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on Plant Genetic Resources

CONSERVATION AND SUSTAINABLE UTILIZATION OF PLANT GENETIC RESOURCES IN SOUTH ASIA

Sub-Regional Synthesis Report

Annex 1 of the Report of the
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The Report was drafted by Dr. Jayawardena, with the guidance of IPGRI's Regional Office for Asia, the Pacific and Oceania, and revised by Dr. Iqbal Kermali, following the Sub-regional Preparatory Meeting, taking into account modifications proposed by the countries. The collaboration of many others, in reviewing Country Reports, and editing the draft is gratefully acknowledged.

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I. INTRODUCTION

1. The countries of the South Asia sub-region, as defined for the purpose of this report, include Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka. The region is endowed with wide variation in climate, soil and agro-ecology and is a centre of diversity for many crops.

2. The sub-region has 19% of global population on 2% of the land area, including almost 50% of the world's malnourished children. In the past 20-30 years, agricultural production has increased dramatically including increases of up to 300% in many commodities. Some of the serious concerns in the current agricultural production include declining growth rates, decrease in productivity due to land degradation, reduction in availability of pulses, absence of improvement in the rainfed areas, emphasis on commodity rather than systems based approaches and population pressure negating production increases. Other disturbing trends includes centralism, homogenization, disempowerment of resource-poor farmers and dismantling of diversity.

3. In the recent years, the green revolution has had a tremendous impact in the sub-region and has altered the environment to fit the high yielding genotypes. The second generation problems which must be solved to achieve sustainable growth include waterlogging and salinization, soil erosion, surface and ground water contamination from agricultural chemicals, resistance to insects, weeds and pathogens due to present methods of control using pesticides, plateauing of yields, and the irreversible loss of landraces and habitats. Special attention will have to be paid to avert poverty, especially in the stressed and diverse areas of rainfed agriculture which occupy a major portion of the sub-region.

4. India is by for the largest country in the sub-region in terms of size and population (Table 1). Its total area is approximately 90% and population is about 85% of the South Asia sub-region. Each of the other countries occupy less then 4% of the total area, while Maldives is represented by 1,190 coral islands grouped into 26 atolls in the Indian Ocean and occupies about 0.01% area only. After India, Bangladesh is the most populated country in the sub-region with about 11% of the total. However, its population density is very high (836 persons/sq. km for Bangladesh compared to 285 for India). Nepal and Sri Lanka have each 2%, while Bhutan has less then 0.2% population of the sub region. Maldives has the highest population growth and population density in the sub region. Bhutan has the lowest population.

Table 1: Basic facts of the countries in the sub-region[1]

	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
Land area	10,294,000	407,000	181,050,000	4,000	4,354,000	2,329,000
Land area (% of the region)	5	0.2	91	0.002	2	1
Land use (1992):						
Arable (%)	66	2	51	10	17	14
Pasture (%)	4	6	3	3	14	7
Forest/woodland (%)	13	66	21	3	41	32
Population	120,433	1,638	935,744	254	21,918	18,354
Population density	836	35	285	847	156	280
Population growth rate (%)	2,32	2,34	1,77	3,58	2,44	1,15
Labour in agric. (%)	65	93	67	64	93	46
Agriculture in GDP (%)	33	50	34		54	25

[1] **Data from UN and FAO statistics**

5. The climate of the sub-region ranges from tropical monsoon in south to temperate in north. The Islands of Maldives are flat with elevations only as high as 2.5 meters. Sri Lanka is mostly low with mountains in the interior. India and Nepal have Himalayas mountain ranges, hills and upland plains cut by the Ganges plains. Deserts are present in west India. Nepal contains eight of the world's ten highest peaks. Bhutan, which is landlocked, is mostly mountainous with some fertile valleys and savanna while Bangladesh is mostly flat alluvial plain with hills in the Southeast. The agro-ecological zones of the sub-region are given in Table 2.

Table 2: Agro-ecological zones ('000 ha)[1]

	Bangladesh	Bhutan	India	Nepal	Sri Lanka
AT1: Dry semi-arid	0	0	27,840	0	24
AT2: Moist semi-Arid	0	0	81,032	515	327
AT3: Sub-humid	898	79	45,579	2,135	1,828
AT4: Humid	724	307	5,015	35	242
AT5: Marginal in AT2-AT4	827	393	19,175	1,653	610
AT6: Fluvisols/ Gleysols	6,885	6	12,149	951	516
AT7: Marginal Fluvisols/ Gleysols	150	0	661	56	19

[1] **FAO 1993 (Classification for Maldives is not available)**

6. The sub-region is subjected to several natural hazards like earthquakes, droughts, cyclones, tornadoes, severe thunderstorms, flooding. Much of Bangladesh is routinely flooded during the summer monsoon season. A large proportion of its population is landless and forced to live on and cultivate the flood-prone land. Landslides during the rainy season are frequent in Bhutan. The low level of islands of Maldives makes them very sensitive to sea level rise. Some of the current environmental issues in the region include overpopulation, deforestation, overgrazing, soil erosion, pollution

A. The Agricultural and Forest Sector

7. Agriculture plays a major role in the sub-region's economy. It produces most of the food requirements, and is a major source of employment and foreign exchange. Over 90% of labour force in Bhutan and Nepal, and 45 to 65% in the other countries of the sub-region is engaged in agriculture. Large scale commercial agriculture is almost non-existent in the sub-region and agriculture is predominantly subsistence and confined to rural areas.

8. Agriculture accounts for over 50% of GDP in Bhutan and Nepal, and 25 to 35% in other countries of the sub-region. The contribution of agriculture to GDP has been declining and it has become increasingly difficult to maintain economic development solely through agricultural development. Efforts to diversify these economies by exploiting cheap and abundant labour for the production of value added industrial goods for export have not always been encouraging. Agriculture will continue to play an important role for future economic development.

9. The principal agricultural crops of the sub-region are rice, wheat, corn, jute, sugarcane, pulses, oil seeds, potato, vegetables and fruits. The major export crops include cotton, jute, tea, rubber, and coconuts. India has become the world's second largest producer of rice, sorghum, groundnut and sugarcane, and third largest producer of wheat, cotton, rapeseed and mustard and seventh largest producer of potatoes. It is also the largest producer and exporter of black tea and has emerged as the second largest producer of fruits and vegetables in the world.

10. Even though these countries have over decades strived hard to achieve a high degree of self-reliance in basic food supply, many are still net importers of substantial quantities of food and fiber. In many areas of the sub-region, under-nourishment is still common. According to UNICEF (1996), the percentage of under nourishment of under five years old children is 67% in Bangladesh, 53% in India, 49% in Nepal and 38% in Sri Lanka. Timber and other wood products are scarce due to high demand and a low supply.

11. Maldives meet nearly 95% of the country's demand for food through imports, although there is sufficient land available for agricultural production. Agriculture has further declined in the recent years partly due to high cost of producing locally compared to imported food.

12. 53% of the total land area of the sub-region may be classified as arable land (50% in India and 3% in Bangladesh) and 24% as forest and woodland (20% in India and 2% in Nepal). The ratio of arable to forest land ranges from 5:1 in Bangladesh, 2:1 in India and 3:1 in Maldives to 1:30 in Bhutan and 1:2 in Nepal and Sri Lanka.

13. Over half of the land with agricultural potential in the sub-region is semi-arid, most of it in India. This includes 38% which is classified as *moist semi-arid* (productive rainfed land, with attainable yields greater than 40 percent of potential constraint-free yields, in zones with 120-179 growing days, with very suitable or suitable soil and terrain conditions) and 13% dry semi-arid (productive and marginally productive rainfed land, with attainable yields greater than 20 percent of potential constraint-free yields, in zones with 75-119 growing days, with very suitable, suitable or marginally suitable soil and terrain conditions). 22% of the agricultural land of the sub-region, including about half of Nepal and Sri Lanka and a quarter of India is sub-humid (productive rainfed land, with attainable yields greater than 40 percent of potential constraint-free yields, in zones with 180-269 growing days, with very suitable and suitable soil and terrain conditions). About 40% of the agricultural land in Bhutan is humid (similar to sub-humid, except with more than 270 growing days) and 50% is marginal (marginally productive rainfed land, with attainable yields of 20-40 percent of potential constraint-free yields, in zones with more than 120 growing days, with only marginally suitable soil and terrain conditions). The latter also occur in Nepal (30%) and Sri Lanka (17%). About 73% of agricultural land in Bangladesh, 18% in Nepal, 14% in Sri Lanka and 6% in India is naturally flooded land (productive lowlands, flooded or water-logged for part of the year with attainable yields greater than 40% of potential constraint-free yields), which constitutes about 10% of the agricultural land in the sub-region. The FAO agro-ecological zones for Maldives are not available.

B. Indigenous Plant Genetic Resources

14. The diversity of the sub-region consists of about 3500 species of higher plants (43% in India, 19% in Nepal, 16% in Bhutan, 14% in Bangladesh, 8% in Sri Lanka, and 1% in Maldives). Percentage endemism is 18% for the sub-region, excluding Bangladesh for which the values are not available. Endemism

is relatively high in India (31%) and Sri Lanka (28%), and approximately 4% and 1%, respectively, of the total number of species in these two countries are threatened (Table 3).

Table 3: Flora and endemism for higher plants in the sub-region[1].

Country	Number of species	Number of endemics	Percent of endemism	Number of threatened species
Bangladesh	5,000	n/a	n/a	33
Bhutan	5,446	50 - 100	1.4	15
India	15,000	5,000	31.3	1,336
Maldives	260	5	1.8	0
Nepal	6,500	315	4.5	33
Sri Lanka	2,900	900	28.0	220

[1] **Source: World Conservation Monitoring Centre, 1992**

15. The South Asia sub-region was included by Vavilov in the Tropical South Asian Centre of Origin. It corresponds to Zeven and Zhukosky's Hindustani area. It is a centre of origin or diversity for several crops including:

- rice;
- taro, yam, breadfruit, winged bean;
- carambola, durian, mangosteen, rambutan, banana, citrus;
- bamboo, lemon grass, nutmeg, clove, betelnut, sandal wood, ginger, cardamon;
- Manila hemp, coconut, sago palm, sugar cane.

16. The Indochinese-Indonesian area is also an important secondary centre of diversity for crops such as:

- cassava, maize, sweet potato;
- mango, coffee.

17. The long history of agriculture in the sub-region coupled with farmers' selection and cultivation of plant species over millennia and traditional farming practices to suit the diverse agricultural ecosystems have all contributed to a rich agricultural biodiversity. In almost all countries of the sub-region, the changes in land use, especially from forest to agriculture and degradation of forest has affected the status of plant genetic resources. For example, in Bhutan, the forest area has declined at an annual rate of 0.4%, and as high as 3.9% in some parts such as Terai. In Sri Lanka, the natural

forest cover has declined from approximately 84% on the total land area in 1881 to about 25% in 1992.

18. In Bangladesh, forests are being lost through encroachment for aquaculture and agriculture. It has been estimated that a loss of 8000 hectares of forest occurs annually due to homestead establishment, urbanization, deforestation, and natural disasters. Some of the forest species that are endangered have been rescued for ex-situ conservation. The rapid depletion of forest also results in loss of medicinal plant species and other wild species and wild relatives of crop plants. The Bangladesh Country Report describes the various species in their forests that have edible fruits or medicinal value and those which are related or allied to crop plants.

19. Rural people who live in and around forest are dependent on a large variety of forest products for subsistence. In a study of ethnobotany of four villages in the Zhemgang district of Bhutan, it was noted that farmers utilize 164 different types of forest plants including bamboo (5 species), cane/rattan (6), ferns (10), fruits (34, yams (15), medicinal plants (19), mushrooms (20), nuts (3), leafy vegetables (7) and trees for timber and fodder (45). In recent years, the aromatic leaves of cinnamon plants that have not yet been domesticated have become an important export commodity for Bhutan.

20. All Country Reports contain descriptions of wild species of cultivated food crops. The country report of Bhutan describes wild species of rice, finger millet, buckwheat, spinach, okra, pigweeed, carrot, garlic, pear, cherry, apricot, apple, apple, banana, grape, mano, strawberry, sugarcane, and tobacco. The country reports also describe the genetic diversity of crop species and have provided examples of traditional varieties being used. For example, in Bhutan, farmers grow many traditional rice varieties like Kalanamak (good taste and fine grain), Jumli Marshi (cold tolerant), Gamadhi (religious value) and Ghaiya (upland variety) besides several traditional and modern varieties. Table 4 gives examples of five kinds of traditional cultivars of rice common in Bangladesh. The traditional varieties of the sub-region include cereals, pseudo-cereals, pulses, oilseed crops, fiber crops, spices, vegetables, and fruits.

Table 4: Examples of some old rice cultivars of Bangladesh[1]

Type of rice crop	Traditional cultivars	Characteristics
Early *Aus* rice	Hashikalmi, Dharial, Dular, Kataktara, Morichboti, Holoi, Shaita, etc.	Adapted to drought prone areas
Medium to deep water *Aman* rice	Shada Pankaiz, Gabura, Malibhangor, Goda Laki, Dud Laki, Lal Aman, Chamara, Balam, Kaika, Dhepa, Baran Dhan, etc.	Used for medium to deep water area due to lack of modern varieties

Type of rice crop	Traditional cultivars	Characteristics
Transplanted *Aman* rice	Rajashail, Nonashail, Hogla Pata, Nonakuchi, Patnai-23, etc.	Adapted to coastal saline areas; no improved variety for these area are yet available
Transplanted rice	Nizershail, Jhingashail, Kartik Shail, Dadkhani, Kataribhog, Kalijira, Chinigura, Khash Kani, Tulshi Mala, etc.	Grown in specific areas for quality/ aromatic grains; no improved varieties with such qualities are yet available
Boro (Winter) rice	Tepi Boro, Akhni Shail, Poshu Shail, Lokhai Boro, Rata Boro, Gopal Veri	Early taller plant types that can withstand early flood

[1] **Extracted from Bangladesh country report.**

21. It is estimated that some 16000 landraces of rice are found in the Indian Gene Centre of diversity along with several closely related genera. For example, *Porteresia coarctata***,** a tetraploid species of the tribe *Oryzae*, is a salt tolerant perennial halophyte native of brackish waters and deltas. It constitutes a potential source for salt tolerant genes for rice improvement.

22. Landraces and traditional cultivars still play a dominant role in the agricultural of the sub-region. Farmers grow and retain these cultivars mainly due to **(i)** non-availability of improved varieties and/or their seeds, **(ii)** low input requirements by traditional varieties, **(iii)** their adaptability to specific ecological niches (i.e., deep water rice, salinity tolerant varieties of crops, etc.), **(iv)** their resistance to pests, **(v)** their specific quality(ies) like finer grain, aroma, specific tastes, etc. These traditional varieties are popular because of their suitability to subsistence farming systems common in the sub-region. In Bhutan, farmers intercrop maize with traditional mandarin fruits which is an important source of income. In other parts of the country, cardamom is grown in land too poor for other food crops.

23. Research and Development activities on traditional varieties are either very much limited or totally absent. The major policy emphasis so far has been on increased yield, especially of a few major crops. In doing so, quality factors inherent in traditional varieties have often been ignored. Under subsistence farming systems, farmers are committed to conservation of traditional varieties when the modern varieties suitable to their socio-economic and ecological conditions are not available to them. However, farmers' methods of conservation and storage have not been documented. It can however be stated that retention of traditional varieties by farmers is not essentially guided by their commitment to conservation, rather by the survival mechanisms adopted

by farmers. Equally important is that suitable market oriented agricultural production systems suited to the farming community are still underdeveloped. Often a bumper production of a crop leads to a fall in the market price of the produce and thus works against farmers' interests.

24. Apart from a limited effort to protect some forest areas, land use policies, either to protect plant genetic resources (PGR) or for sustaining agricultural production, have not yet been formulated. Rather, the drive for increasing the food grain production (by promoting high yielding rice and wheat), has threatened both minor cereals as well as non-cereal crops. These contributed significantly to genetic erosion of land races. For example, high quality rice varieties like Bashful, Biroi, etc. are hardly grown these days by Bangladesh farmers, even though the market demand for these is there. Such a situation is leading to changes/imbalances in cropping patterns, causing soil sickening in many areas, especially in areas devoted to rice monoculture and/or rice-wheat cropping systems.

25. Commercialization of horticultural crops in Maldives has put the farmers at higher risks especially due to serious disease outbreaks due to the use of imported varieties. The outbreak of the longicorn beetle had devastating effect on the bread fruit trees of one island community, killing more than 80% of trees in full maturity. Citrus has been nearly wiped out of the country due to the infection of bacterial canker. Recent introduction of white flies has nearly killed most of the guava plants.

26. In Sri Lanka, major factors causing decline in forest cover include high population density, land alienation, forest clearance for agriculture, non sustainable timber extraction, informal encroachment of the forest lands, etc.

II. ASSESSMENT OF PLANT GENETIC RESOURCES PROGRAMMES AND ACTIVITIES

A. National Programme, Policies and Legislation

27. India's PGR programme is a model to the region, while in countries like Bhutan and Maldives, the national programmes are non existent. In Bangladesh, Nepal and Sri Lanka, the national programmes are scattered among different ministries and institutes. The forestry sector has generally been isolated from the national conservation strategies in these three countries.

28. All six countries of the sub-region have ratified the Convention of Biological Diversity. Except for Bhutan, all are members of the FAO Commission on Genetic Resources for Food and Agriculture. All countries except Bhutan and Maldives adhere to the International Undertaking on PGRFA. Table 5 shows the major indicators of national programmes on PGR in the sub-region.

Table 5: The major indicators of national programmes on PGR in South Asia sub-region

	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
National Programme			yes			
Advisory Body	yes		yes			yes
FAO Commission on GRFA	yes		yes	yes	yes	yes
FAO International Undertaking	yes		yes		yes	yes
Convention of Biodiversity	yes	yes	yes	yes	yes	yes
Quarantine Regulation	yes	yes	yes		yes	yes
Plant Breeder's Rights	no	no	no	no	no	no
Seed Certification	yes		yes			yes
Enviromental Protection Law	yes		yes			yes

29. Bangladesh, Bhutan, India and Sri Lanka are signatories to the International Plant Protection Convention and have Quarantine Legislation. Nepal has national regulation on Quarantine. In Maldives, the Quarantine Legislation is being formulated. No country in the sub-region has breeders' rights system. India is considering plant breeders' rights legislation that would reward the providers of genetic resources, in line with farmers' rights. Bangladesh, India and Sri Lanka have laws relating to seed certification.

Bangladesh

30. There is no integrated national programme on PGR. The national policies on PGR are not well organized and well developed. The programmes are scattered at different institutes/organizations spread over different ministries. The autonomous research institutes work on different crops and

each of them maintains the genetic resources mainly for the crop improvement programmes. Coordination among institutions is inadequate.

31. Legislation for the prevention of PGR erosion is absent, except for a poorly enforced ban on use of trees for brick making and a ban of tree cutting in high forests. There has been an increased interest on policies for the conservation of biodiversity and protection of environment after the 1992 Biodiversity Convention. National awareness on biodiversity is rather low.

32. Current quarantine laws are not conductive to germplasm exchange for research purposes. Special legislation is needed for *in vitro* materials. The Seed Policy, which has not been gazetted, allows free trade of farmers' varieties. Intellectual Property Rights Legislation is absent. At present friendly and liberal exchange of PGR is possible through bilateral arrangements. Before initiating agricultural development projects, environmental impact statements are required.

33. The PGR programmes, in general, are understaffed and lack sufficiently trained personnel. The existing personnel are drawn from other disciplines and thus need specialized training. Although there are no organized training courses, one institute has already offered courses to PGR workers from neighbouring countries.

Bhutan

34. Very little activity on PGR has been undertaken so far. Firstly, because the research programme is weak and there is no genebank for *ex situ* conservation. Secondly, the urgency is not felt because the agriculture system is largely subsistence and forest cover is high. The subsistence mountain agriculture ensures *in situ* conservation of the indigenous PGR while the Forest Laws and Plant Quarantine Act regulate the use and exchange of PGR for mutual benefits. There is a high level of awareness of importance of plant and forestry diversity. A project proposal to establish a PGR Centre has been prepared with the assistance of then IBPGR.

India

35. The National Bureau of PGR (NBPGR) is the nodal organization in India for planning, conducting, promoting, coordinating and leading all activities concerning collecting, introduction, exchange, evaluation, documentation, safe conservation and sustainable management of diverse germplasm. The Bureau has developed a network of activities based on partnership with other relevant institutes and organizations including research centres and Universities. Crop advisory committees have been constituted for specific crops or groups of crops. Crop curators have also been designated for major crops.

36. The model one-window system of PGR conservation in India covers all activities including training, germplasm exchange and information exchange. In India, there is a high degree of awareness among the political leaders on the importance of conservation. Agricultural research and education system are well developed with significant national commitment to sustain the agricultural research education and production including PGR activities. The NBPGR has strong national, regional and global linkages.

37. A national expert committee under the Department of Environment and Forestry is responsible for the affairs concerned with the Convention of Biodiversity. The 1970 Patent Act excludes agricultural plants and life-saving drugs. A *sui generis* system is being developed for plant variety protection. NBPGR plays a leading role in the formulation of the proposed legislation.

Maldives

38. The national conservation activities consist mainly of developing a few of its uninhabited islands to be made into reserves. However, the islands have maintained their virgin vegetation due to their small size, remoteness as well as the strong traditional management system. A number of these traditional systems have been made into laws. There is a strong awareness among the population for conservation.

39. The country has a well organized conservation policy for timber plants. Similar policies for herbs, medicinal plants and micro flora are lacking. Ministry of Fisheries and Agriculture is responsible for PGR. An Environmental Action Plan has been developed by the Ministry of Planning, Human Resources and Environment. An Environmental Protection Law has been recently gazetted. Legislation on quarantine is still under process.

Nepal

40. There is a strong tradition of conservation of forests for religious purposes. At present, the two Ministries of Agriculture and of Forest and Soil Conservation are involved in PGR activities. National workshop on PGR held in November 1994 recommended the need for establishing a National System and a National Coordinating Committee. PGR staff are not adequate and lack specialized training. In country training programme is absent.

41. Nepal has signed the 1992 Convention of Biological Diversity and is a member of FAO Commission on Genetic Resources for Food and Agriculture. The country is a member of the International Plant Protection Convention (IPPC) and has legislated plant protection regulations. The existing regulations on quarantine are adequate for the movement of germplasm. Legislation to protect wild and collected germplasm is absent. However, endemic and endangered forestry species are protected through a

number of forest acts and legislations. Impact of crop improvement programmes on PGR is not considered when planning the projects. Farmers are encouraged to adapt improved technologies through support and subsidies, as a result of which, genetic erosion remains unchecked. The unrestricted export of medicinal plants has led to their gradual loss. Export of timber has been banned to protect forest genetic resources.

Sri Lanka

42. The PGR Centre is mandated to function as the National Centre for PGR and to establish linkages with the national system under the Ministry of Agriculture, Lands and Forestry. The PGRC was established under Department of Agriculture, while the natural forests fall under the Forest Department. Other ministries involved include Ministry of Plantation Crops, Ministry of Environment, Ministry of Indigenous Medicine and Ministry of Science, Technology and Personnel Development.

43. The country's constitution has embodied into it the duty of every person to conserve and protect nature. This has been emphasized in the National Environmental Act implemented by the Central Environmental Authority through a national conservation strategy. The Ministry of Environment has set up a National Experts Committee on Biodiversity for implementation of Convention of Biological Diversity. The Fauna and Flora Protection Ordinance provide protection within and outside the protected areas. There are very strong village traditions on sustainable natural resource management.

44. Transfer of seeds and *in vitro* materials is regulated through quarantine laws. National laws restrict unregulated collection and export of flora. The sale and distribution of seeds come under the Seed Certification Scheme. IPR legislation has not yet been formulated. There is no incentive to farmers for on-farm conservation of traditional varieties.

B. Sub-Regional Programme and Networks, and International Collaboration

45. The National Coordinators of South Asian countries have met several times to stimulate collaboration in the sub-region. A PGR network is now being formalized. Such a network would include specific components concerned with advancing or conserving PGR in its objectives, sharing the germplasm and information, and sharing other resources, including funding and technology.

46. Most countries have some collaboration with FAO (Table 6) and the International Agricultural Research Centres of the CGIAR. IPGRI is very

active in the sub-region through its coordinating office in New Delhi, India. IPGRI promotes crop-specific networks for crops such as bamboo, rattan, allium, groundnut, *Musa*, sweet potato and okra with other countries in the Asia Pacific region. One CGIAR centre, ICRISAT, located in India has a mandate for semi-arid tropics with global responsibility for *sorghum, chickpea, pigeon pea, groundnut, pearl millet*, and *minor millet*. Other CGIAR centres are also very active in the sub-region.

Table 6: FAO programme activities in the Sub-Region

Project Code	Countries	Project title
TCP/BGD/4554	Bangladesh	Vegetable Seed
TCP/BGD/6613	Bangladesh	Development and Use of Hybrid Rice
BGD/87/025	Bangladesh	Horticulture Research and Development
BHU/87/016	Bhutan	Integrated Horticultural Development
TCP/BHU/6611	Bhutan	Kitchen Gardening for Better Nutrition
IND/90/007	India	Phytotron Facility at the Indian Agricultural Research Institute (IARI)
IND/91/008	India	Development and Use of Hybrid Rice Technology
TCP/IND/4453	India	Assistance to Horticultural Development in Madhya Pradesh
TCP/IND/4554	India	Vegetative Propagation of Walnuts
TCP/IND/4555	India	Oil-Palm Development (Smallholders)
IND/94/01T	India	Development and Application of Modern Bio-Technology
RAS/89/040	Regional	Improvement of Food Legumes and Coarse Grains
RAS/93/066	Regional	Biotechnology and Biodiversity
GCP/RAS/135/IJO	Regional	Assistance to National Jute and Kenaf Seed Programmes

47. In Bangladesh, all individual institutions working on PGR have close linkage with IPGRI. Other International organizations that have close linkages on PGR activities include IRRI, ICRISAT, CIMMYT, CIP, ICARDA, IITA, International Jute Organization, IUCN, IDRC, ODA, SDC and AVRDC. National staff have received training from almost all the CGIAR centres. FAO/UNDP have in the past helped Bangladesh in various PGR programmes including the establishment of genebanks. Bilateral arrangements exist with several countries including Australia, China, Egypt, India, Japan, Malaysia, Nepal, North Korea, Pakistan, Sri Lanka, Thailand and Turkey.

48. All germplasm activities carried out so far in Bhutan are confined to joint collections carried out with IPGRI and IRRI. Some of these collections are preserved in gene banks outside the country.

49. India is host to headquarters of ICRISAT and the IPGRI sub-regional coordinating office. NBPGR has maintained a very effective and fruitful collaboration with all International Crop Research Institutes especially for germplasm introduction, exploration, collection, evaluation, multi-locational testing, documentation/cataloging and training. The bureau has taken a leading role in collecting germplasm and has proposals to expand its information database through strong regional cooperation and international linkages. Its current collection represents safe duplicate samples of a number of International Institutes mandated crops including the global collections of pigeonpea, safflower, sesame, *Vigna mungo*, *Vigna umbellata*, okra, egg plant; the Asian collections of *Amaranthus*, *Capsicum*, *Raphanus*, *Brassica juncea*; and the Indian collection of minor millets. The country has several bilateral programmes, current ones being with Russia, China, USA, Pakistan, Vietnam, Japan, Canada, UK and several other countries in Europe and Africa.

50. Nepal has benefited from several IARCS, especially IPGRI, IRRI, CIMMYT, ICRISAT, ICARDA and CIP, and regional research centres such as AVRDC. It has received technical and financial support from FAO for agro-horticultural and agro-forestry crops. The country does not have any bilateral agreement on PGR activities as such, but its agriculture system has been assisted by several countries including Japan, India, USA, Germany, UK, Switzerland, etc.

51. Sri Lanka has collaborated with FAO, IPGRI, other IARC and regional research centres. The National PGR Centre was developed with a grant from the Japan International Corporation Agency. The country does not have any bilateral agreements on PGR.

C. Conservation Activities

Collecting

52. In Bangladesh, the collecting programmes are seldom well planned or mission oriented, except in the case of jute and to a limited extent for rice. The in-country collections are considered grossly inadequate. There is a reasonable collection of the diversity for pulses, millets, yam, sesame, eggplant, okra, etc. Organized explorations are yet to be undertaken for many other crops. The major sources of germplasm outside the country have been the IARCs including IRRI, AVRDC, CIP, ICRISAT, CIMMYT, ICARDA, IITA and IJO.

53. In Bhutan, only limited formal germplasm collection missions have been undertaken, mainly with IBPGR/IPGRI in 1981 and IRRI in 1983. Besides rice, no comprehensive collection efforts have been made on other crops. The 1981 IBGRI mission noted serious threat to indigenous wheat and rice. The 1983 mission collected traditional rice varieties from high and medium altitudes, but did not cover remote areas. Records of the Royal Botanic Garden, Edinburgh list 163 horticultural species introduced to other countries from Bhutan.

54. The NBPGR of India has the national mandate for planning, organizing, coordinating and conducting explorations in India and abroad in collaboration with its own regional network, ICAR institutes, Agricultural Universities and State Department of Agriculture and concerned national programmes. It pursues this activity vigorously and expeditions to collect valuable genetic variability comprising of crop landraces and related wild species are being regularly organized. However, several regions/pockets still require attention. More efforts are also required for wild species.

55. The conservation activities in Maldives are not well developed. There is no genebank due to lack of trained personnel and financial resources to maintain such a capacity. Few collections have been done with assistance from FAO and these collections are housed at the Botanical Gardens in Sri Lanka, the Royal Botanic Garden in Kew, The British Museum, Smithsonian Institute in Washington and Coseratoir Botanique, Geneva. There is an urgent need for collection, especially of medicinal plants and minor plants, some of which are threatened with extinction.

56. In Nepal, plant exploration missions by botanists/breeders from Germany, Japan, USA and other European countries have been undertaken since 1937. Since 1986, the Research Council has initiated multicrop collecting missions to collect the indigenous germplasm. International agencies also collaborated in such activities. For example, IRRI launched wild rice exploration mission in 1988 and IBPGRI sponsored eggplant and Okra collecting mission in 1990.

In situ conservation

57. Conservation of wild flora can best be achieved *in situ* conservation, through protection of habitats and ecosystems. In the sub-region, the protected areas, as distributed according to IUCN management category (Table 7), cover approximately 5% of the total area. 68% of the protected area is category IV (conservation through management intervention) and 32%

is category II (ecosystem protection and recreation). A small portion (less than 0.2%) is category I (wilderness protection) and is located in Sri Lanka. Only two countries have more than 10% of their territory designated as protected area and include Bhutan (19%) and Sri Lanka (12%). Nepal has approximately 8% and India has about 4%. Less than 1% of Bangladesh is protected.

Table 7: Protected areas of the Sub Region as classified according to the IUCN management categories[2]

Country[1]	Category I		Category II		Category III	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Bangladesh	0	0	0	0	0	0
Bhutan	0	0	6,606	14	0	0
India	0	0	31,892	1	0	0
Nepal	0	0	10,144	7	0	0
Sri Lanka	315	0.5	4,363	7	0	0
Total (subregion)	**315**	**0.2**	**53,005**	**32**	**0**	**0**

Country[1]	Category IV		Category V		Total (protected)	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Bangladesh	833	1	134	0.09	967	1
Bhutan	2,411	5	0	0	9,017	19
India	104,443	3	186	0.01	136,521	4
Nepal	941	1	0	0	11,085	8
Sri Lanka	3,280	5	0	0	7,959	12
Total (subregion)	**111,908**	**68**	**320**	**0**	**165,549**	**5**

[1] **Information for Maldives is not available**

[2] **Category I: Strict Nature Reserve or Wilderness Area; Category II: National Park; Category III: Natural Monument; Category IV: Habitat/Species Management Area; Category V: Protected Landscape/Seascape; Category VI: Managed Resource Protected Area**

58. Biosphere Reserves are areas of terrestrial and coastal ecosystems that are internationally recognized within the framework of UNESCO's Man and the Biosphere (MAB) Programme. In India, fourteen biosphere reserves have been identified, of which seven are already operational. Sri Lanka has several biosphere reserves.

59. Forestry programmes in the sub-region have made some progress in *in situ* conservation. For example, the forest resources of Bangladesh include mangrove forests, hill forest, plain land forest, unclassified state forest and village grooves. In Bhutan, forests are conserved *in situ* in national parks and wildlife reserves. India has a National Conservation Strategy that constitutes biosphere reserves, wetlands and mangrove areas. Apart from these efforts in

forestry, very little *in situ* conservation exists in the sub-region. Greater success could have been achieved for *in situ* conservation of wild relatives of edible fruit plants, medicinal plants, ornamentals and wild relatives of crops, if their programmes were integrated with the forest conservation programmes. For example, in Bangladesh, three *in situ* conservation sites for wild relatives of rice have been planned.

60. *In situ* conservation for agricultural and horticultural crops is a relatively new concept in the sub-region. Efforts are being made for *in situ* conservation of landraces and wild relatives. However, landraces have been maintained by farmers and their efforts are just beginning to get recognition.

61. In Sri Lanka, home gardens are common in the rural areas. These gardens are potentially an important system of conservation that need wider recognition. The system is based on a well-defined plant association and canopy structure that reflect a variety of complementary functions. At the outer perimeter, coconut and fruit trees predominate and canopy is progressively reduced with the planting of spice crop trees. Vegetables occupy the inner perimeter. Indigenous yams are grown near the well or open drainage areas while medicinal plants are frequently grown under shade. Ornamentals mostly occupy the front garden near the house. This system is especially useful for conserving the diversity of perennial fruits such as Banana, Mango, Jack fruit, Citrus, Avocado, Mangosteen, Durian, Rambutan, Guava, and Papaya.

Ex situ conservation

62. In Bangladesh, about 25,189 accessions are stored in three genebanks and four institutes along with 1,234 agroforestry species. About 22,000 are stored in the three genebanks established with assistance from donors. The operational budget for these genebanks is not sufficient. Several problems threaten the stored materials, including power failures, lack of spares and poor maintenance. Thus the long term storage is not safe or reliable. Safety duplication is done in collaboration with IRRI and Canberra Genebank in Australia, but is not satisfactory. In some cases, the duplicate samples are not the same as those in the country.

63. Two of the three genebanks in Bangladesh focus on specific crops. The Rice Research Institute maintains about 7,500 accessions of indigenous and exotic rice including wild species. The Jute Research Institute serves as the global repository for jute and allied fiber crops and their wild progenitors and relatives. At present, a total of 6,000 indigenous and exotic accessions are maintained. The Institutional holdings outside the genebanks include collections of teas, sugarcane, rice and brassicas. The existing facilities for seed conservation are almost adequate at different institutes in the country for

active and base collections. But the expansion of PGR activities may also need increasing conservation facilities.

64. Bangladesh Forest Research Institute has established *ex situ* field conservation stands of bamboo (36 species), rattan (7 species) and a number of important tree species in arboretum, orchards and field gene banks. The *ex situ* stands are mainly geared to supplying seeds and planting materials. They represent mostly indigenous materials. However, some exotic collections are also included. There is a need to expand these collections with plantation species, vegetatively propagated materials (like tea and sugarcane), perennial fruits (like mango, jackfruit, litchis, citrus, guava) and annual crops (like banana, pineapple, papaya), other underutilized species and wild relatives of useful crops. *In vitro* efforts are practically non-existent in the country.

65. In India, conservation of cultivated plants and their wild relatives is the sole responsibility of NBPGR. Thus all *ex situ* measures are undertaken at the national level. In addition, several botanical gardens managed by other organizations also help in *ex situ* conservation. High priority has been given to the maintenance of collections in fields, orchards, plantations, herbal gardens, botanic gardens and more recently in genebanks. In many cases, conservation methods also involve storage as seeds backed by a limited number of clones in field or *in vitro* gene banks. The newly built national genebank has a capacity of about one million accessions and currently holds 144,109 accessions. The national facility for plant tissue culture repository at NBPGR has well-planned programmes for cryopreservation of seeds, pollen, embryos, embryonic axes as well as *in vitro* cultures.

66. There is no national gene bank in Nepal. Altogether 8,383 accessions of about 64 crop species are preserved at a genetic seed house (a prefabricated structure) in the Division of Agricultural Botany. Physical facilities for processing, cleaning, drying, sealing, packaging, etc. are absent. This capacity can be used for short term conservation only. Local landraces collected since 1938 are preserved at foreign gene banks based on mutually agreed terms and include 8,941 accession in Japan, 1,809 in USA, 1,488 in Philippines, 498 in Taiwan, 175 in CIMMYT, Mexico and 101 in India.

67. In Nepal, 2,500 accessions of the forestry genetic resources are conserved as living plants and seeds in National Parks, Wild Life Reserves, and gene conservatories in eight parts of the country. Endangered orchids, ornamentals and other plant species are conserved in Tissue Culture Laboratory. Protocols for micropropagation of 75 plant species have been developed and include trees, medicinal plants, horticultural plants, ornamental species and orchids. Horticultural farms and herbal conservatory are used to conserve horticultural and medicinal plants respectively. The introduced and

indigenous fruit crops including mango, litchi, guava, apple, peach, pear, plum and citrus are preserved in different horticultural farms and stations.

Regeneration

68. Field maintenance and regeneration also provide opportunity for identifying donor stalks which are likely to be used in breeding programmes. However, too frequent regeneration can lead to genetic erosion due to environmental hazards, genetic drift, mechanical failures or human errors.

69. In Bangladesh, only a small proportion of accessions can be regenerated due to lack of funds, facilities, human resources, and lab/field spaces.

70. In Nepal, self pollinated crops are regenerated on regular basis. Adequate facilities like green house, net house, etc. are not available to undertake satisfactory regeneration of cross pollinated crops.

Characterization and documentation

71. Information database system is very important at national, regional and global levels to back up conservation of genetic resources for not only immediate utilization but also for future use.

72. Documentation and information management of PGR activities are poor in Bangladesh. Computerized databases are absent and information is handled manually. About 50% of jute, 30% of rice and a negligible number of accessions in other crops have been characterized. A preliminary evaluation of about 20% of jute and 30% of rice accessions have been completed. Characterization and evaluation data do not always include information on physiological responses and micro-biological characteristics, though disease and insect susceptibility is usually recorded. This information is reported in annual reports of respective institutes. There is no feedback system, thus information from the users of germplasm is not available to the genebanks.

73. The NBPGR of India plans to expand its database through strong regional cooperation and international linkages.

74. In Nepal, the information regarding collection, characterization, evaluation has been documented manually and distributed through annual reports, technical papers and personal contacts. Computerization has been initiated. About 28% of the germplasm accessions have been evaluated. The evaluation and characterization data of barley, buckwheat, finger millets, amaranths and grain legumes have been published.

D. Use of PGR in the Sub-Region

75. In Bangladesh, a very small proportion of accessions has been used locally in breeding programmes except for rice (10%) and jute (5%). A good number of germplasm has been supplied outside the country, mostly to IARCs, USA, Japan, West Africa and India. So far, the outgoing germplasm (8,400 accessions) has surpassed that which has been brought into the country (4,500 accessions). The indigenous germplasm has been very useful in breeding programmes especially for rice, jute, sugarcane, pulses and oilseeds. In rice, of 62 varieties released, about half are derived from indigenous materials; in jute, 20 out of 23 varieties were from indigenous materials; and in the case of leafy vegetables an estimated 90% of the varieties are from local materials. However in the case of potato and wheat, virtually all varieties are derived from exotic materials. The Forest Research Institute has demarcated areas in natural forests where valuable indigenous forest genetic resources occur. About 950 trees of twelve species have been selected for conservation with a long term view of supplying superior planting materials.

76. The landraces preserved in Nepal are used by breeders and researchers. About 8% of the accessions have been made available to the research programmes and include crops like rice, mustard, blackgram, sesame, niger, linseed, sarson, buckwheat, amaranthus and fox tail millet. The inadequate number of plant breeders is the major constraint in PGR utilization. The non-timber forestry plants, especially medicinal and aromatic plants, have been in use for many years. They have been further encouraged by the establishment of herbal nurseries which have also helped to propagate endangered medicinal plants. Forest nurseries, some maintained by farmers or their communities, provide seedlings for forest management.

E. PGR Exchange

77. The exchange of seeds with different national, regional and international institutions is a regular activity but needs to be formalized and enhanced. The exchange of seeds and planting materials among farmers is the common practice.

III. NEEDS, OPPORTUNITIES AND PRIORITIES FOR THE GLOBAL PLAN

78. Through their country reports, the countries of the sub-region identified the following as representing their needs for consideration during the preparatory process for the International Technical Conference.

Genetic Diversity

- Make an assessment of the genetic diversity of PGR, the rate and extent of genetic erosion, and prioritize genetic resources activities based on the information gathered from such studies.
- Review and record the indigenous knowledge on biodiversity including the farming practices and use of medicinal herbs, and establish a central database for such information.
- Collect, conserve and utilize the genetic resources before they are lost or threatened with extinction.
- Identify and control activities with adverse impact on the biodiversity.
- Stop further genetic erosion by discouraging the encroachment of forested areas and controlling grazing by livestock. Reduce habitat destruction and rate of introduction of new varieties and exotic species.
- Identify gaps in the current conservation and utilization of genetic resources and take mitigation action.
- Define and describe bio-geographic regions and major eco-systems more scientifically and accurately in relation to the biodiversity they contain.
- Emphasize research on ethnobotany, sericulture, coral islands, saline environment farming and carrying capacities of plant and animal diversity.
- Assess the impact of developing the uninhabited Islands on biodiversity of Maldives.

National Programmes

- A sound national programme on plant genetic resources is not only desirable but essential for efficient conservation and sustainable utilization of PGR in most countries of the sub-region.
- Develop national PGR systems consisting of high level committees with powers to secure funding and personnel to implement the national policies on conservation and sustainable utilization of PGR.
- Promote and strengthen networking among partners at both the regional and the global level.
- Obtain the commitment of the highest level of responsible governments to promote conservation and sustainable utilization of PGR.
- Develop a consolidated strategic multi-sectorial framework for conservation of full complement of biodiversity as well as for the national biodiversity action plan.

- Periodically review the research programmes and increase support for those involved in the conservation and sustainable utilization of PGR.
- Create national awareness through educational programmes and sensitize the public on the benefits of biodiversity and to put its conservation in a proper perspective.

Policies and Legislation

- Formulate national legislation and regulatory framework for access to PGR and their exchange in relation the Biodiversity Convention.
- Develop legal mechanism to safeguard the conservation and sustainable utilization of PGR for the benefit of the people.
- Develop national guidelines, procedures, polices, legislation and modalities for compensation for access to PGR. Ensure benefits to the local communities affected by conservation measures.
- Implement the ordinance that prohibits the collection, sale and export of indigenous and endemic plant species listed in a schedule. Species that are threatened need to be included in the schedule.
- Encourage use of multilateral transfer agreements (MTA) on mutually agreed terms and other contractual arrangements for germplasm exchange.
- Recognize and reward farm families and the breeders for informal innovations. Consider farmers' rights to use their saved seed and to ensure the quality of seed.
- Assess the impact of land tenure and traditional property rights on conservation and sustainable utilization of PGR.

Convention of Biological Diversity

- Identify and analyse options to meet the objectives of CBD, that is, conservation, sustainable use and benefit sharing strategies.
- Assist in preparation of the first national report for CBD Conference of Parties, 1997

Capacity Building

- Strengthen scientific and technical capacity of research programmes.
- Strengthen national capabilities, build up research capacity and develop linkages between scientists and institutions.
- Develop institutions, technologies and personnel for enhanced conservation and sustainable utilization of plant genetic resources.

- Infrastructure for conservation of orthodox and recalcitrant seeds, vegetatively propagated materials, including facilities for cryopreservation laboratory and DNA banks.

Conservation

- Strengthen facilities and refine technologies for long term *ex situ* conservation and storage of duplicate samples.
- Establish national PGR facility including infrastructure for *ex situ*, *in situ*, *in vitro* conservation, regeneration, characterization, evaluation and documentation for most countries of the sub-region.
- Strengthening and integration of various activities of national programmes including field genebanks.
- Review and establish new protected areas and assess the prospects for *in situ* conservation outside the protected areas. Identify areas for protection, and for *in situ* and on farm conservation of wild species and landraces of crops.
- Involve farmers, NGOs, school children, and private sector in the conservation programmes.
- Set funding priorities and mechanisms to support the activities of farmers and communities on conservation and sustainable utilization of PGR.

Utilization

- Strengthen national variety improvement programmes and integrate such programmes with PGR activities.
- Perform extensive multi-locational evaluation of PGR.
- Develop core collection for promoting use and reduce cost of maintenance.
- Develop *in vitro* facilities for Micropropagation of elite strains of agricultural and horticultural crops, forestry species and medicinal and aromatic plants.
- Develop and strengthen the agronomic research units and investigate their funding constraints.

Biotechnology

- Develop biotechnological capabilities to upgrade the national PGR Programmes, especially for bilateral and collaborative research.
- Develop capacity in biochemical and molecular characterization of PGR.

- Use molecular characterization of accessions for their verification in case of disputes on ownership.

Documentation System

- Develop PGR documentation and data management systems to facilitate conservation and utilization nationally and regionally.
- Create and update national databases and their networking both within the country and within the sub-region. Maintain and update information in these databases from international sources.
- Develop and maintain centralized computerized database systems in countries that still lack them.
- Support the documentation of all flora including those used in herbal preparations.
- Document the species as well as the rate of introduction on new varieties of plants to the countries of the sub-region.
- Promote and encourage exchange of technical information and databases on PGR among all programmes within and outside the sub-region.
- Develop international framework for multilateral transfer agreements for sharing genetic materials of economic value, recognizing country's sovereignty over PGR and allowing each country to reach its position.
- Ensure that the collections conserved at international genebanks are made available to the national programmes on request as well as the benefits arising out of this germplasm are shared by the country where the collections originated.

Policies

- Ensure effective representation of the concerns of the developing countries.
- Develop national legislation for protecting the rights of the peasants, farming communities and indigenous people.
- Mechanisms of rewards and compensation to farming families, communities and farmers have to be decided at global level under the auspices of FAO.
- All form of "rights" on living materials should safeguard the national interest for legal, ethical and practical reasons.
- Minimize any adverse effects of Convention and GATT/WTO.

- There should be a simultaneous consideration of sustainability of agricultural production, food security, nutritional security, and higher standard of living in the developing countries.

Funding Mechanism

- Develop a global funding mechanism to support the gene rich countries and regions having weak institutional and technical capacity for funding infrastructure development, personnel development and expertise.
- Create international fund to assist PGR programmes in conservation and sustainable use of biological diversity to minimize destruction of natural habitats and genetic erosion.
- Establish regional fund for the conservation and sustainable utilization of PGR.

National Programmes

- Assist national programmes in developing their capabilities in conservation and utilization of PGR so that these countries secure full benefits of their valuable assets.
- Identify gaps in collection at national, regional and global levels with the help of expert groups. Assign priorities to wild relatives, endemic species and perennial crops such as fruits and other underutilized plant resources.
- Provide global or regional support to in-situ conservation of wild relatives in areas that overlap national boundaries.
- Facilitate global assistance to on-farm conservation and strengthen national variety development programmes.