

Status, trend and application of **plant biotechnology** in Nepal

Hari P. Bimb

Biotechnology Unit

Nepal Agricultural Research Council

Khumaltar, Lalitpur, Nepal

A presentation in the National Workshop on Biotechnology and Development
Concerns in Nepal jointly organized by SAWTEE, LI-BIRD & BSN, 21 August
2009, Everest Hotel, Kathmandu, Nepal

What is Biotechnology?

The Convention on Biological Diversity (CBD,1993) defines biotechnology as “...*any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use*”.

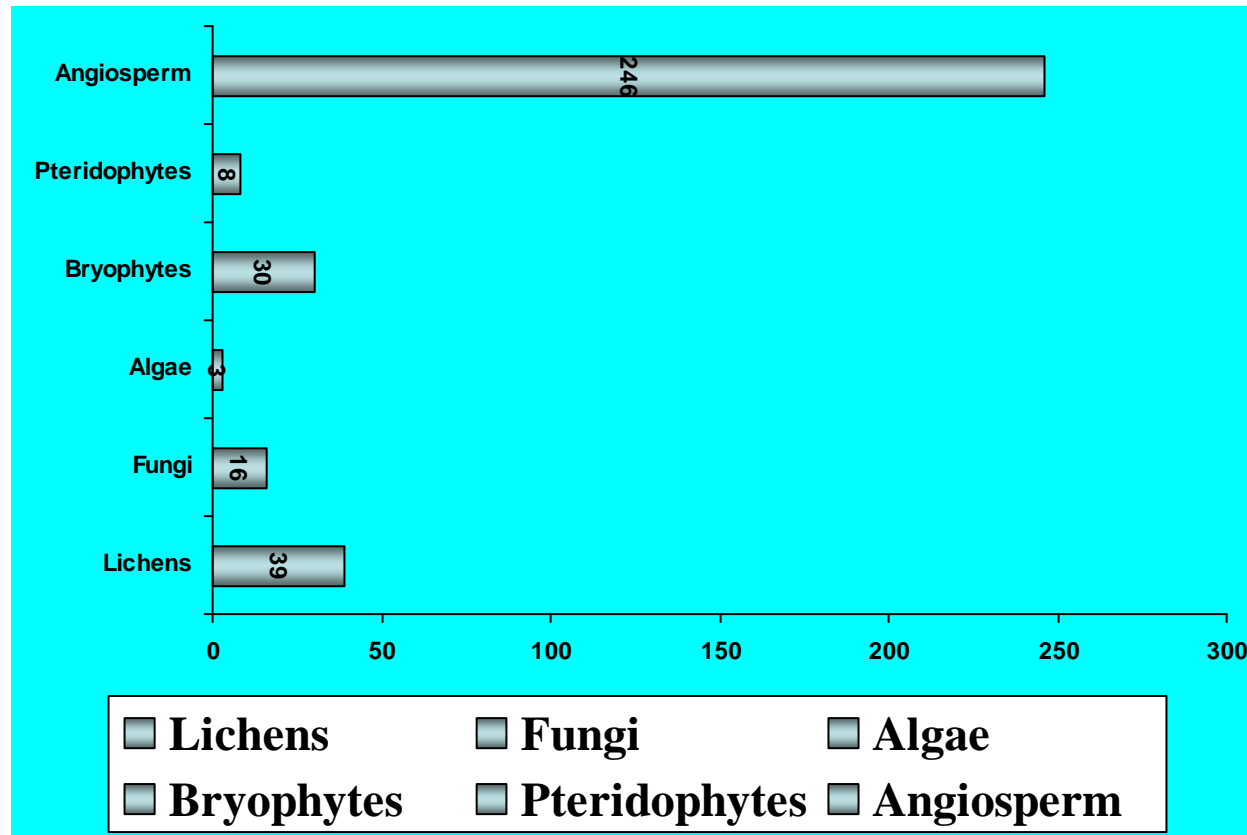
A broad collection of tools that can be applied for a range of different purposes:

1. Genetic Improvement
2. Genetic Characterization & Conservation
3. Disease Diagnosis
4. Vaccine Development
5. Genetic Modification

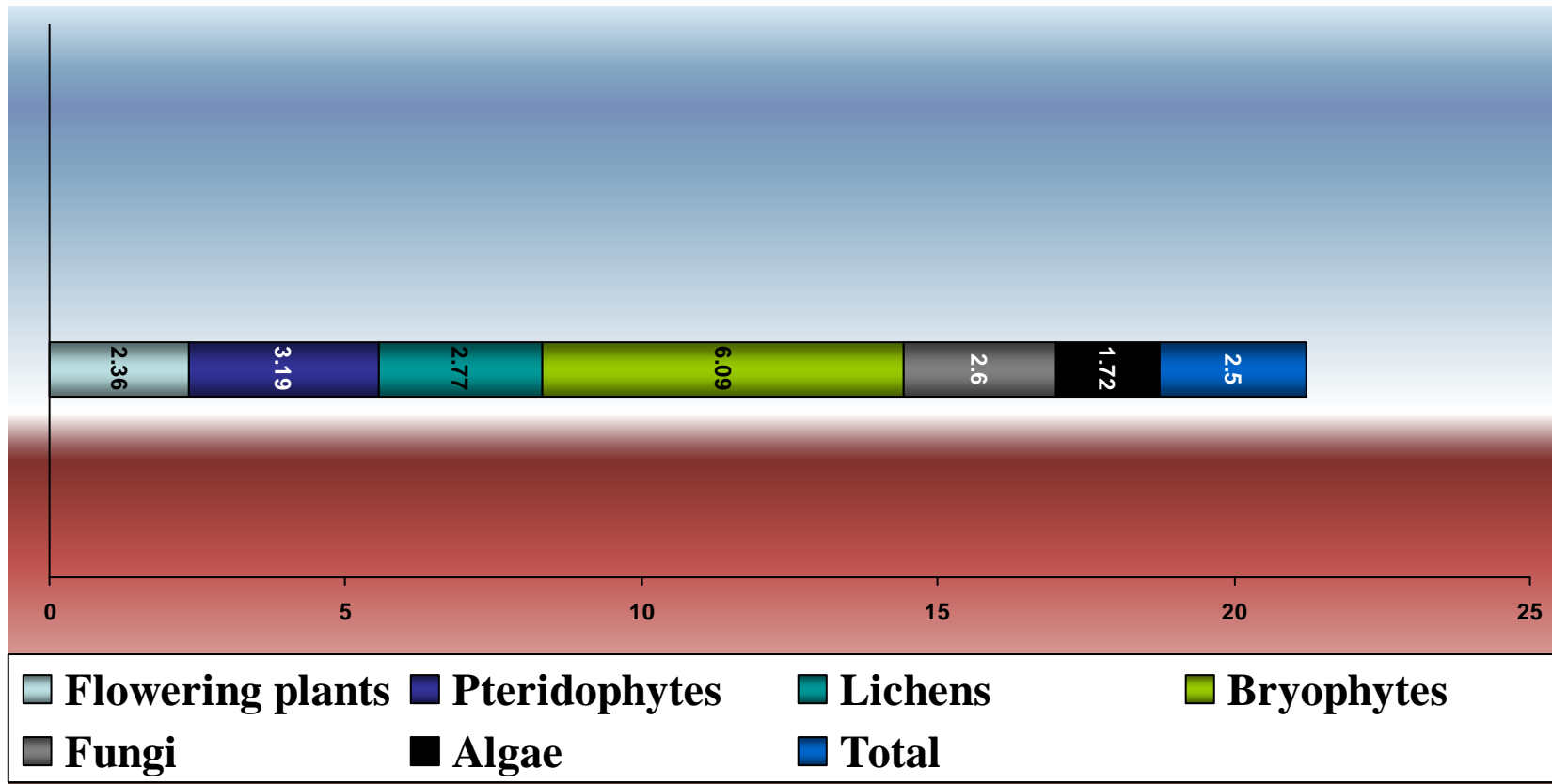
Number of species of flora and fauna in each physiographic zone (adapted from NBS 2000)

Group	Terai and Siwalik hills < 1000m	Mid-hills 1000-3000m	Highlands >3000m
<i>Plantae</i>			
Bryophytes	61	493	347
Pteridophytes	81	272	78
Gymnosperm	-	16	10
Angiosperm	1885	3364	>2000
<i>Animalia</i>			
Butterflis	325	557	82
Fishes	154	76	6
Amphibians	22	29	9
Reptiles	68	56	13
Birds	648	691	413
Mammals	91	110	80

Indemic species of Nepal (MFSC, 2002)



Nepal's % of the world's total plant species



Diversity Richness of PGR and their indicators in Nepal (70-4000M)

SN	Group	Species/Cultivars/Types
1	Cultivated species	200
2	Ecosystem types	118
3	Fine grain and aromatic rice	102
4	Flowering plants	7000
5	Flowering plants endemic to Nepal	370
6	Fodder trees and shrubs	170
7	Food value crops	550
8	Forest types	35
9	Horticultural crops	400
10	Improved cultivars	188
11	Medicinal plants	700
12	Mushrooms	174
13	Rice landraces	2000
14	Vegetables	200
15	Vegetation types	75
16	Wild edible plants	500
17	Wild relatives of cultivated plants	120
18	Wild relatives of fruits	71

Modern Biotechnology or Genetic Engineering or Genetic Modification

In vitro nucleic acid techniques (Recombinant DNA and direct injection of nucleic acid into cells or organelles) and fusion of cells beyond the taxonomic families

Genetic Modification can be used to create Genetically Modified Organisms (GMOs)

Genetically modified organism (GMO) or Living modified organism (LMO)

Definition:

**Living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology
(CBD)**

In other words:

Organisms that have been transformed by the insertion of one or more genes (called trans-genes), usually from a different species

Example: “Golden Rice” : genes from maize and bacteria, *Erwinia uredovora* and still work is going on for biofortification (Zn and Fe)

Immediate Need for Agricultural Biotechnology in Nepal

- Conservation and utilization of rich diversity**
- Food security and food safety**
- Value addition and quality seed, seedling and sapling production**
- Compete for agricultural and herbal products in international market (WTO)**
- Bioprospecting**
- Biosafety**

Non-GM Biotechnology currently being used in Nepal

- **Tissue Culture of Plants**
 - Shoot culture of various plants
 - Meristem culture for virus elimination from Potato
 - Embryo Rescue (breeding barrier)
 - Haploid Production
- **Microbial**
 - Nif Bacteria, Rhizobium (Biofertilizer)
 - Azolla, Mycorrhiza (Biofertilizer)
 - Mushroom
 - Pseudomonas, Trichoderma ect. Species (Biopesticides)
 - Fermentation (Beverage and Cheese)

Non-GM Biotechnology continued...

- **Molecular Markers**
 - Isozymes
 - SSR
 - RAPD
 - SNP
- **Diagnostics**
 - Disease of Plant, Animal and Human (microbial)
 - Forensic (Parental, Criminal)
 - ELISA (Virus Detection in Horticultural Crops and Human), Monoclonal Antibodies
- **Vaccine Production**

Molecular Markers

- Characterization, Finger-printing, Identification
- Screening (Disease and Germplasm)
- Diversity Study
- Population Genetic Structure
- Linkage & QTL Map Construction
- Gene Tagging
- Marker Assisted Selection (MAS)



SSR profile in Barley

Institutions in Biotechnology Research and Development

- **Public**

- **Nepal Agricultural Research Council, MoAC**
- **Nepal Academy of Science and Technology, NAST**
- **National Forensic Laboratory, MoST**
- **Department of Plant Resources, MoF&SC**
- **National Herbarium and Plant Laboratory, MoF&SC**
- **Department of Agriculture, MoAC**
- **Department of Livestock Services, MoAC**
- **Quality Seed Control Center, MoAC**
- **Department of Food Technology & Quality Control, MoAC**
- **Central Department of Microbiology, TU**
- **Central Department of Botany, TU**
- **Research Center for Applied Sciences, TU**
- **Department of Clinical Microbiology, TUTH**
- **Department of Biochemistry, TUTH**
- **Epidemiology and Disease Control Division, MoHP**

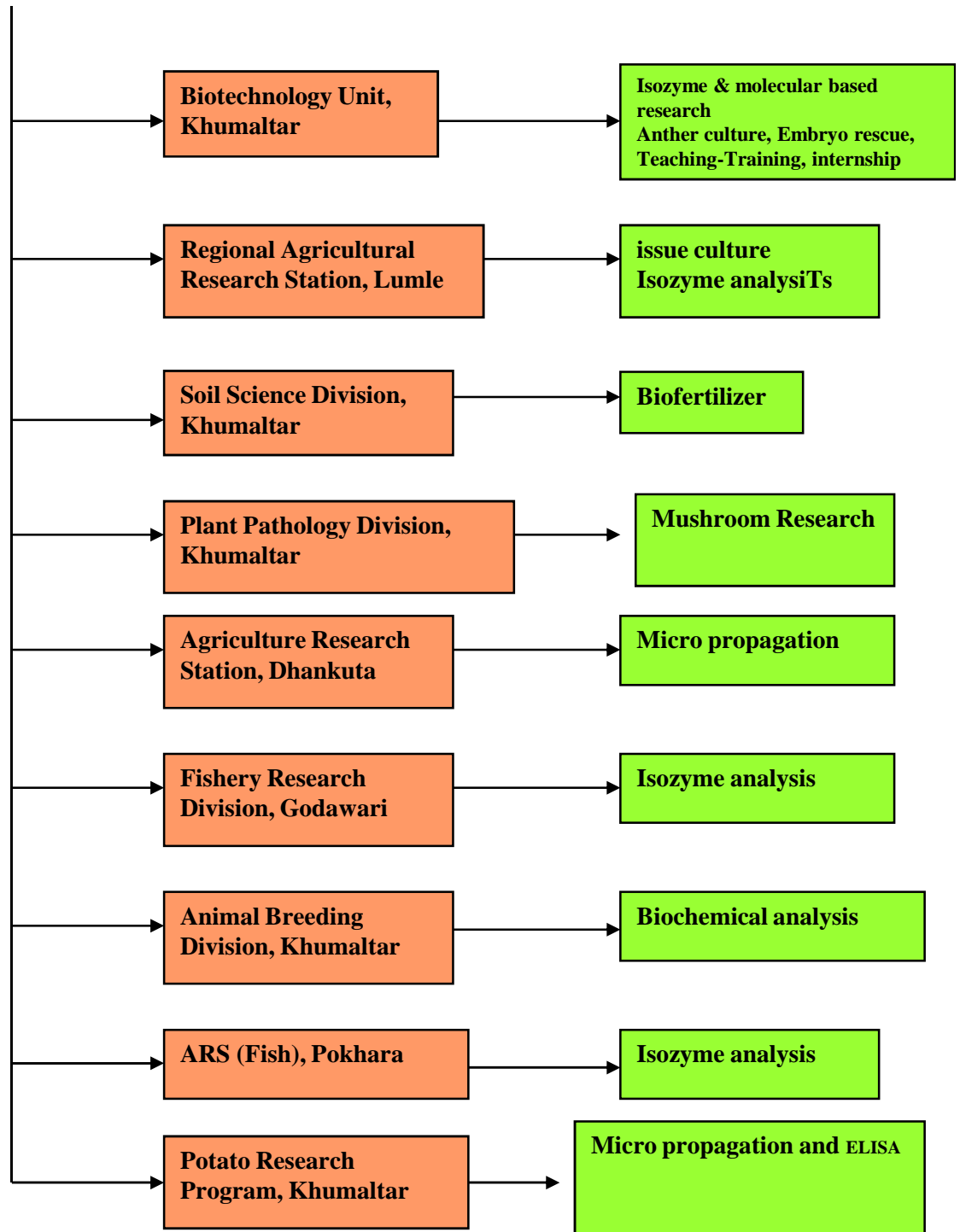
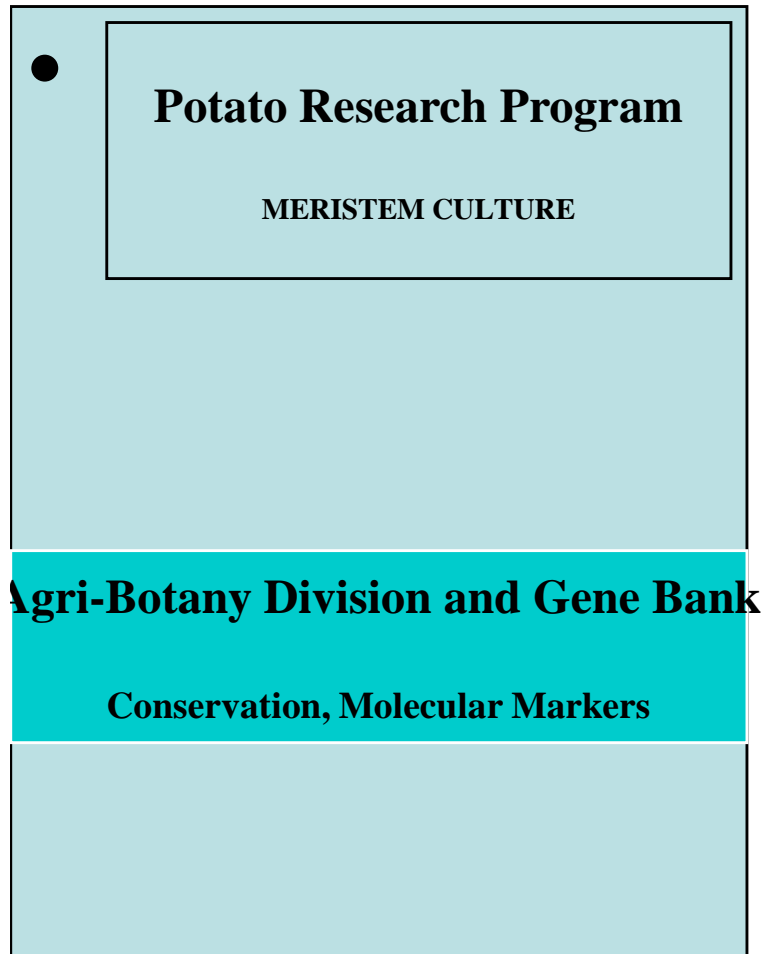
Private

- Department of Biotechnology, KU
- Purwanchal University (HICAST, White House Collge, SAAN)
- Pokhara University
- Research Laboratory for Biotech. & Biochem. (R-LABB)
- Sikkim Manipal University (Lord Buddha Education Foundation)
- Center for Molecular Dynamics Nepal (CMDN),Thapathali, Kathmandu
- D2Hawkeye Nepal , Bishalnagar, Kathmandu
- Genetics Nepal Pvt. Ltd, Gwarko, Lalitpur
- Intrepid Nepal, Thapathali, Kathmandu
- GREAT, Naya Baneshwar
- Everest Biotech Pvt. Ltd., Maharajganj
- Central Department of Food Technology, Dharan
- Department of Food Microbiology, National College, Kathmandu
- BP Koirala Memorial Cancer Hospital, Bharatpur, Chitwan
- BP Koirala Institute of Health Sciences, Dharan
- National Tuberculosis Center, Thimi
- NBA
- NBS
- NEMBIS

Public Funds on Biotechnology (NRs in '000)

Institution	2006/7 Operational	2006/7 Capital	2007/8 Operational	2007/8 Capital
Potato Research Program	600	-	600	-
Agriculture Botany Div. (Genebank)	200	15000	67	30000
Biotechnology Unit	1200	3500	1400	1100
SQCC		8000	200	6000
National Forensic Lab	700	24000 (grant)	700	16000 (grant)
NAST	1010	-	1886	-

Biotechnology in NARC



Supportive Policies in Biotechnology

Agricultural Policy 2005

Seed Policy 2000

Biotechnology Policy 2005

Nepal Biosafety Framework (NBS) 2007

The Science and Technology Policy 2004

Agro-biodiversity Policy (2007)

Plant Protection ACT 1972 (New Bill, Draft)

**Plant variety protection and Farmers' Right bill
(Draft)**

Intellectual Property Right Bill (Draft)

Major Issues Regarding GMOs:

- Nepal is ill-equipped to deal with any environmental disasters emanating from GMO products
- **Qualitative test for initial screening and quantitative test might give a decisive answer concerning the labeling requirement**
- **Cartagena Protocol on Biosafety proposed (25 January 2002) for the first time, methods for GMO detection and quantification**
- Selection of appropriate GMO technology
- **Need for quality, neutral, balanced and factual information**
- **Impact on food production and food security that encompass several following issues:**
 - Potential failures of GM crops
 - Potential negative impact of Bt crops producing toxins resistant pest, impact on non-targeted biocontrol organisms and soil fertility
 - Potential transfer of insecticidal properties to wild species of crops

Major issues contd....

- Potential loss of genetic diversity
- Testing grounds by scientists and companies promoting GM organisms
- The relative costs (financial, social, political versus relative benefits i.e. productivity and food security)
- Fear of handing-over PGR to multinational companies creating IPR problems.

WAY AHEAD

1. **A competence national authority to review, assess, implement and monitor biosafety and other environmental concerns such as genetic erosion, agro-ecological disruption**
2. **Setting of basic standards for the testing, importation and exportation, and commercial use of genetically modified organisms**
3. **Ensuring that the release of GMOs is based on a sound and comprehensive scientific assessment (ecological and other risk)**
4. **Elaboration of specific laws and regulations**
5. **Identification in existing legislations**
6. **Collection of records and dissemination of information**
 1. **vulnerability of the environment, local plant genetic resources (diversity and extent of erosion) and agricultural system).**

WAY AHEAD continued

7. **Appropriate mechanisms of safety should be developed for the plant-animal-human food chain**
8. **Primary or secondary centers of genetic diversity conserved for posterity**
9. **Transgenic approach should be considered as complementary**
10. **International guidelines set up by the FAO-WHO Codex Commission for assessing and managing the health risks posed by GM foods should be closely followed**
11. **Strengthening and streamlining of the transgenic research program in the public and private institutes**
12. **Capacity building and human resource development**
13. **Ensuring proper flow of scientific and technical information, genetic materials and other critical components related to development and testing of transgenic crops among the related institutes and public.**



**THANK YOU FOR
YOUR KIND
ATTENTION**