	Exotic & Local Exotic & Local Exotic & Local Exotic & Local Exotic & Local Exotic & Local Exotic & Local Exotic & Local	Yellow grain Yellow grain White grain Yellow grain Yellow grain White grain White grain White grain	1973 1984 1987 1989 1989 1995 1995 1997
Barley	- Solu uwa	NB 1054	Naked grain	1990
Fingermillet	- Okhale-1 - Kabre Kodo-1	Local from Okhaldhunga Local cultivar from Surkhet	Blast tolerance	1980 1990
Chickpea	- Trishul - Dhanush	Local cultivar from Nepal -do-		1979 1979
Lentil	- Sindur	Local selection (Lo-111-25)		1979
Pigeonpea+	- Bageswori - Rampur rahar	- Local selection - Local selection	- Resistant to Sm* - Resistant to Sm	1991 1991
Cauli-flower	- Kathmandu local	- Local selection	- Large white	1994
Radish	- Pyuthane rato	- Local selection	- Red	1994
Asparagus bean	- Khumal Tane - Sarlahi Tane			1994 1994
Eggplant	- Sarlahi green			1994
Cucumber	Local	Local selection		1994
Sponge gourd	- Kusle - Kantipure			1994
Broad leaf Mustard	- Khumal broad leaf - Marpha broad leaf - Khumal rato pat			1989 1994 1994
Rice landraces used in crossing programme		Haridware / P. masino//IR 64 Atte / IR 64 // Atte Atte / Khumal-3 // Atte Atte / NR 10353 // Atte Atte / Himali // Atte Gudgudo / Himali // Gudgudo Gudgudo / IR 36 // Gudgudo Patle / IR 36 // Patle Jumli marsi / IR 36 // Jumli marsi Jumli marsi / IR 64 // Jumli marsi Jarneli / IR 64 Juha / IR-64		
Wheat landraces used in crossing programme		Dabdi local/NL 297/3/NL 539/Siddhartha//NL 297/4/BL 1022 Lumle local/NL 297/3/NL 251/Fan#1//NL 297/4/NL 539 Balangkha local/NL 297/3/NL 297/Ning 8319//BL 1022/4/NL 539 Change local/NL 297/3/NL 297/Ning 8201//BL 1022/4/NL 539 Masino wheat/NL 297/3/Siddhartha/Ning 8201//NL 297/4/NL 539 Sano wheat/NL 297/3/YMI#6/NL 539//NL297/4/BL 1135 Pangdure wheat/NL 297/3/NL 251/G 162//NL 297/4/NL 539		

*Sm= Resistant to Sterlity Mosaic. Source: NARC (2007) and Upadhyay and Gauchan, (2008).

ANNEX 8

ENHANCING LANDRACES: THE METHODOLOGY



ANNEX 9

PROTECTED PLANTS OF NEPAL

Under the Forest Act 1993 and Article 70, the Government of Nepal has notified restrictions on the following (since 12 February 2001):

- **Ban on collection use, sale, distribution, transportation and export of the following medicinal herbs**

	Scientific Name	Nepali Name	English Name
1.	*Dactylorhiza hatagirea*	Pancha ounle	
2.	*Juglans regia* bark	Okhar ko bokara	Walnut
3.	*Picrorhiza scrophulariflroa*	Kutaki	Gentian

- **Ban on export outside the country, Except the processed product on permission of Department of Forest**

1.	*Nardostachys grandiflora*	Jatamansi	Spikenard
2.	*Rauwolfia sepentina*	Serpagandha	Serpentina
3.	*Cinnnamimum glausecens*	Sugandhakokila	
4.	*Valeriana wallichi*	Sugandhawal	Indian Valerin
5.	*Lichen species*	Jhyau	
6.	Rock exude	Shilajeet	
7.	*Abies spectabilis*	Talispatra	Fir
8.	*Taxes wallichiana*	Loth Salla	Himalayan Yew
9.	*Cordyceps sinensis*	Yarsa gomba	

Trees

- **Ban on transportation, export, felling for commercial purpose**

1.	*Michaelia champaca*	Champ	
2.	*Acacia catechu*	Khayer	Cutch tree
3.	*Shorea robusta*	Sal	
4.	*Bombax malabaricum*	Simal	Silk cotton tree
5.	*Dpterocarpus marsupium*	Satisal	
6.	*Dalbergia latifolia*	Bijayasal	
7.	*Juglans* sp. (Only of National Forest)	Okhar	Walnut tree

REFERENCES

CBS (Central Bureau of Statistics). 2003. Population monograph of Nepal, Vol. I. CBS, Kathmandu, Nepal.

Collins, W.W. and G.C. Hawtin. 1999. Conserving and using crop plant biodiversity in agroecosystems. Chapter 14 in Biodiversity in Agro ecosystems (W.W. Collins and C.O. Qualset, eds.). CRC Press.

FDD (Fruit Development Division). 2007. Horticulture Development Program: Annual Achievements. FDD of Department of Agriculture, Kathmandu, Nepal.

Gyawali, S., K.D.Joshi, R.K. Tiwari and B.R. Sthapit. 2003. Diversity assessment for the enhancement of Jethobudho landrace of Kaski, In On-farm management of agricultural biodiversity in Nepal (B.R. Sthapit, M.P. Upadhayay, B. K. Baniya, A. Subedi and B.K. Joshi, eds.). Proceedings of a National Workshop, 24-26 April 2001, Lumle, Nepal. NARC, LI-BIRD and IPGRI.

MoAC(Ministry of Agriculture and Cooperatives). 2007. Statistical Information on Nepalese Agriculture 2006/2007. Agri-business Promotion and Statistics Division of MoAC, Kathmandu, Nepal.

MoF (Ministry of Finance). 2008. Economic Survey, Fiscal Year 2007/08. MoF, Kathmandu, Nepal.

Munasinghe, M. and lutz, E. (1993), "Environment economics and valuation in development decision making", Environment Working Paper No. 51, The World Bank, Washington, DC.

NARC (Nepal Agricultural Research Council). 2007. Released and Registered Crop Varieties in Nepal 1960-2007. NARC, Lalitpur, Nepal.

NPC, 2007. Three-Year Interim Plant (2007/08-2009/10). Kathmandu; National Planning commission, Government of Nepal.

NSC (National Seed Company Ltd.). 2007. Proceedings of National Seed Company Ltd., NSC, Kathmandu, Nepal.

Rijal DK. 2001. Community Biodiversity Register: Developing Community Based Database for Genetic Resources and Local Knowledge in Nepal.

Rijal, D.K. 2002. Concerning the Biodiversity Conservation, the Concept of Community Seed Banking: Process and Constriants. Adarsha Samaj, Pokhara, Nepal.

Shrestha, Pratap, Kamalesh Adhikari and Mahesh Nath Srestha. 2008. Implications of plant variety protection and Farmers' Right Bill for Seed Production and Marketing in Nepal. Paper presented at the Fourth National Seed Semianar. 19-20 June. Organised by National Seed Board at Lalitpur, Nepal.

Shrestha, S.G. 2004. Irrigation System Performance Indicators in Relation to Farm Livelihoods in Chitwan, Nepal. Doctorate Degree Dissertation of Asian Institute of Technology, Thailand.

Shrestha, S.G. 2007. Necessity for Watershed Conservation for Nepal's Overall Development (Nepalko Samasthigat Vikashko Lagi Jaladhar Sanrakshanko Apariharyata in Nepali). Article published in Hamro Sampada on February 2007.

SNV and ICIMOD. 2006.

Subedi A, Chaudhary P, Baniya B, Rana R, Tiwari RK, Rijal D, Jarvis D, Sthapit B. 2003. Who Maintains crop Genetic Diversity and How: Implications for on-farm Conservation and Utilization. Culture & Agriculture, 25 (2): 41-50.

UNDP, 2004. Nepal Human Development Report 2004: Empowerment and poverty Reduction. Kathmandu: United Nations Development Programme.

UNEP, 1995. Global biodiversity Assessment. Cambridge University Press, Cambridge.

WCMC (World conservation Monitoring Centre), (1996), Industrial Reliance upon Biodiversity, WCMC, Faculty of Economics, Cambridge University Cambridge.

World Bank. 2008. World Development Indicators Data Base. www.worldbank.org accessed on April 2008.