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ABBREVIATIONS:

AEC – Agro-Ecosystem

AIR – All India Radio

AMUL – Anand Co-operative Milk Union Limited

ANOVA – Analysis of Variance

AOA – Agreement On Agriculture

BCPP – Biodiversity Conservation Prioritization Project

BDA – Biological Diversity Act

BPH – Brown Plant Hopper

BR – Biligiri Rangana Hills

C/PBRs – Community/People's Biodiversity Registers

CBD – Convention on Biological Diversity

CGRs – Crop Genetic Resources

CIKS – Center for Indian Knowledge Systems

CPRs – Common Property Rights

CSIR – Council of Scientific and Industrial Research

DD – Doordarshan

DDS – Deccan Development Society

DES – Department of Economics and Statistics

Dom. bd. – Domesticated Biodiversity

DST – Department of Science and Technology

DWD – Diverse Women for Diversity

EU – European Union

EVMs – Ethno Veterinary Medicines

FAO – Food and Agriculture Organization

FRLHT – Foundation for Revitalization of Local Health Traditions

GATT – General Agreement on Tariff and Trade

GIAN – Grassroots Innovations Augmentation Network

GNP – Gross National Product

'GO's – Government Organisations

GREEN – Genetic Resource, Energy, Ecology and Nutrition

GRT – Green Revolution Technologies

HBN – Honey Bee Network

HYV's – High Yielding Varieties

IAKTs – Indigenous Agriculture Knowledge and Technologies

ICAR – Indian Council of Agricultural Research

ICRISAT – International Crop Research Institute for Semi Arid Tropics

IDRC – International Development Research Center

IIM – Indian Institute of Management

IISc – Indian Institute of Science

INM – Integrated Nutrients Management

IN-PGRS – Indian National Plant Genetic Resources System

IPGRI – International Plant Genetic Research Institute

IPM – Integrated Pest Management

IPR – Intellectual Property Rights

IUPGR – International Undertaking of Plant Genetic Resources

IVRI – Indian Veterinary Research Institute

KRRS – Karnataka Rajya Raitha Sangha

LBC – Local Biodiversity Chronicles

MSSRF – M.S. Swaminathan Research Foundation, Madras

NAAS – National Academy of Agricultural Sciences

NABARD – National Bank for Agriculture and Rural Development

NAGS – National Active Germplasm Sites

NAP – National Agricultural Policy

NBAGR – National Bureau of Animal Genetic Resources

NBPGR – National Bureau of Plant Genetic Resources

NBSAP – National Biodiversity Strategy and Action Plan

NDRI – National Dairy Research Institute

NGO's – Non-Government Organisations

NIF – National Innovation Foundation

PDS – Public Distribution System

PGRs – Plant Genetic Resources

PIC – Prior Informed Consent

PVP FRA – Plant Variety Protection and Farmers Right Act

R & D – Research and Development

SANFEC – South Asia Network on Food, Ecology and Culture

SAPs – Strategies and Action Plans

SAUs – State Agricultural Universities

SRISTI – Society for Research and Initiatives for Sustainable Technologies and Institutions

TRIPS – Trade Related Intellectual Property Rights

TWG – Thematic Working Group

UAS – University of Agricultural Sciences, Bangalore

UPOV – Union for the Protection of (new) Plant Varieties

WTO – World Trade Organisation

WWF – World Wide Fund

Executive Summary

I. BRIEF INTRODUCTION: The Thematic Working Group (TWG) on Dom. bd, presents a set of broader macro level **Strategies and Action Plans** (SAPs) for the conservation and use of domesticated bio-diversity (dom. bd.) in an equitable and sustainable manner in India. These SAPs are framed based on the key suggestions which emerged during the two meetings: on September 29, 2000 at the Development Research Communication Center, Calcutta and on August 11, 2001 at the University of Agricultural Sciences, Bangalore, the inputs received from the members and the information collected from different sources/occasions. Adequate emphasis is given to caste, class, gender and regional dimensions of the use of dom. bd. The domesticated biodiversity was approached under three major headings, viz: (a) ***Agri-diversity*** with special focus on dry land field crops, homestead farm diversity and diversity in tribal agricultural system along with the agro-ecosystem diversity; (b) ***Livestock diversity*** which includes milch & draught animals, small ruminants, and poultry; and (c) ***Other forms of dom. bd.*** which includes cultured fish species, honeybees, camels and pet dogs. In addition to this, focus was given to the Informal Knowledge and Technology System which includes ***Indigenous Agricultural Knowledge and Technologies (IAKTs), Ethno Veterinary Medicines (EVMs)*** and ***local/traditional/indigenous institutions*** associated with Dom. Bd,.

II. MAJOR ISSUES ADDRESSED: The current knowledge on dom. bd. was used to address the following major issues:

2.1. Relationship With the Other Forms of Biodiversity: Forms of domesticated bio diversity like native honeybees are playing crucial roles in enhancing the overall diversity in the nature. In a few cases, native livestock breeds and plant species become necessary to maintain the overall balance of the local ecosystem. For instance, the grazing habit of domesticated animals like buffaloes and camels is found to be controlling the weed population in the surrounding eco-systems of Rajasthan. This, in turn, is helping the nesting habitat of bird colonies. However, crop husbandry in a broader context also contributes to the decline of biodiversity as a given piece of land where diverse native plant species were growing originally was converted into agriculture to grow a few 'domesticated' plant types. Similarly, domesticated livestock population, when crossed the threshold limits, (from the point of carrying capacity of ecosystem), became detrimental to forest diversity through over grazing or higher grazing intensity. An understanding of these intricacies is essential while assessing the links between domesticated and other forms of biodiversities.

2.2. Institutions, Indigenous Cultures and the Equity: Conservation and use of dom. bd. is closely associated with the religion, culture and lifestyles of indigenous and folk communities. For instance, it is a taboo among the pastoral communities to sell the female breeding stock. It is a custom even today to maintain the breeding bull as a 'temple bull' or as a community resource in Tamil Nadu, Rajasthan and many other parts of India. Similarly, traditional fishermen communities are following the custom of restraining in fishing during the period of fish brooding. The deep and sophisticated ecological knowledge of bio-diversity has given rise to cultural rules for conservation reflected in notions of sacredness, taboos and other forms of 'institutions'. Focusing on these 'institutions' prevents a mere mechanistic approach to the conservation of dom. bd. Above all, the conservation of dom. bd. addresses the livelihood security issues of the marginalized majority in the rural areas. This, obviously strengthens the equity dimension of conservation of biological diversity in India.

2.3 Dom. Bd. and the Informal Knowledge and Technology Systems: Conservation and use of dom. Bd. had been influenced historically, by two strains of informal knowledge and technology systems; ***Indigenous Agricultural Knowledge and Technologies (IAKTs) and Ethno Veterinary Medicines (EVMs)***. This is important to note that these informal knowledge and technology systems are used exclusively on dom. bd. and they, in turn, are depending heavily on the bio-diversity. For instance, the indigenous 'protection' measures are employed mostly on native crops and local breeds of animals. And, these protection measures are depending on the local plant diversities such as the herbs, shrubs and plants available in the locality. In this way, dom. bd

and bio-diversity are linked with each other which is strengthened further by IAKTs and EVMs. This interplay of informal knowledge and technology systems, dom. bd and bio-diversity has to be harnessed effectively to evolve eco-friendly, culturally compatible, low cost technologies for sustainable development

2. 4 Women, Dom. bd. and Food Security: Rural women have been playing historically a key role in the selection, conservation and management of domesticated biodiversity in India. Though their immediate objective is to meet household food and nutritional security, there are a variety of reasons why women have taken up this role. A study reveals that the homestead farms under women's custody consists on an average, 1500 plants belonging to 50 different species in Kerala. Rural women all over India are responsible for maintaining back yard poultry and preserving the local breeds therein. The Adivasi women in Andra Pradesh are known to rear the renowned ***Aseel*** poultry breed in their back yard. Women's ingenuity in this regard is not confined to kitchen garden or back yard animal husbandry but is also extended to dry land farming also. The farm women are found to be the custodians of unique local varieties of paddy, pulses, ragi and other millets in many villages in dry belt of South India. The significant initiative by the Scheduled Caste women of Andra Pradesh, amply proves that if access to land, technology and information is given, women can play a lead role not only in the conservation of bio-diversity but also evolve an alternative public distribution system based on it. This provides strong justification for a gender sensitive approach to food security through the conservation of dom.bd. in India.

2. 5. Valuation of Dom. Bd: The value of biological diversity is difficult to define and estimate, nevertheless, some discussion of the issues involved is very essential. Economists recognize two main types of value: *the use value* and *the nonuse value* associated with bio-diversity. Use value is attached to the *utilitarian benefits* which may accrue directly or indirectly or even in the future (called 'option' value) to the user. The direct use value of bio-diversity can be of consumptive, productive or non-consumptive in nature. A local variety of food crop provides several indirect use values such as taste, palatability, cooking quality, disease and drought resistance, supply of more fodder and so on. A study conducted by *Navadanya* indicates that dry land farmers growing paddy and ragi have more preference for the indirect 'non-market' benefits than for the grain yield in South India. Similarly, it was very well established that the breeding goal of pastoral nomads in livestock is not primarily to increase the meat and milk yield. They also consider local requirements such as survival under high environmental risks, draftability, good mothering instincts, herd ability, ability to walk long distances or climb steep slopes, aesthetic preferences and even loyalty to the owner!

The nonuse value is the 'intrinsic' value independent of its use; direct or indirect, present or future, attached by individuals for its continued existence. The cultural or religious values of biological diversity is a form of nonuse value. Besides, the biological diversity provides two categories services; information and insurance which are fundamental to the very progress of human society.

2. 5. Valuation of Dom. Bd: **If all these 'real' benefits of dom. bd. are properly assessed, acknowledged, valued and made to reflect in the market transactions, its value may increase much higher, even higher than that of the modern high yielding crop variety or livestock breed. But, the present markets, institutions, political setup and the value system fail to capture and reward these benefits fully. These failures result in the systematic under valuation, leading to sub optima; less than the socially desired level of conservation of dom. bd., the issue is focused mainly in the report.**

2.6 Spatial Distribution of Dom. bd., and Their Vulnerability: For the purpose of exploration and collection of agi. diversity, the National Buaro of Plant Genetic Resources (NBPGR) has delineated the country into 10 diverse phyto-geographical agro ecological zones and 39 sub zones. Among these, the Western *ghats* and the North-Eastern Himalayas are the two 'hot spots' of biological diversity in the world. Within these are several specific regions which merit special attention for the purpose of conservation of *agro biodiversity*. A few such regions are: (a) River beds of Eastern Uttar Pradesh for conservation of cucurbits vegetables.(b) Nangangudu taluk in Mysore district of Karnataka for an unique variety of banana called "Rasabale" (c) Garwal and Kumaon hill regions of Uttaranchal for uridbean and minor fruits; both tropical and temperate

species. (d) Homestead forms of Western Ghats regions of Karnataka and Kerala for fruits such jackfruits and unique varieties of vegetables, flowers and medicinal plants. (e) Salt and heat affected regions of Gujarat and Rajasthan for salt and drought tolerant species of Triticum species (f) Adilabad district of Andhra Pradesh for landraces in rice which are tolerant to abiotic stresses with superior kernel quality. (g) For nondomesticated wild and under utilized crops -North Kanra district in Karnataka, Aravalli hills, Rajasthan and the Western Himalayas region.

In the case of livestock breed, there is a 'critical' stage/number, below which if population falls, the restoration is impossible. Species wise, the list of breeds deserving attention for conservation initiative in this respect are *Ponganur, Rathi, Sahiwal, Krishna Valley, Vechur, Malnad Gidda, Amrithmahal, Umbalacherry, Kangeyam, Nar, Sahiwal* (**cattle breeds**) *Jaffarabadi, Bhadawari, Nili-Ravi, Pandharpuri, Toda,* **(buffalo breeds),** *Kheri, Bonpalo, Nilgiri, Hassan, Bannur (Mandya), Changthangi, Vembur,Kachakatty black* **(sheep breed),** and *Jamnapari, Sangamneri, Tellicheri (Malabari), Surthi, Beetal, Chegu, Jakhrana, Gohelwadi,* **(goat breeds).** There are still several uncharacterized breeds such as *Kanchu Mekha* a dwarf goat variety, extensively found in the Eastern Ghats region of Andhra Pradesh, which is yet be acknowledged as distinct breed. The spatial distribution of these unique plant varieties and livestock breeds and their vulnerability to extinction and survival must draw a special attention while envisaging policies and programs to conserve them.

2.7. Forms Conservation: The Dom. Bd. has two distinct options; *in situ* (on farm) and *ex Situ* (in gene bank) for conservation. Both these methods of conservation; *in situ* and *ex Situ,* have their own merits and demerits which are worth evaluating before embarking a particular form or a combination of these two forms for conservation.

III. CAUSES FOR THE LOSS OF DOMESTICATED BIO-DIVERSITY: Introduction of Hybrids/HYVs in agriculture and cross breeds in livestock is the most fundamental cause for the loss of dom. bd. There are several factors which 'aid' to this process of loss of dom. bd. in a country like India. These include; (a) **overriding market considerations** leading to commercialization and farm mechanization; (b) **over emphasis on consumptive criteria** like preferring more 'quantity'-grain yield neglecting the 'quality' parameters like nutrition, health, taste, palatability as well as fodder requirements; (c) **focusing more on the irrigated farming system** while planning the agricultural development instead of higher agro-eco systems like watershed; and (d) **a high time preference for money** (i.e. high discount rate) wherein immediate direct, private benefits are preferred more than the benefits in the distinct future. In addition, Govt. policies such as **input subsidy and price policy** which support only HYVs and the **international treaties** such as the GATT agreement which push through rigorously high tech corporate agriculture have all acted as the root cause for the loss of dom. bd. in India. Commercial application of agri biotechnology, in this background, can 'potentially' pose a major threat to the very survival of bio-diversity. Present formal education system which is unable to create curiosity and respect for traditional wisdom, grass root creativity, indigenous knowledge and technologies also contributes to the loss of domesticated biodiversity. Encroachment and consequent privatization of common pool resources such as *"gomala"* land is the most serious cause for the loss of dom. bd; especially the livestock diversity in India.

IV. STAKE HOLDERS, MAJOR INITIATIVES AND THE GAPS: Farmers, including tribals, and women within them, individual livestock owners, communities of livestock herders, fishermen and others who depend directly or indirectly for their livelihood on dom. bd. are the **primary stakeholders**. Scientists, Government. research and development (R&D) bodies, farm organizations and NGOs who work for the conservation of dom. bd. or speak on behalf of the primary stake holders are the **secondary stake holders**. Industry and corporate sectors who commercialize the R & D efforts, international agencies and the donors who help the conservation of dom. bd are the **tertiary stake holders**. The 'stakes' of secondary and tertiary stake holders needs to be clearly defined. Any stakes claimed by them while commercializing the dom. bd. or the related knowledge and technologies through IPR system needs to be viewed seriously so that the interests of primary stake holders and their sovereign right is not compromised.

Self motivated ecological farmers, women and the indigenous communities are the natural

repository of information and the associated knowledge and technologies surrounding the dom. bd.. They are mainly responsible for *in situ* – both on-farm and in-house (ex. seed) conservation of dom, bd. *ex situ*, especially the in vitro conservation of dom. bd. is carried out by the Government R & D institutes like NBPGR, which is used mostly for further R & D purposes. The initiatives by ***Honeybee network*** and Community Biodiversity Registry are instrumental in the documentation and exchange of information related to dom. bd. **The main gaps perceived in this respect are**: (1) Inadequate institutional support for small and subsistence farmers in the dry regions who are using the *agro biodiversity*. (2) No incentive or compulsions for large and commercial farmers to conserve and use *agro biodiversity* especially under assured irrigation.(3) Isolated and sporadic nature of ecological farming experiment confined to a few cases. (4) Inadequate agrarian reforms in assigning property rights over land and other natural resources to women, marginal and indigenous landless communities. (5) Inadequate emphasis, under government R & D setup, a mechanism to involve the primary stakeholders for a participatory and decentralized *in situ* conservation. (6) Inadequate co-ordination and coalition among the NGOs, grassroots organizations and others to influence the policy making process effectively.

V. PROPOSED STRATEGY AND ACTION PLAN:

Based on the various issues addressed, threats falling on dom. bd., major initiatives by the stake holders and the gaps noticed in this regard, the following **STRATEGIES AND ACTION PLANS (SAPs)** are identified to conserve and use Dom. Bd. in an equitable and sustainable way in India. In addition, key recommendations emerged in various workshops and seminars such as NAAS – NBPGR workshop (1997), International Conference on ***Ethno-veterinary Medicine Alternative for Livestock Development*** held in Pune (1997) and other occasions are also considered.

STRATEGY 1: COLLECTIVE EFFORTS TO ENHANCE THE ACCESS OF PRIMARY STAKE HOLDERS, ESPECIALLY OF WOMEN, TO LIVELIHOOD SOURCE: *The primary stakeholders, due to their low socio-economic status are individually weak in 'bargaining'. Hence, collective actions are very crucial to enhance the capability of the primary stakeholders to conserve and derive full benefits of the conservation to achieve food and livelihood security objectives in a sustainable way.* ***(A1)*** **Strengthen and Extend Ongoing Initiatives** such as ***Community Grain and Gene Fund*** program of Deccan Development Society, Hyderabad, ***Seed Sangha*** of GREEN Foundation Bangalore and *Beej Bahao Andolan*, Garhwal. **(*A2)* Encourage Women's Co-Operatives** to conserve and exchange dom. bd **(*A3)* Extension Through Women Workers, (*A4)* Plant Multi Purpose Tree Species** that serve the purposes of fuel wood, fodder, food. in the avenue sides and other common places and **Give Usufruct (*Patta*) Rights to Poor.**

STRATEGY 2: INSITU CONSERVATION, IMPROVEMENT AND EXCHANGE: *An elaborate arrangement to in situ conservation along with participatory crop improvement for direct exchange of plant genetic materials among farmers/communities themselves is required. The in situ conservation is very consistent with equity, security and cultural values associated with Dom. Bd. Further improvement and exchange of the genetic resources need to be undertaken with active involvement of the primary stakeholders who conserve them. (A1)* **National Action Plan** for Participatory *in situ* Conservation and Development, **(*A2)* A 'Controlled' *In situ* Conservation System** for the varieties threatened for extinction ***(A3)* Develop Agri. Diversity Catalogs, (*A4)* Create Agri Diversity Exchange System** encouraging ***Seed Fairs / Melas*** and empower the communities to exercise control over exchange and use.

STRATEGY 3: INTEGRATING DOM. BDCONCERNS INTO FOREST AND ENVIRONMENTAL POLICIES: *Policies and programs related to forestry and environment have not given adequate emphasis on Dom. Bd There are several mutually supportive linkages, as discussed in the section 2.2.1, among forestry, environment and Dom. Bd In order to strengthen these linkages, it is necessary to integrate Dom. Bd. concerns in to forest and environmental policies and programs***(A1) A National Action Plan on Underutilized/Wild Food Crops,** to undertake documentation, conservation, use and exchange by giving priority to specific

locations like Himalayas and Western Ghats, regions. **(A2) Promoting the Cultivation of Wild Relatives** -wild foods, vegetable, fruits, medicinal plants, ornamental plants like orchids initially in the surrounding kitchen garden / homestead farms. **(A3) A National Action Plan for Tribal/forest dwellers' Agriculture** -equal focus on ***jhum*** or shifting agriculture so as to retain its positive aspects for agro biodiversity and cultural sensitivity, while tackling the negative side. **(A4) Include Time Tested Herbal Healing Practices in our Primary health Care Delivery** both for human and animals- training and orientation of govt. health staff /community health workers in utilization of medicinal plants.

STRATEGY 4: PROTECTION AND PROMOTION OF NATIVE APICULTURE: *Native honey bees symbolize a perfect interface among agro biodiversity, forestry and ecosystem diversity. In spite, the native apiculture did not find a place it deserves in the polices and programs aimed at the development of the sectors mentioned above. Hence a separate strategy to protect and promote the native apiculture is required.* **(A1) To Maintain the Native Strains in Pure Form: -**like ***Apis cerana***, without any contaminations and strict control against the introduced exotic species such as ***Apis mellifera*** which are suspected to cause diseases such as Thisac brood on our native strains. (**A 2) Large Scale Promotion of Apiculture** in both rural as well as urban areas**. (A3) Training youths from tribal and forest dwelling communities** to promote apiculture. **(A4) Large Scale Planting 'bee trees'** while taking up forestation program both in rural as well as urban areas.

STRATEGY 5: AGRO ECOSYSTEM BASED PLANNING AND DEVELOPMENT: *Agro ecosystem based planning helps to harmonies conservation values with that economic issues that may arise while conserving and using of dom. bd.* **(A1) Agro Ecosystem Based Crop and Livestock Planning -** keeping in mind the assigning the responsibility of planning on natural resources to the *Gram Sabha* and the customary rights of indigenous communities such as *adivasi***,** the watershed can be taken as an ideal unit for planning and development. Local varieties and breeds need to be incorporated in to farming systems under watershed development. **(A2) Assign Top Priority to Land Care and Management Systems** -conserve prime farmland from conversion to non-agricultural uses, preserve the loss of the biological potential of the soil, check different kinds of soil erosion, restore the soil fertility through agro forestry and other arable practices. **(A3) Treat Water As a Social / Public Resource** - a strong public policy for regulation of water use; especially surface and ground water, improve traditional rainwater harvest and underground storage methods, recycle rainwater and home-used (waste) waters.**, (A4) Strengthen Conservation of Living Aquatic Resources** –restoration of tanks for multiple uses in South India, regulate the land use in coastal areas., **(A5) Research to Anticipate the Likely Consequences of Climate Change on Agriculture** - explore the funding source to undertake systematic research to evolve mechanism for coping with them.

STRATEGY 6: CONSERVATION OF ANIMAL GENETIC RESOURCES: *As mentioned in the section 2.2.3, the indigenous livestock breeds are more vulnerable to reach the 'critical' stage/number below which if population falls, the restoration is impossible. Keeping this in view, the following general actions are suggested to conserve animal genetic resources in India.* ***(A1)*** **Systematic Survey and Assessment of the Indigenous Livestock Breeds,** ***(A2)*** **Ensuring of Pure Lines and Conservation, (*A3)* Periodic Monitoring of Threatened Breeds** like *Ponganur, Vechur, Ongole , Amrithmahal and Krishna valley* (***A4)*** **Increased Role for Developmental Agencies like NABARD.**

STRATEGY 7: SPECIFIC LIVESTOCK BREEDING PRPGRAMS:*A livestock breed improvement program must help to conserve and make the breed fit well to the local climate, cultural and economic conditions. Multi-purpose breeding rather than a specialized single purpose breeding (as practiced in the developed countries) should be followed in our country. The breeding*

strategy must complement the multipurpose farming systems, in which livestock, crop and tree production are integrated to produce food, fiber, energy, fuel and wood while maintaining the soil fertility and overall sustainability of the system ***(A1)*** **Promote Herd Societies,** ***(A2)*** **Selective Breeding to Meet the Desired Goals of Farmers and Communities, A3) For Small Ruminants** applications of "Open Nucleus Group Breeding" involving the local community. **(A4) For Poultry** – Improved village-level disease management strategies and location specific programmes to conserve and popularise the indigenous breeds like ***Aseel, Kadakanth, Chittagang, Maly*** and other breeds in different parts of India. **(A5) For Canine –** conserve indigenous dog breeds such as ***Rampur, Mudhol*** and Himalayan breed. **(A6) For Other Animals** - there is an urgent need to study and document the status of indigenous breeds of horse, camel, pig, donkey, yak , mithun and ducks and prepare **A National Action Plan** to take up remedial measures so as to arrest their degeneration..

STRATEGY 8: GRAZING AND FODDER DEVELOPMENT: *Adequate opportunities for grazing and supply of fodder are the essential pre requisite to conserve indigenous livestock population. Increasing the supply of fodder from agriculture, non agriculture as well as the wild sources, restoring the traditional CPR institutions such as the Gomala (grazing) lands are the two essentially required action plans in this respect* ***(A1)*** **Increased Supply of Fodder and Feed for Livestock, (*A2)* Strengthen Village Grazing lands "*Gomala"* as CPR Institution Strict Legal Action Against The Encroachment Of The CPR Land,** institutionalization of indigenous management knowledge governing the CPR and empowering fully the ***Panchaythi Raj*** institution to take control over the CPRs in India.

STRATEGY 9: CONSERVATION OF CULTURED FISH DIVERSITY: *Fresh water bodies like rivers, ponds and tanks are the main sources of indigenous cultured fish species in India. Several government departments are managing these water bodies which have poor coordination and give rare attention for conservation of cultured fish species. Hence, cultured fish species are the neglected item under fish fauna.* ***(A1)*** **Enhance the Availability of Seeds, (*A2)* Research Studies,** to assess the status of indigenous fishes, their composition and breeding behavior **(*A3)* *In situ* propagation of desired *ichthyo,* *(A4)* Strengthening the Community Based Management** through training, credit, marketing and technical assistance to fisher folk.
(*A5)* Include Endangered species Under Wild Life Protection Act.

STRATEGY 10: Development of SUPPORTIVE TECHNOLOGIES FOR DOM. BD: *Blending various technology systems is required to conserve and promote the use of dom .bd. in equitable and sustainable ways. The actions required in this respect are:* ***(A1)*** **Liberal Promotion of Time Tested and Compatible Technologies** like IAKTs **(**Indigenous Agriculture Knowledge and Technologies), EVMs (Ethno Veterinary medicines) , watershed development, dry farming technologies and organic farming technologies **(*A2)* Selective Use of Conventional Breeding and Vegetative Propagation,** so that varieties /breeds evolved will relay more on internal resources, IAKTs/EVMs and remain under the control of farmers, women and the community. Encourage participatory plant/livestock improvement methods. **(*A3)* Very Careful and Restrictive Application of Bio-technology mostly for conservation** purposes when the species/variety/breeds are at the verge of extinction., **to control** pests and disease where all other measures have failed, **for eradication** of deadly weeds causing harms to ecosystem. ***Enforcement of rigorous bio-safety measures preceded by a transparent and systematic Environmental Impact Assessment are must in all these cases.***

A broader consensus thorough public debate and discussion, involving farmers, environmentalists, scientists, NGOs and other stakeholders on commercial application of bio-technology in agriculture and ways and means to ensure a "social control" over it are very essential.

STRATEGY 11: INFORMAL KNOWLEDGE AND TECHNOLOGY SYSTEMS: Conservation and use of Dom. Bdhad been influenced historically, by two strains of informal knowledge and technology systems; Indigenous Agricultural Knowledge and Technologies (IAKTs) and Ethno Veterinary Medicines (EVMs). There is a mutually supportive roles and interplay as discussed in the section 2.2.2 among informal knowledge and technology systems , dom. bd and bio-diversity. These mutually supportive roles have to be harnessed effectively to evolve eco-friendly, culturally compatible, low cost technologies for sustainable development. ***(A1)*** **Systematic Documentation and dissemination,** of IAKTs and EVM of both individuals as well as communities in local vernacular ***A2)*** **Systematization and Scaling up** whenever required for larger application. Ensure that they remain under community control ***(A3)*** **Promotion of Healers' Associations and Networks,** ***(A4)*** **Debate and Legislation on IPR related to IATKs and EVM** to understand the intricacies in the context of WTO and arrive at a consensus.

STRATEGY 12: MARKET AND POLICY REFORMS: *These reforms are required to correct various forms of 'failures' in the policy and market arenas which come in the way of appreciation and proper valuation of various 'forms' benefits and services provided by Dom. Bd.discussed in the section 3.2.4. These must result in the higher values for Dom. Bd. and ultimately higher benefit to those conserve them leading to optimum production and supply of the products and services of Dom. Bd.in India.* ***(A1)*** **Subsidy and Price Support for the Products of Dom. Bd,** to begin with consider the crops such as Ragi, Jower and other minor millets and link it up with the present *Public Distribution System* (PDS). **(*A2)*** **Incentives for Conserving of Dom. Bd. a**wards, rewards material as well as non material forms at individual as well as the collective level can be envisaged. The initiatives of National Innovation Foundation of India can be further strengthened in this respect. **(*A3)*** **Declare 'Ecological Farms' as Biodiversity Heritage Spots**, (***A4)*** **Institutional Credit and Insurance, (*A5)*** **Publicity and Propaganda** by making use of govt. owned mass media; TV and radio **(*A6)*** **Cooperative Marketing and Traditional Food Resorts, (*A7)* Avoid Concentration in Seed Market** in the hands of a few firms/MNCs

STRATEGY 13: EDUCATIONAL REFORMS TO INCLUDE DOM. BDCONCERNS: *Education curriculum on biological and agricultural sciences for the students at schools and college levels needs to be modified and reoriented so as to include various values and benefits along with the equity, cultural and ethical dimensions of Dom. Bd To create interest and respect on diversity in young minds, innovative methods are called for.* ***(A1)*** **Create Curiosity in Students' Mind** Innovative methods like ***Biodiversity Contests*** by creating a *"**bio-diversity contests fund**"* in each state to conduct contests, quizzes, essay writing and other such competitions for school and college students, **(*A2)*** **Syllabus Modification** include IAKTs/EVM into agricultural/veterinary curricula **(*A3)*** **Maintain Niche Diversity Center in Schools and Colleges, (*A4)*** **Training and Reorientation for Scientific Community** on the issues on equity, gender, food security, ethics, sustainability, culture and informal knowledge and technologies related to dom. bd **(*A5)* Alternative Methodology to Value the 'Total Benefits' of Dom. Bd.:**

V. PRIORITIZATION AND FOLLOW UP:

Prioritization: The TWG has formulated 57 Action Plans to achieve 13 broader Strategies, in order to conserve and use Dom. Bd in an equitable and sustainable way in India. Nearly 65 percent of these actions are classified as 'Medium Term' as they require a duration up to 5 years for implementation. Similarly, next 30 percent action plans require 'immediate to short term', (up to two years duration) and the last five percent are long duration actions. To implement these actions, in nearly 58 percent cases, clear programs mostly by the state and central governments are required. In 22 percent cases, policy reforms are required. To implement 15 action plans R & D initiatives and in 4 cases building of 'institutions are called for.

As the time and resources available to implement these action plans are limited they have to be pursued in a prioritized way. Though prioritization is a subjective exercise, by looking into specific socio-economic context of a country like India, livelihood security of the people and the ecological security issues associated with Dom. Bd can be taken as two bottom lines in this respect. In addition, other criteria such the time period (which needs be implanted immediately) and cost effectiveness (which requires relative smaller resources such as 'the development of national action plans, conduction workshops) have to be considered while prioritizing the actions related to the above mentioned two sub themes. There are a few actions which are addressing the possible negative implications of items such as biotechnology and IPRs, on Dom. Bd and consequently on the above mentioned two priority objectives. And finally, actions on policy reforms and building of institutions will have long term implications on the conservation and use of Dom. Bd. All these criteria are taken into account while prioritizing the actions which address the above mentioned two top priority objectives. As these two objectives are closely interlinked, many actions prioritized overlap with each other. The table below gives such prioritized actions along with the possible agencies to implement the same.

Table;

Prioritized Action Plans along with the Proposed Implementing Agencies:

A) ON LIVELIHOOD SECURITY OBJECTIVE		
Sl No	***Action Plan***	***Implementing Agency***
1	**Strengthen and Extend Ongoing Initiatives**	Central Ministry of agriculture with the support of the NGOs like DDS and GREEN Foundation
2	**Encourage Women's Co-Operatives**	Min. of Agriculture With key NGOs
3	**Plant Multi Purpose Tree Species:**	Government (State) – Departments of Forestry and Revenue jointly
4	**Create Agri Diversity Exchange System**	NGOs with State Govt. Department of Agriculture/Horticulture
5	**ı Plan on Underutilized/Wild Food Crops**	NGOs with Ministry of Forest & Environment, ICAR
6	**A National Action Plan for Tribal/ Forest dwellers' Agriculture**	NGOs with Ministry of Forest & Environment, ICAR and SAUs
7	**Periodic Monitoring of Threatened Livestock Breeds**	State Veterinary Colleges/Department and NGOs
8	**Promote Herd Societies:**	IVRI, NDRI, State Govts. Veterinary Colleges and NGOs
9	**Increased Supply of Fodder and Feed for Livestock**	IVRI and NDRI along with State Departments of Agriculture and Livestock
10	**Strengthen the Village Grazing lands "*Gomala"* as CPR Institution**	Central Govt. with State Government – State Revenue Department
11	**Strengthening the Community Based Management for Cultured Fish**	State Fishery Department along with Fishery Colleges or R & D centers, active involvement of NGOs
12	**Systematization and Scaling up of IAKTs and EVMs**	Key NGOs like SRISTI /DDS / GREEN Foundation/ANTHARA/SEVA with the support of NIF and Min. of agriculture ICAR/IVRI/SAUs
13	**Promotion of Healers' Associations and Networks**	Key NGOs like ANTHARA/SEVA with the support of Min. of Agriculture /ICAR/IVRI/ SAUs
14	**Debate and Legislation on IPR, related to IATKs and EVM including the application of agri. bio-technology**	Key NGOs like Honey Bee Network, Research Foundation, Gene Campaign, Forum for Biotechnology and Food Security with support of Min. of Agriculture and other Depts.
15	**Subsidy and Price Support for the Products of Dom. Bd**	Min. of Agriculture Govt. of India
16	**Institutional Credit and Insurance**	The NABARD along with Min. of Agriculture Government of India

(B) ECOLOGICAL STABILITY OBJECTIVE

17	**Maintain the Native Strains in the Pure Form**	Ministry of Forestry and Environment (Central) along with State Govts. and SAUs
18	**Large Scale Planting of 'bee trees'**	Ministry of Forestry and Environment (Central) along with State Forest Deportments
19	**Agro Ecosystem Based Crop and Livestock Planning**	State Department of Agriculture and Forestry
20	**Assign Top Priority to Land Care and Management Systems**	State Department of Agriculture and Revenue Department to prevent conversion
21	**Treat Water as a Social Resource**	Ministry of Forestry and Environment , Water Resources (Central) along with State Govt.
22	**Conserve Living Aquatic Resources**	Ministry of Forestry and Environment (Central) along with State Govts.
23	**Research to Anticipate the Likely Consequences of Climate Change**	ICAR and other R & D institutions With SAUs

Implementation and Follow Up: Various central Ministries, R & D initiations, NGOs, State Developmental Departments, SAUs and others are considered as the possible agents to implement prioritized and other action plans mentioned above. The Central Ministry of Agriculture, along with its R & D institutions such as NBPGR and SAUs together assigned the responsibility of implementing 25 or 30 percent of the action plans. Other Central Ministries such as Environment & Forestry, Rural Development, Health together assigned the responsibility to implement nearly 20 percent of the action plans. The key NGOs are also assigned the responsibility of implementing nearly 17 percent of the action plans and almost 30 percent for various state development departs such as agriculture, horticulture and others. As the Central Ministry of Agriculture, Govt. of India and its R & D institutions such as ICAR as well as SAUs have to play key role, a committee under the Ministry of Agriculture can be set up to co-ordinate and oversee the implementation of various SAPs. In addition to the scientists from the concerned R & D institutions, adequate representations should be given to the NGOs, farmers and communities associated with the conservation and use of Dom. Bd. The TWG on Dom. Bd. may be assigned the role of advocacy, guidance and evaluation of the progress in the implementation of various SAPs periodically.

I. INTRODUCTION

The diversity of crops, livestock (including poultry), domestic pets, cultured fishes and bees is most often overlooked when biodiversity is being addressed. Domesticated plants and animals not only formed a critical part of human civilization and cultures but also evolved with constant interaction with them. The origin of genetic diversity in crops and livestock is linked with the development of human influenced ecosystems. Since the dawn of pastoralism and agriculture, people around the world over promoted the conservation, development and the use of plant and animal varieties to meet ecological, economical, and cultural needs as well as conditions. These included household food security, higher productivity, better taste, resistance to pests and diseases, ability to withstand adverse conditions like floods, drought or frost, cultural and ritual uses, and so on. Due to the gender division of roles and responsibilities, and women's primary responsibility for household sustenance, women have traditionally played a key role in selection (especially the seeds), storage and managing domesticated biodiversity, including livestock, for maximizing household food security. By virtue of this role, women in most cultures have been the repositories of unique knowledge on domesticated biodiversity.

India has been one of the global centers of domesticated biodiversity. Its farmers have developed an astonishing variety of crops, livestock, and pets, a diversity that has stood them in good stead through difficult times and helped them to meet diverse human needs. However, the last 3 or 4 decades have witnessed a shift away from biologically diverse agriculture, to more homogenous farming and pastoral practices which have often included a shift in decision making, related to such matters from women to men, and from farmers to formal sector agricultural scientists and bureaucrats. This shift has been a result of policies and programs oriented towards increasing the commercial productivity of farming systems, using a rather narrow definition of productivity, in terms of quantities of grains, milk, or wool alone, ignoring issues of household food security, requirements of livestock and cultural needs. Such policies and programs have ignored the importance of diversity in the lives and livelihoods of women and men farmers, in providing a more stable and creative genetic base for agriculture, and as the bases for a holistic concept of productivity which integrates the biomass, food security and the cultural needs of a community. As a result, we are fast losing domesticated biodiversity and along with this, our traditional knowledge is also losing its significance. With this as the background, the Thematic Working Group (TWG) made an attempt to come up with a set of Strategies and Action Plans (SAPs) to conserve and use of domesticated bio-diversity in an equitable and sustainable way in India.

1.1. Scope of the TWG:

The components covered under domesticated biodiversity (Dom. Bd) are**:**

(a) ***Agro biodiversity*** with special focus on dry land field crops, homestead farm diversity and diversity in tribal agricultural system, along with the agro-ecosystem diversity;

(b) ***Livestock diversity,*** which includes milch & draught animals, small ruminants, and poultry; and
(c) ***Other forms of Dom. Bd.*** which include cultured fish species , honey bees, camel and pet dogs. Other domesticated animals like donkeys and horses, though important, could not be included due to non-availability of the information.

In addition, focus was given to the Informal Knowledge and Technology System which includes ***Indigenous Agricultural Knowledge and Technologies (IAKTs), Ethno Veterinary Medicines (EVMs)*** and ***local/traditional/indigenous institutions*** associated with of Dom. Bd,.

1.2. Objectives:

With this as the background, the Thematic Working Group, undertook the following:

1. **Review of literature to assess the current knowledge on domesticated bio diversity, along with the associated informal knowledge and technology system and identification of major issues to be addressed while evolving SAPs.**
2. **Distinguishing the various values of Dom. Bd and assessing the majors threats as well as consequences of the loss of Dom. Bd.**
3. **Analysis of existing measures (individuals, communities, NGOs and GOs) for conservation, both *in situ* as well as ex situ and the 'gaps' in these measures.**
4. **Identifying appropriate Strategies and Action Plans to conserve and use domesticated bio-diversity in an equitable and sustainable way by recognizing ;**

    - ***the measures (short and long-term) needed to plug the gaps, including the policy, program, institutional, R&D and other actions at local, national, sub national, corporate and international levels.***

    - ***the measures to integrate domesticated biodiversity with agricultural productivity, household security and the livelihoods of farmers/pastorlists and other grass root communities, depending on Dom. BD.***

1.3. Contents of the TWG:

In addition to the **Introduction Chapter,** this report contains four more chapters. **Chapter II** deals with the current knowledge of the three main categories of domesticated bio-diversity and key issues emerged in the assessment of the same in India. **Chapter III** highlights the various values associated with the dom. bd., major threats causing its losses and the consequences of the loss of dom, bd. **Chapter IV** enlists the main stakeholders of dom. bd., major initiatives undertaken by various categories within them and the major 'gaps' identified in their initiatives. Based on the various issues addressed, threats falling on dom. bd., major initiatives by the stake holders and the gaps noticed in this regard, **13 broader STRATEGIES** and **57 specific ACTION PLANS** are identified to conserve and use Dom.

Bd. in an equitable and sustainable way in India. The **Chapter V** deals with them in details. Final section gives a list of prioritized action plans along with the suggested method to co-ordinate and follow up the implement of various SAPs.

1.4. Methodology followed:

Methodology followed to address the set objectives of the study is described below:

1. It was decided to adhere in principle, to the ***Guidelines and Concept paper*** on Domesticated Biodiversity prepared by NBSAP to pursue the set objectives of the TWG. The direction and broader framework for the study were drawn from the two TWG meetings held on September 29, 2000 at the Development Research Communication Center, Calcutta and August 11, 2001 at University of Agricultural Sciences, Bangalore.

2. Due to the constraints of resources and time, it was decided to make use of the available information based on the ongoing or past works by resources persons in the concerned subject mater areas. Accordingly a list of resource persons was identified at the August 2001 meeting to provide relevant information and key inputs. The list of such resource persons involved is given in the *Appendix I.*

3. In the meantime, state nodal agencies and other NBSAP partners were approached to get additional information and inputs from different parts of India.

4. Extensive review of research reports and publication of the National Bureau of Plant Genetic Resources, New Delhi, other ICAR institutions, state agricultural universities and other GOs and NGOs related to Dom. Bd. was undertaken .

5. The items not covered were addressed through visits, discussions and interactions in the seminars, workshops and other occasions both within and outside the country which were attended by the coordinator. The details of such important visits/interactions by the coordinator are furnished in the *Appendix I.*

6. The salient findings of the TWG was presented in the Midterm National Workshop of NBSAP held at Pasthapur, AP from 13-15, June 2001.

A draft copy of the Executive Summary (ES) along with the complete set of Strategies and Action Plans was circulated among the members and others who provided the inputs. The ES was presented at the Final National Workshop of NBSAP held on 11-14, November 2002 at New Delhi. The final report was prepared by considering the comments and suggestions of the members and other resource persons.

II. CURRENT KNOWLEDGE AND THE KEY ISSUES:

This section deals with the current knowledge of three categories of domesticated bio-diversity and the key issues emerged in the assessment of Dom. Bd. in India.

2.1 Current Knowledge of Dom. Bd.

Current knowledge of the three components of dom. bd.; viz. agro biodiversity, livestock and other forms of Dom. Bd. is assessed in terms of (a) a brief history (b) geographical delineation and special distribution; (c) relationship with other forms of bio diversity; (d) informal knowledge, technology and institution system associated with dom. bd.. The analysis of current knowledge of Dom. Bd has helped to identify key issues which were focused while developing the SAP on dom. bd.

2.1.1. Brief History:

India is the site for the first domestication of several crops and livestock species. This is clearly demonstrated through both the antiquity and historical facts. Reference to agro biodiversity in the Vedic tradition is depicted through the concepts of ***Navadhanya*** (nine grains) related to ***Navagraha*** (nine planets). The nine planets correspond to nine grains which include two cereals, pulses and an oil seed. It is to be noted that these nine grains not only contain several essential nutrients but their cultivation also forms a sustainable mixed farming, which enhance the fertility of the soil also.

2.1.1.1 Agro biodiversity: Though agro biodiversity, is a small fraction of the total biological diversity, it has been playing an important role in sustaining the food and nutritional security of mankind. Out of over 2,50,000 species discovered so far, only around 3000 are domesticated. In fact, only 30 plant species; notably rice, wheat, maize and potato, account for food and calorie requirements of human beings. (NBPGR 1999).

Available records which throw light on the history of agricultural crops date back to the Neolithic (4500-4000 B.P.) and Harappan (4600-3750 B.P.) cultures, both characterized by the incipient farming. Neolithic culture sites have been located in the north, east and south of India, while the Harappan sites are all located in the western region of the subcontinent, including Pakistan. The important food/fodder crops identified during this period include wild forage plants, rice, wheat, barley, peas, lentils, ragi and wild beans. Melons and the fruit of an unidentified legume were also found at Harappan sites.. The occurrence of highly advanced cultivars are believed to have been due to contacts with advanced contemporary cultures.

Box: 1.

History and Antiquities of Grain Amaranthus and Rice:

Grain amaranths has at least twenty vernacular names across different regions of India indicating its great antiquity, ancient association and popularity especially among the tribal communities in India. Amaranths grow vigorously, resist drought, heat and pests and have a high reproduction rate (one plant produces more than 50,000 to 1,00,00 seeds) and adapts readily to new environment. During the sixth century A.D. when Arabs started invading India via Kashmir and Gujarat state, the simple, religious and peace loving people from Gujarat, Maharashtra and Madhya Pradesh started migrating to the safer and isolated places like the Himalayas. When the situation turned calm, the people returned to their native places ,and brought with them the seeds of several useful land races of the Himalayas such a grain amaranth, which eventually got established in the rest of India. In Mehsana area of Gujarat state, it is cultivated and grown extensively as one of the staple food crops. In the 9th century, with the establishment of a holy shrine in Northwest Himalayas by Adi Shankaracharya, pilgrimage to these remote areas increased. A large number of devotees visiting holy places from different parts of India needed food. They not only consumed the seeds of amaranths, but also carried while returning. In this way amaranths became the only permitted food for those who observe fasts during religious occasions. Through the pilgrims, the spread of crop, and in turn variability in the crop also increased..

The rice appears to have been the most popular cereal in the Chalcolithic (4000-2800 B.P.) period. While it appears to have been used exclusively in eastern India, it was eaten in conjunction with other cereals in northwest and central India. In the first part of the last millenium (the Early Historic Period, about 1600-1700 B.C.), rice was found in the eastern and central Indian sites such as Sonepur, Rajgir and Pataliputra in Bihar, Rajghat and Hastinapur in Uttar Pradesh, Nagda, Ujjain and Garkhalia in Madhya Pradesh, and Kunnatur in Madras. Scholars all over the world believe that NE India is the most important 'single area' of the origin of domesticated rice. The great ancient Indian surgeon Sushruta who compiled his monumental book "Sushrut Samhit" about 2600 BC described a group of rice varieties (Shali Varga) having medicinal properties. Here he furnishes the details of autumn ripening rice known as "Shali" and says that shali rice is sweet in taste, easy to digest, tonic, alleviating pitta, slightly aggravating vata and kapha, oily and results in reduced fecal matter. The main varieties described by him under this (shali rice) category are: lalshali, kalam, ardkam, panduck, sugandhak (vasumati), shakunahrit, puspandak, pundrek, mahashali, sheet bheeruk, radhrapuspak, deerghshook, kanchnak, mahish, mahashook, haynok, dushak, mahadushak, etc. He further describes that Lalshali (Red rice) is the best among all in medicinal properties. It has good effect on eyes, skin, body strength, bouls and "tridoshas" (vata, pitta, kapha); removes all poisonous substances from the body, and provides relief from fever (Sharma 1998)

A Russian scientist N.I. Vavilov (1951) classified the world's crop-producing

regions into eight centers of plant origin. Of these areas of crop genetic diversity, India was central to what he called the Hindustan Centre of Origin of Crops and Plant Diversity. Vavilov's terminology for India was well justified, for this region has produced a significant share of the major crops used all over the world over. At least 356 species of domesticated crop species of economic importance and 326 species of their wild relatives are believed to have originated here (NBPGR, 1999). These spread across the entire range of crops known to humans: cereals, millets, legumes, vegetables, fruits, oilseeds, forages, fibers, sugar yielding plants, condiments, spices, medicinal and aromatic plants, and others. *Appendix II* gives list of the major agricultural crops with rich diversity prevailing in India. Plants with their primary and secondary centers of Evolution in India are; rice (*Oryza sativa*), pigeon pea (*Cajanus cajan),* turmeric (*Curcuma longa),* ginger *(Zingiber officinale),* black pepper (*Piper nigrum),* banana *(Musa spp).*, bitter gourd (*Momordica charantia),* okra *(Abelmoschus esculentus),* coconut *(Cocos nucifera),* cardamom *(Elettaria cardamomum),* cinnamon *(Cinnamomum zeylanicum),* jackfruit *(Artocarpus spp).*, sugarcane *(Saccharum spp.),* bamboo, *(taros Colocasia and Alocasia),* cucumber *(Cucumis sativus),* eggplant *(Solanum melongena),* rapeseed *(Brassica rapa ssp.)* campestris, sacred basil *(Ocimum sanctum),* indigo *(Indigofera tinctoria),* sunhemp *(Crotalaria spp.), Amaranthus spp.*, and gooseberries *(Embelica spp)* (Querol 1992). The region is also considered a secondary centre for diversity of grain amaranths, maize (*Zea mays),* red pepper (*Capsicum anuum),* soybean (*Glycine max),* potato (*Ipomea batata)* and rubber (*Ficus elastica*) (Khoshoo, 1991).

Crop genetic diversity in India is great not only at the species level, but also at the intra-species or the varietal level. Indeed, Indian farmers have been able to develop, through various deliberate and accidental processes, a crop varietal diversity which is truly astounding. Though crop species and varietal diversity is found throughout India, certain regions have heavy concentrations. These include the Western and Eastern Ghats, North-East India, North-Western Himalayas, Central India, and the Deccan Plateau . The NBPGR which is administered by the crop science division of the Indian Council of Agricultural Research, the Ministry of Agriculture, the Government of India, has been undertaking an elaborate exploration activity since 1976 in order to survey, document and conserve – ex situ, the agro biodiversity in India. This, in a way provides an overview of the agro biodiversity present in India. The NBPGR system is the most elaborate ex Situ conservation set up in the world. It has a total collection of 1,45,167

germplasm as on March 2001. Within that cereals (26 %), pulses (20 %), vegetables (18 %) millets (10 %), oil seeds (10 %) and other crops such as fiber, fruits, spices, medicinal and under utilized crops form 18 percent of the total accessions . The rice germplasm which forms 17 percent of the total collection is the single largest item under the NBPGR ex *Situ* conservation system (Dhillon, 2001) . The rich diversity in agricultural crops is confined mainly to the dry and rain fed regions in India.

A) Home gardens: These are the mixed farming systems comprising seasonal and perennial crops, plants and trees, and also with a variety animals and birds, sustained in the land surrounding the house. Home gardens were mostly prevalent in humid or sub-humid tropical areas such as Western Ghats and coastal regions Kerala, Karnataka and North-Eastern states of India. The prevailing conditions such as the rainfall, topography and other climatic factors favour the development of home gardens in these regions. These home gardens, in addition to supplying fruits, vegetables and fodder are also catering to the 'critical' household requirements such as medicinal plants, flowers (for religious and cultural purposes) and requirements such as timber for construction. It was noted that the homestead farms have also helped to maintain the traditional varieties of cattle in the farm-families in spite of the wide spread use of crossbred cattle in Kerala**.** The preference for those varieties that can be sustained on home grown feed and materials, and other entitlements, has caused the prevalence of such cattle. In addition, homestead farms are also generating cash income through the market transactions (Santhakumar 2002). On an average, 1575 plants belonging to 49 different species are raised in the homestead farms of Kottayam district in Kerala. Composition wise, almost 60 percent is annual spices followed by tuber crops and cash crops. The details are given in the table below:

Table 1:

Homestead Farm Diversity In Kottayam District In Kerala

Sl. No.	***Categories***	***Plants***		***Species***	
		Numbers	***% to total***	***Numbers***	***% to total***
1.	**Annual spices**	**919**	**58.56**	**2**	**3**
2.	**Tuber crops**	**226**	**14.14**	**2**	**3.56**
3.	**Cash crops**	**192**	**12.25**	**4**	**7.83**
4.	**Vegetables**	**38**	**2.44**	**7**	**13.45**
5.	**Fruit crops**	**82**	**5.17**	**9**	**17.71**
6.	**Tree spices**	**8**	**0.48**	**1**	**2.75**
7.	**Perennial trees**	**58**	**3.71**	**7**	**15.14**
8.	**Medicinal plants**	**31**	**2**	**7**	**14.47**
9.	**Ornamental plants**	**20**	**1.25**	**11**	**22.09**
	All	**1575**	**100**	**49**	**100**

Source: Deepthi and Prakash (2001).

B) Tribal and Forest Dweller Agricultural Diversity: The traditional agriculture like shifting cultivation and tribal agriculture have been known for their exceptional diversity. Ramakrishnan (1989, 1992) has shown how *jhum* cultivators in the north-east use a mixture of a minimum of 4-5 crops, and occasionally as many as 35 crop species. Crop mixtures change from region to region, even within a region, depending upon local ecological conditions and the socio-economic and cultural traits of the farming communities. Indeed, agro-forestry in many forms has also been prevalent in some parts of India, and has tended to use the considerable diversity of species. Highly stratified, and dominated by woody perennials, these farms almost tend to resemble a forest.

The unique agricultural system followed by tribal/forest dweller communities encompasses (a) pastoral agriculture; (b) shifting or *Jhum* cultivation and (c) the settled cultivation with mixed and/or multi-storeyed cropping systems. The Western and Eastern Ghats forest regions of South India, North Eastern hilly regions, Arunachal Pradesh, Chattishghar states, specific locations like Abujhmarh in Madhya Prades, Adilbad district in Andra Pradesh, BR hills in Karnataka host these types of agricultural system in India. The tribal and forest dwellers agricultural system is rich with both crop species as well as varietal diversity. The table below highlights the rich agro-diversity conserved by the ***Soliga*** tribal community in BR Hills in Karnataka. On an average, 87 crop varieties were cultivated in tribal farms which belonged to 51 different. Fruits, cereals, vegetables and legumes were the main crop varieties. The details are given in the table below:

Table: 2

Crop Diversity in *Soliga* Tribal Community in BR Hills of Karnataka

Crop Types	*No of Species*	*No. of Varieties*
I Cereals	**4 (8 %)**	**16 (18 %)**
a) Finger millet	1	8
b) Maize	1	3
c) Amaranths	1	3
d) Navane	1	2
II. Legumes	**7 (13.5 %)**	**11 (13 %)**
a) Beans	4	5
b) Redgram	1	2
c) Field bean	1	3
d) Horse gram	1	1
III. Vegetables	**9 (17.5%)**	**14 (16 %)**
a) Pumpkin	2	6
b) Gourd	3	4
c) Squash	2	2
d) Colocasia	2	2

IV. Oilseeds	**5 (10 %)**	**7 (8 %)**
a) Mustard	1	2
b) Castor	2	3
c) Niger	1	1
d) Sesamum	1	1
V. Tubers	**8 (16 %)**	**9 (11%)**
a) Tubers	6	7
b) Tapioca	1	1
c) Sweet potato	1	1
VI Fruits	**9 (17.5 %)**	**16 (18 %)**
a) Banana	2	4
b) Mango	1	2
c) Citrus	3	4
d) Papaya	1	2
e) Guava	1	2
f) Jack	1	2
VII Others	**9 (17.5 %)**	**14 (16 %)**
a) Coffee	3	3
b) Marigold	3	6
c) Mulberry	1	3
d) Chilli	2	2
Total	**51 (100 %)**	**87 (100 %)**

The figures in the brackets are the percentages to the total values

Source: Reddy et. al. (2001)

C) Agro Eco-system Diversity: Agro ecosystems stand out from the natural ecosystems as they have been converted from the latter and are managed by human beings for their own use. These may often overlap with forests, grasslands and costal ecosystems where agricultural plots/crop lands form part of a mosaic of land use. These are highly diverse ecosystems that are used for agriculture in similar ways, with similar components and similar interactions and functions (FAO, 1999). The notable feature of agro-ecosystems is its diversity in terms of their natural resource base (including soil, water, nutrients, crop and livestock), management practices, productivity levels, human culture and associated indigenous technologies and knowledge system. The AES diversity is mainly due to its adoptions to varying environments of specific locations and its response to management practices of farming communities through successive generations (Rana, 2001).

Conway and Barbier (1990) look at agro-ecosystem as 'conceptual system' which provide a framework to assess and operationalise efficiency, equity and sustainability objectives. Accordingly, an agro-ecosystem is *"an ecological and socio-economic system, comprising domesticated plants and/or animals and the people who husband them, intended for the purpose of producing food, fibre or other agricultural products".* Agro-ecosystems defined in this way fall into a hierarchy comprising of plants and animals forming the

components of farm agro-ecosystem the lowest level. Several such farms form the village and watershed agro ecosystems. Similarly, region, state, nation and world agro-ecosystems can be identified, each agro-ecosystem forming, a component of the agro-ecosystem at the next higher level. Conway and Barbier (1990) focussed on various properties such as efficiency, equity, stability and sustainability of an agro-ecosystem and showed that, depending on the underlying ecological, economic and political factors influencing them at each levels, there exists 'trade-offs' among these properties. For example, a farm agro ecosystem, being a production and hence an economic unit, focuses more on the 'private benefits' and efficiency objectives. The watershed being predominantly an ecological unit draws more focus on conservation and sustainability aspects. Hence, from the point of view of conservation of agro-diversity, the aspect of agro-ecosystem property at different levels, which decides the possible 'trade off' is very important.

Based on agro-climatic factors including the availability of water, the following five broad agro-ecosystems can be delineated at the country level.

I. Rainfed Agro-Ecosystem, II. Arid Agro-Ecosystem,
III. Irrigated Agro Ecosystem, IV. Coastal Agro Ecosystem and,
V. Hilly and Mountainous Agro-ecosystems

These, from the point of survey, planning and program implementation related to agro biodiversity, are further divided at the country level, into ten zones and 39 sub zones, the details of which is given in the *Appendix V*.

At the sub national level, states are subdivided based on weather, rainfall, soil type and other related climatic factors in to different agro-climatic zones. This is used for the purpose of crop planning and management. For instance, the state of Karnataka is subdivided in to ten agro-climatic zones and different crops or cropping systems in each zone is given in the Appendix VI.

The crops or the cropping systems in the different agro-climatic zones mentioned above are to a large extent recommended or 'imposed' one by the agricultural extension system which speak least about the agro biodiversity. *Agro biodiversity* in a particular region was in fact evolved in response to prevailing agro-ecological conditions which is neglected in the current discourse of agricultural development. Contrary to this, the AP Coalition, in Defence of the Diversity in Andra Pradesh has made a significant attempt to record the agro biodiversity currently present in different agro-climatic zones of Andra

Pradesh to compare its status with what was prevailing 30 years ago. The report developed through a participatory process involving only the farmers highlights the comparative status of agro biodiversity in three main regions; Telangana, Rayalaseema and Coastal Andhra in the state (DDS, 2002) .

The Agro-Ecosystem analysis and categorisation of a particular region, based on the agro-ecological features coupled with the crops, their combination and diversity are very useful to identify the threats/pressures which each agro-ecosystem is facing and recommending policies and programs to correct the same.

2.1.1.2. Livestock diversity:

The history of domestication of animals in India goes back as far as to 7000 B.C. At Bagor, in Rajasthan, sheep/goats were identified as the principal domestic animal while at Adamgarh, in Madhya Pradesh cattle *(Bos indicus)*, buffalo *(Bubalus bubalis)*, sheep *(Ovis aries)*, goat *(Capra hircus)*, pig *(Sus domesticus)*, and ass (*Equus asinus)* were reported as domestic animals (Kothari, 1995). India has the distinction of not only having rich diversity in animal species but also in the widest range of breeds within each species, thereby representing a significant percentage (around five) of the world's domesticated livestock diversity. Species wise, buffaloes, camels and goats are prominent in India. The table below highlights this:

Table: 3

Livestock Diversity in India:

Species	***World***	***India***	***Percent***
1. Cattle	787	30	***4***
2. Buffalo	72	19	***26***
3. Sheep	920	59	***6***
4. Goat	351	29	***8***
5. Pig	353	3	***1***
6. Ass	77	3	***4***
7. Horse	384	9	***2***
8. Camel	56	8	***14***
9. Chicken	606	18	***3***
Total	**3606**	**178**	***5***

Source: Sahai and Vijh (2000)

The rich livestock diversity is not only the result of richness in agro-ecological and socio-cultural diversities but also of the meticulous selection strategies adopted by the indigenous/pastoral communities since centuries in India. There are a number of such communities specialized in livestock breeding in the country. A list of a few such pastoral communities involved in the conservation and breeding of livestock is given in the Table 6.

These communities have followed a breeding strategy with multiple objectives which in fact enormously helped to enhance the livestock diversity in India. Horses and camels in India have been developed both as riding and pack animals . Breeds which were used for riding had a light and slender body while those selected as pack animals were often of heavier in build and sturdier in structure. Cattle and buffaloes bred for draught didn't not have dairy qualities but rather their selection was based on their ability to adopt and perform different agricultural operations .

Animals which migrate were selected on the basis of their ability to withstand the pressures of migration and the stresses imposed therein. This was true for many sheep breeds found in the semi arid region of country. The cattle breeds like the *Dangi* and *Siri* selected in areas with heavy rainfall had a special skin, which could withstand heavy rains. Resistance to disease and parasites was other factor which the local breeders focused while selecting a particular breed . Amongst chicken, selection had largely been towards the birds, which produce quality meat, could withstand diseases, made good brooders and cocks, which had a good fighting ability.

A certain degree of selection had gone even in semi domesticated animals like the *Mithun* and the yak. In the case of the Yak , bull calves showing larger body size and having attractive colors and horn patterns were selected as future sires for breeding. In some areas Yak and *Siri* cattle hybrids were also reared for areas which were too low in altitude for the yak and too high in altitude for cattle . The Monpas a Buddhist tribe of the West Kameng and Tawang areas of Arunachal Pradesh used Mithuns for hybridization with local Siri cattle.

As breeding and well maintaining a quality animal were costly activities, many of the best breeds of horses and cattle were developed by the local rulers rather than farmers in the past. The *Amrit Mahal* of Karnataka was developed in the reign of Tipu Sultan , The *Gaolao* of Vidarbha by the Maratha rulers and the now almost extinct *Punganur* by the rulers of Mysore . In many parts of the country, breeding animals are maintained as a community resource and the entire village treats and feeds these animals with a great deal of reverence. Buffalo and cattle bulls of good breeds are allowed to wander at will through different villages. They are also given extra nourishment, care and are allowed to stay wherever they find convenience .

Box: 2

***Amrithmahal (Dhuyu, Nambri)*- An Important Cattle Breed of South India**

Amrithmahal is one of the best-known draught breeds of India. The home tract of this breed is spreads over Chikamagalur, Chitradurga, Shimoga, Tumkur and parts of Mandya, Mysore and Hassan districts of Karnataka. Amrithmahal was originated from three distinct cattle varieties viz. Hallikar, Hagalvadi and Chitaldoorg. The credit for developing this breed goes to the viceroy of Vijayanagar dynasty at Srirangapatana between 1572-1617 AD. The animals were further developed by his successors and rulers of Mysore.

Establishment of large herds of cows (Benne chavadi) was initiated by the Mysore King, Chikka Devaraya Wodeyar (1672-1704 AD). He reserved about 240 huge grazing lands (kavals) measuring 4,13,539 acres for their grazing. Haider Ali and his son, Tippu Sultan, thoroughly organized and renamed the Benne Chavadi as Amrithmahal, and the kavals as Amrithmahal kavals. After the fall of Tippu Sultan, the Amrithmahal kavals and improvement of the breed came under the control of Royal families of Mysore and the Commissioners of Madras province. The Amrithmahal bullocks were extensively used for military operations for the transport of artillery and ammunition both by Mysore kings and the British. In 1923, the job was entrusted to the Department of Agriculture, Govt. of Mysore and the control was finally transferred to Dept. of Animal Husbandry and Veterinary Services in 1945.

Presently, Amrithmahal cattle breeding station is located at Ajjampura, Chikamagalur district with subcentres at Birur, Basur, Habbanaghatta, Lingadhalli, Kyadigere and Chikkayammiganur in Karnataka. The Amrithmahal kavals were distributed in 6 districts, but within easy reach of each other. The kavals are covered mainly with indigenous varieties of grasses like Heteropogan, Themida and Discanthium. These kavals are classified into summer, rainy and winter kavals and are used for gazing of Amrithmahal cattle around the year. The cattle are maintained in ranch system. At present, there are 56 Amrithmahal kavals under the ownership of the Animal Husbandry Department, Government of Karnataka.(Govindaiah et.al.2001)

India has contributed richly to the International livestock gene pool and to the improvement of animal production in the world. Heavy Indian cattle breeds like *Ongole, Gir,* and *Kankrej* played a dominant role in the development of meat industry in Latin America especially in Brazil. Currently, some of the finest zebu (local) breeds are found in South America, but not in India, its native country. On the dairy side, the *Sindhi* was exploited to evolve the Australian Milking Zebu and the Jamaica Mount Hope. Indian breeds of cattle attracted international attention long ago as cattle breeds like the *Gir, Ongole* and *Sahiwal* were exported to the Americas and Australia under the name '*Brahman bulls*' during 19th

century . The special properties of these animals were perfectly suited for the grasslands of the Americas, the prairies and the pampas as well as Australia and New Zealand. Excellent animals were taken to these countries by the then colonial rulers. The contribution of local communities in evolving the livestock breeds is not adequately accounted and acknowledge under the present discourse on IPR as well as benefit sharing mechanism. This needs further focus while evolving SAP on conservation and utilization of livestock diversity in a sustainable and equitable way in India.

2.1.1.3. Other Categories of Dom. Bd.

Other categories of Dom. Bd. considered here include honeybee, cultured fish, camel and pet dogs. A brief history of each case is presented below:

A. Native Honey Bees: Though the association of man with honeybees dates back to civilization, the bee keeping made a big stride with the invention of the movable frame hive during the eighteenth century. There are more than 12 species of honey bees that are found in the Indian sub continent. But only two species; the *Apis cerana* (native one) and the *Apis mellifera (exotic)* are domesticated. Honeybees, as excellent bio-agents for cross-pollination of crops and incredible collectors and suppliers of honey, find a special place in the progress of human civilization. Though all angiosperms reproduce basically through sexual reproduction, most plants adopted themselves for cross pollination. The role of honeybees in this respect is incomparable. The increase in the seed settings of different crops and the requirement of honey bee colonies to get maximum benefits are well researched. For instance, the yield of seeds in sunflowers is know to increase by 72 - 82 in number per plant and to reap maximum benefit in this respect a minimum of 3 bee hives are required per hectare cropped area (Bhat, 2002). The contribution of honey bees in enhancing agricultural productivity is significant. Due to this role, the native honeybees find a special place here.

B. Cultured Fish Diversity: Fresh water ponds and tanks are the main sources of indigenous cultured fish species in India. The cultured fish species are represented by fresh water and brackish water fauna. Fresh water fish production takes place in ponds lakes and tanks which occupy 4.34 million hectare lands, 1.3 million hectares of bheels and derelicit waters and 1.2 lakh kilometer length irrigation canals and channels in India. Carps, catfishes, Mashers, Cichlids, Murrells, Feather backs and weed fishes are the important freshwater fishes in India. The farming in brackish water is just decade old and restricted to indigenous species. Diversity in our country's water bodies has contributed greatly to fish diversity in India. The fish biodiversity of Western Ghats is regarded as the 'Hot Spot' by the United Nations.

C. Canine Diversity: India has one of the oldest canine cultures and Tamil Nadu has many distinct indigenous dogs. Indian breeds are sturdier, distinctive and less expensive to maintain. Some breeds like the *Kombai* and *Banjara* are in the verge of extinction. It is only in the last decade or so that there has been some awareness of Indian breeds of dog. There have been some sporadic individual efforts made to promote these breeds through the Kannel Clubs. In 1979 the North Eastern Kannel Club was established mainly to conserve the Himalayan breed. The notable of all these efforts is the setting up of the Dog Breeding Unit at Madras in 1981 to conserve indigenous dog breeds.

D. Camel Diversity: After Somalia and Sudan, India ranks third in camel population in the World. But, camel population in India is fast declining. It is estimated that around one million camel population exist in India and Rajasthan with 71% of the total camel population stands first. It is followed by Haryana (16%), Gujarat (4%), Punjab (4%), Uttar Pradesh (3%) and Madhya Pradesh with 2% (Pundir and Nivsarkar, 1998). The draught power of Indian camels works out 1.5 - 2 tons over a period of four hours, covering a distance about 30-40 km. Camels are specially suited for ploughing of sandy soils and are capable of ploughing 50 square meters per hour or a whole hectare within just 20 hours (Ilse and Singh, 1999). The camel pastoralism represents an ecologically sustainable means of exploiting arid lands and makes a significant contribution to food production and food security in drought prone areas in other parts of the world. However in India, the camel is regarded primarily as a source of transportation and provider of physical power rather than a source of livelihood. In some parts of India, the camel milk is used as food, but it is not widely prevalent.

2.2. The Key Issues:

The key issues which emerged from the assessment of the current knowledge on dom.bd. and which need further focus are discussed below:

2.2.1 Relationship with the Other Forms of Biodiversity and Ecosystem: The dom. bd has been evolved with constant interactions with wild and other forms of bio-diversity as well as eco-systems. Many time the interactions are mutually supportive and in a few cases antagonizing too. Some forms biodiversities like native honey bees which facilitate cross pollination, are playing crucial roles in enhancing the overall diversity and ecosystem stability in the nature. In a few cases, native livestock breeds and plant species become necessary to maintain the overall balance of the local ecosystem. For instance, grazing habit of the domesticated animals like buffaloes and

camels is found to be controlling the weed population in the surrounding eco-system in Rajasthan. This, in turn, is helping the nesting habitat for bird colonies. In Kumbalgarh sanctuary (Rajasthan) pastoralists claim that the browsing by camels actually increases the tree growth rates (Ilse, 2000). A specific livestock breed is suited to a specific ecological regions and in fact it becomes a part of ecological diversity of the region. For example the *Changthangi* goats of Kashmir are suited for Himalayan climates while the *Garole* of the *Sunderbans* is suited for marshy climates. Interaction between livestock and the environment in such as cases is also very important in maintaining the environmental balance of the region. Local breeds often have a history of interaction with wildlife and habitats have evolved through grazing pressure from both wild life and livestock. Local breeds and species may therefore even be necessary to maintain an ecological balance and to conserve the specific ecosystem. Pastoralists follow rotational grazing system which is congenial to the local ecosystem. For example farmers send 'Malaimadu' cattle in Tamil Nadu for forest grazing when crops are in cultivation in the plain lands. After the harvest of crops, the cattle are allowed to graze the left over stubbles on the harvested field. The large quantity of dung supplied by 'Malaimadu' cattle, helps to sustain the productivity of land which produces cash crops such as paddy, grapes and banana in the region.

However, crop husbandry in a broader context became a threat to wild biodiversity as, a given piece of land where diverse native plant species were originally growing was converted into agricultural land to grow a few 'domesticated' plant types. Similarly, domesticated livestock population, when crossed the threshold limits, (from the point of carrying capacity of ecosystem), became detrimental to forest and ecosystem diversity through over grazing or higher grazing intensity.

The agro biodiversity, represented by a specific local variety in farmers' fields – plays an important role in maintaining and enhancing the ecosystem stability and integrity. An indigenous plant variety by adopting to the local soil, water and environment and by developing resistance to biotic and abiotic stresses, places less demand on external sources of inputs such as agro-chemicals and irrigation water. The adoption of the variety to the local conditions also enables to conserve soil, water and surrounding ecosystems through nutrient cycling, controlling insect populations and plant diseases as well as through an optimal relationship between pests and predators in the ecosystem. A salt tolerant paddy variety, for instance, not only performs well in the salt affected soils but also addresses the problems of salinity and hence helps to restore the ecosystem integrity. There is also an

indirect benefit from agro biodiversity. As the use of external sources of chemical inputs and irrigation water is relatively lower, the damage on our ecosystem is also less in the case of local crop varieties compared to HYVs,

A diversified home garden with agro-forestry found mostly in the Western Ghats regions and coastal districts of South India is performing valuable ecological functions at the level of the farm and watershed agro-ecosystems. These functions are in terms of affecting solar radiation, runoff, and the movement of air, soil and nutrients . Such influences on soil characteristics, microclimate, hydrology and other associated biological components can enhance the productivity of a given agro-ecosystem. The species diversity that exists in home gardens and other such poly cultures, are also claimed to have beneficial aspects in terms of control of pests and diseases . (Shanthakumar 2002). An understanding of these intricacies is essential while assessing and strengthening the links between domesticated and other forms of biodiversities as well as ecosystem stability.

2.2.1.A. Wild relatives of crops: The term 'crop genetic resources' encompasses both cultivated crops and their wild relatives Every crop and livestock species which is in use by humans today has at some point in the past originated from the wild. Even after domestication, the link with the wild has not been broken: crops and livestock still exchange genes with their relatives in the wild, a process which was actively encouraged by traditional farmers, and which is profitably used even by the modern agricultural sector. India is an important center of several wild crops relatives and livestock. Around 800 species of wild crop relatives have been recorded in India which are distributed among various phytogeographical regions, as given in the table below (Rana, 1993):

Table: 4

Distribution of wild crop relatives in India.

S. No.	***Regions***	***No. of species***
1	Western Himalayas	125
2	Eastern Himalayas	82
3	North-eastern India	132
4	Gangetic Plains	66
5	Indus Plains	45
6	West Peninsular Region/ Malabar Coast	145
7	East Peninsular Region/ Deccan Plateau	91
	Total	**686**

The centers of wild crop diversity are thus spread over much of India, with different crops concentrated in different regions. The Eastern Peninsula is a major centre for wild rice

diversity. Relatives of maize are primarily distributed in the east and west Peninsular humid and semi-humid tract extending to north-eastern India, and occasionally in the south *(e.g. Coix gigantea)*. The Indo- Burmese region is well-known for its wild forms of *Digitaria cruciata and Coix lacryma-jobi*. Wild relatives of millets are found in the north- eastern hills, and in the hills of Tamil Nadu. The western and north-western portions of the Himalayas are known for wild wheat and barley relatives, amongst others. The Western Ghats too have important wild germplasm like cereals, spices, and millets (Arora and Nayar 1984).

Maximum diversity of wild relatives in India occurs in the case of rice. Of the 25 species of wild rice known from the world, India harbors seven. (Richharia and Govindaswami, 1990). The wild perennial form *Oryza perennis* occurs in Orissa, while another perennial *O. officinalis* is found in the Khasi hills of north-eastern India (Mehra and Arora, 1982). Wild relatives of sugarcane are concentrated in the eastern and north-eastern parts of India (Mehra and Arora, 1982). The wild sugarcanes *Saccharum erianthus, S. narenga,* and *S. sclerostachya* occur in the eastern Peninsular tracts extending to north-eastern India. Studies have shown that the sugarcane cultivated in north India is derived from hybridization of *S. spontaneum with S. officinarum.*

The species *Orize nivara,* found in Central India, has become famous as the only known rice with resistance to the dreaded grassy stunt virus. Gene exchange between cultivated and wild rice varieties has given rise to forms described as fatua, or spontanea, or species such as *O. rufipogon*. The forma fatua is considered to be the progenitor of *O. sativa*, the rice commonly in use today (Mehra and Arora, 1992). This exchange of genes with wild relatives is very important as this will result in enhanced variability in crop genetic resources and all other benefits from them.

2.2.2. Institutions, Cultures and Informal Knowledge and Technology Systems: Conservation and use of Dom. Bd. is an integral part of the culture and lifestyles of our traditional society. For instance, at the Puri temple in Orissa, it is the custom that Lord Jgannatha has to be worshipped by offering the rice prepared from freshly harvested paddy variety every day. This traditional 'institution' is continued till recently with the intimate knowledge of rice varieties prevalent in the olden days which mature and come to harvest at different points of time of the year This was followed by a careful selection and improvement of the existing varieties. Similarly, a unique paddy variety called *Hegga* is conserved mainly to offer rice as '*Nivedyam'* to Goddess *Annapurneswari* in *Horanadu* temple in Western Ghats region of Karnataka. The *Haalublu* paddy variety is exclusively used even today for house swarming ceremony in the old Mysore region in Karnataka.

Box: 3

Dependence of IAKTs on Bio-Diversity:

To treat the seed before sowing, a mixture of cow dung, milk, ghee and the juice of Solanum indicum, (Gulla), the mixture of the incense of Embelia ribes (Vayuvilanga), Commiphora weightii (Mahishakshi), flower of Terminalia tomentosa (Mathi) fish meat, turmeric and mustard were prescribed in the classic texts. Similarly to avoid disease attacks a prophylactory pest control measure with soil application of the mixture of Ferula foetida (Ingu), Barleria busivolia (Gubbi balli), Embelia ribes (Vayuvilanga), cashew seeds, mustard, cow horn creeper in cow urine was mentioned (Chandrakanth and Basavaradhya 1995).

So is the case with indigenous and folk communities. It is a taboo among the pastoral communities to sell the female breeding stock. It is a custom even today to maintain the breeding bull as a 'temple bull' or as a community resource in Tamilnad, Rajasthan and many other parts of India. Similarly, traditional fishermen communities are following the custom of restrain in fishing during the period of fish brooding. The deep and sophisticated ecological knowledge of bio-diversity has given rise to cultural rules for conservation reflected in notions of sacredness, taboos and other forms of 'institutions'. Focusing on these 'institutions' prevents a mere mechanistic approach to the conservation of Dom. Bd These institutions in turn govern the informal knowledge and technology system which is crucial for the sustenance of dom. bd.

The conservation and use of Dom. Bd. had been influenced historically, by two strains of informal knowledge and technology systems; ***Indigenous Agricultural Knowledge and Technologies (IAKTs) and Ethno Veterinary Medicines (EVMs)***. It is important to note that these informal knowledge and technology systems are used exclusively on Dom. Bd and they, in turn, are depending closely on the bio-diversity. For instance, the indigenous 'protection' measures are employed mostly on native crops and local breeds of animals. And, these protection measures are depending on the herbs, shrubs and plants available in the locality. Added to this, most of these traditional varieties have been conserved by the resource poor farmers in the dry regions for subsistence purposes, IAKTs rather than the modern technology system was the best choice for their cultivation. In this way, dom. bd and bio-diversity are linked with each other which is strengthened further by IAKTs and EVMs.

The Cosmo vision which governs the informal' knowledge and technology systems is rooted deeply in both classic/Sanskrit/Vedic tradition and in the folk or tribal or

indigenous tradition. Both in fact contributed enormously to nurturing the amazing range of biodiversity popularly called " ***The Hindustan Center of Origin of Crops, Plants and Livestock Diversity***" . Ancient texts related to agriculture are the ***Vrukshayurveda*** (Ayurveda of plants), Krishi Shastra (science of agriculture) and Mrgayurveda (animal science). They provide a wealth of knowledge on a variety of areas, form the collection and selection of seeds to pests and disease control mechanism. Major ancient texts which provide a clear understanding of Vrukshayurveda are:

a) Varahamihara, 505 AD, ***Brihat Samhita, Vrikasshayurveda*** part I, Chapter 55 Edited by M. Ramakrishna Bhat, Motilal Banarasidas, Bangalore, India, 1981.
b) Chavundayaraya, 1025 AD, ***Lokopakarakam, Vrikasshaurveda*** Chapter 6, Edited by H. Shesha Iynger, Govt. Central Manuscript Library, Madras, India 1950.
c) Sarangadhara 1963 AD, ***Vrikasshaurveda*** Edited by S.K. Ramachandra Rao, Kalpataru Research Academy, Bangalore, 1993.
d) Similarly, ***Mrugayurveda,*** deals with traditional Indian medicine on animals, published by *Lok Swaqsthya Parampara Samvardhan Samithi*, 1995, Madras.

These texts are focusing more on the plant protection practices based on indigenous knowledge. They provide an integrated approach to control pests and diseases of crops by treating the soil, seed, plant and the environment. They in fact, advocated a self reliant agricultural system where in, the agro biodiversity occupied the central position. Three congresses on ***Traditional Sciences and Technology of India*** held at Bombay (1993), Chennai (1995) and Varanasi (1998) respectively and the X World Sanskrit Conference held at Bangalore (1997) have not only deliberated in details but have also documented systematically the informal knowledge and technology systems related to crop and animal husbandry in India.

Agro-ecological complexity of the dry and risk prone regions further cements the informal knowledge and technology system with Dom. Bd. Hence those initiatives in the conservation of Dom. Bd like Deccan Development Society, Hyderabad, Navadhanya, Garhwal, Himalaya, GREEN foundation, Bangalore, Anthara, Pune as well those aimed at the documentation of IAKTs and EVM like Honey bee network IIM, Ahmedabad have to focus exclusively on dry and risk prone regions in India. Inadequate focus on IAKTs and

EVMs by formal R & D institutions including SAUs, ICAR and ICRISAT has badly constrained the effectiveness of these institutions in addressing the development of dry land agriculture in India. However, the tribal agriculture provides a good illustration for the interplay of institution, IAKTs and agro-diversity, the case of *Sidhi* tribal agriculture in Karnataka clearly demonstrates this .

Box: 4

Institution, IAKTS and Agro-Diversity in *Sidhi* Tribal Agriculture:

The Sidhi tribes which are said to be of African Negroid origin are settled in the thick forests of Western Ghats Ankola, Mundagod, Haliyal and Yellapur taluks in Karnataka. This 15-20 thousand strong population is characterised by the diversity of religions to which they belong - the Hindu, Islam and the Christianity. The incessant croaking of frogs, the flights of winged termites, the tree clinching fire flies and the flowering of wild jasmine are some of the signs, based on which they predict rains begin for land preparation. Ploughs prepared out of local trees are used one after the other for land preparation. The Sidhis use ploughs of Careya arborea first and later use ploughs of Stynxnas nuxvomica. They believe that the plough by Careya arborea makes the land fertile and the bitterness in Styxnus nuxvomica kills the insects in the land.

The Sidhis have preserved several indigenous varieties of paddy characterised by taste, disease resistance and higher fodder yield. The Sidhis prepare a unique compost manure by mixing the leaves of Termilalia tomentosa, Tephrosia Paniculacto, Styxnus nuxvomica and Careya arborea leaves with cow dung. The native paddy varieties used by the sidhis like Ommadlu. and Shevakhar were disease resistant . The Sidhis use the branches of Caryota urens to control leaf roller and the juice prepared out of Casiafistula or Pongamia Pinnata leaves to prevent insect attacks on paddy. They also control a fungal Pyricularia Oryze, which attacks paddy in all the stages of its growth by mixing a solution prepared out of the bark of Careya arborea tree and water and make this dispersed through water on the field (Prakash et. al. 1995)

There are several innovative farmers in India who, not only harmonized the links between bio-diversity and IAKTs but also extracted the best out of them to achieve high level of efficiency in agricultural production. For example, the story of an young and innovate farmer, Mr. Dinesh , Saru village in Shimoga District, Karnataka in growing a native paddy variety called *Jolige* organically with the indigenous methods of control of pests and disease amply demonstrates this . Mr. Dinesh obtained highest yield of 17 quintal per acre in the region. To control plant from the brown plant hopper (*Nilaparvata lugens*) (BPH) a sucking insect pest severe on paddy) Mr. Dinesh used an effective bio-

pesticide made out of *Mukkadaka'* (*Lasiosiphon eriocephalus)* - a common plant in the locality which is very bitter and found to cause burning even if a small amount of the extraction falls on the skin.

Box: 5

An Effective Bio-Pesticide from *Mukkadaka'*

To one kg Mukkadaka leaves Mr. Dinesh added 10 liters water and boiled it. The solution was filtered and diluted with water in the ratio of 1:10 and was sprayed twice; once during nursery stage and another after transplanting of paddy and has never seen BPH in his field. He found that the decoction was effective even against the crabs attacking the paddy (Hittalagida 1998). Mr. Dinesh was honored at the International Conference on Creativity of Grassroots People at IIM Ahmedabad during 1997.

There are some interesting cases where the native/indigenous crops themselves are used as ITKs. The case of grain amaranthus is one such example. In certain areas of Himachal Pradesh, (*Radhu, Khanag, Kullu, and Pangi*), the stocks of grain amaranth are used to preserve meat and apple fruit up to 4-6 months. It is reported that the meat remain fresh for one and half month and becomes more tasty where as the apples remained farm fresh for 4-6 months when kept submerged in grain bins of amaranth. In Tamil Nadu and Kerala hills, the tribals use the juice of stem and leaf *Amaranthus spinosus* to cure kidney stones. In Uttarakanda people consider that it helps in the curing of measles in children. In Himachal Pradesh the decoction of the plant is used for treating ailments of the foot and mouth disease in animals. Grain amaranthus, when grown on the border of maize field is known to ward-off bird damage to maize cob (due to colour effect of red inflorescence.) (Kothari, 1997) .

This interplay of informal knowledge and technology systems , dom. bd and bio-diversity has to be harnessed effectively to evolve eco-friendly, culturally compatible, low cost technologies for sustainable development.

2.2.3. Spatial Distribution of Dom. bd., and Their Vulnerability: For the purpose of exploration and collection of agi. diversity, the National Buaro of Plant Genetic Resources (NBPGR) has delineated the country in to 10 diverse phyto-geographical agro ecological zones and 39 sub zones. The details are given in *Appendix III.* Among

these the Western *ghats* and north-eastern Himalayas are the two 'hot spots' of biological diversity in the world. Within these are the several specific regions which merit special attention for the purpose of conservation of *agro biodiversity*. A few such regions are:

1. River beds of Eastern Uttar Pradesh for the conservation Cucurbits vegetables.
2. Unique fruit items like Nangangudu *Rasabale* a banana variety grown in Mysore district of Karnataka.
3. Garwal and Kumaon hill regions of UP for uridbean and minor fruits; both tropical and temperate species.
4. Homestead forms of Western Ghats regions of Karnataka and Kerala for jack fruit species, vegetables, ornamental and medicinal crops
5. Salt and heat affected regions of Gujarat and Rajasthan for salt and drought tolerance species of *Triticum* species
6. Adilabad district of Andhra Pradesh for landraces in rice which are tolerant to abiotic stresses with superior kernal quality.
7. For non domesticated wild and under utilized crops - Westren Ghats forestry in North Kanra district in Karnataka, Aravalli hills, Rajasthan and Western Himalaya region.
8. Land races of **rice crop** Arunachal Pradesh, Garo Hill District of Meghalaya, JHum region of Nagaland, Gangetic plains & Hazaribagh district in Bihar, upland rice germplasm of Gujarat and salt tolerant indigenous rice varieties from West Bengal.
9. Wild relatives of crop plants in Aravalli hills of Rajasthan.
10. Ethno botanical plants in Abujhmarh region of Bastar in Madhya Pradesh.

In the case of livestock breed, there is a 'critical' stage/number, below which if population falls, the restoration is impossible. It is important to note that the indigenous livestock breeds are very vulnerable for extinction which depends on the number of factors inter alia; population size, recent trends in the population, size of the herd, number of breeding bulls and the extent of crossbreeding in the breeding tract. The different stages mentioned below related to the degree of vulnerability in the case of a livestock breed as suggested by FAO panel may be useful for deciding about the need for conservation of the breed:

Table: 5

Degree of Vulnerability In The Case Of A Livestock Breed:

Degree of Vulnerability	*Features*
I. Normal	Population is not in danger of extinction and can reproduce without genetic loss. No visible changes are seen in population size.
II. Insecure	Population numbers are decreasing rapidly
III. Vulnerable	Some disadvantageous effects endanger the existence of the population. Preliminary measures need to be undertaken for preventing further decline in number
IV. Endangered	The effective population size is too small to prevent genetic loss. Due to small size, high inbreeding occurs and genetic variability is reduced. Need to initiate conservation action
V. Critical	Close to extinction. Genetic variability is reduced to the below the level of ancestral population. Action to enhance the population size is essential for survival.
VI. Extinct	No possibility of restoring the population. No purebred males and females can be found.

Source: Bodo (1990)

It is reported that the survival of 50% of the goat breeds, 20% of the cattle breeds, 30% of the sheep breeds and all the 18 breeds of poultry is threatened in India. (Balain and Nivasrkar, 1991). Species wise, the list of breeds deserving attention for conservation initiative in this respect is given below:

Table: 6

Breeds Facing Extinction Among Different Livestock Animals in India

Animals	*Breeds Facing Extinction*
Cattle	Bachaur , Dangi , Kenkatha , Siri , Kherigarh, Rathi, Krishna Valley, Red Sindhi , Sahiwal , Tharparkar , Punganur* , Vechur *, Malnad Gidda, Amrithmahal, Umbalacherry, Kangeyam, Nar
Buffalo	Toda , Nili ravi , Bhadawari, Jaffarabadi, Pandharpuri,
Sheep	Nilgiri , Bhakarwal ,Poonchi , Karnah , Gurez, Changtahngi , Muzafarnagari , Chokal , Munjal , Jaisalmeri , Kheri, Bonpalo, Hassan, Bannur (Mandya), Changthangi , Vembur,Kachakatty black
Goat	Jamna pari , Barbari , Surti , Beetal , chegu , Changthangi , Jhakrana, Sangamneri, Tellicheri (Malabari), Gohelwadi, Kanchu Mekha
Camel	Double humped camel , Jaisalmeri , Sindhi
Poultry	All indigenous breeds Aseel, Kadakanth, Chittagang and Maly
Cultured fish	*Schistira sijuensis* and *Horaglanis krishnispecies*
Pet dogs	Kombai**, Banjara**, Himalayan breed, Rampur and Mudhol

Species count below 5000, **Almost extinct

Source : Zhihua Jiang (1992)

The spatial distribution of these unique plant varieties and livestock breeds and their vulnerability to extinction and survival must draw a special attention while envisaging policies and programs to conserve them.

2.2.4. Women and Dom. Bd Rural women have been playing historically a key role in the selection, conservation and management of domesticated biodiversity in India. Though their immediate objective is to meet household food and nutritional security, there are a variety of reasons why women have taken up this role. A combination of these reasons have made women in most cultures the repositories of a unique knowledge on domesticated biodiversity. Women's ingenuity in this regard is clearly manifested in kitchen garden/homestead farm diversity and back yard poultry in different parts of India**.** For instance, women in the *Maland* region of Karnataka are maintaining several unique varieties of flowers, fruits, vegetables, ornamental and medicinal plants in their Kitchen gardens. The diversity prevalent in these kitchen gardens is catering to the 'intra household' food security requirements; inter alia taste, nutrition, palatability, aesthetic, cultural and for primary health care to children and women during the critical period (*Hittalagida*, 2002). A study in Kerala reveals that the homestead farms under women's custody consist on an average 1500 plants belonging to 50 different species. Rural women all over India are responsible for maintaining back yard poultry and preserving the local breeds therein. The Adivasi women in Andra Pradesh are known to rear the renowned ***Aseel*** poultry breed in their back yard. The *Aseel* is known for its taste and highly relished meat quality, beside, being famous for cock fighting. It also fetches a good price in the market. Hence, the conservation of *Aseel* poultry breed is having immense implication on the livelihood security of marginalized Advasi women in the region.

Women's ingenuity in this regard is not confined to kitchen garden or back yard animal husbandries but is also extended to dry land farming. The farm women are found to be the custodians of unique local varieties of field crops such as paddy, pulses, ragi and other millets in many villages in the dry belt of Karnataka and the Tamil Nadu border South India. Their selection criteria is mostly 'non market' in nature like taste, nutrition, cooking quality, fodder availability and even medicinal property ! For instance, a pearl millet variety named "*Kambu*" in the Thally region possesses several medicinal properties, in addition to nutritional, taste and cooking qualities. This variety is conserved by a woman called Gowramma, There is also the case of a landless women, Maduramma, who, by taking the land for lease from the local landlord is growing a unique indigenous finger millet called *"Kempu ragi"* in the same region. There is also a significant imitative by DDS, Hyderabad in motivating the schedule caste women not only for conserving the agro biodiversity but also for evolving an alternative public distribution system. This, amply proves that <u>if access to land, technology and information is given, women can play a lead role in the conservation and use of bio-diversity in an equitable and sustainable way. This</u>

provides strong justification for a gender sensitive approach to food security through the conservation of dom.bd. in India.

2.2.5. Forms of Conservation: The Dom. Bd. has two distinct options; *in situ* (on farm) and *ex Situ* (in gene bank) for conservation. According to the definition given in the Convention on Biological Diversity (CBD), *in situ* conservation is "*the maintenance and recovery of domesticated or cultivated species in the surroundings where they have developed their distinctive properties"(UNEP, 1994).* Several NGOs with the active involvement of farmers and communities have been undertaking the *in situ* conservation of domesticated biodiversity in different parts of India. Virchow (1999) put forth the concept of a "controlled *in situ* conservation system", with a flexible and self-targeting market incentive mechanism to involve the farmers. This system comes only into effect when a native variety is endangered by extinction. This incentive system meets the main criteria for an economic efficient regulation mechanism and is therefore suggested as an operational way of maintaining all CGRs as well as increasing the agricultural production at the same time.

However, there is a limited experience of *in situ* conservation for the formal R & D sector with a very few studies and no standard protocols for its management especially in compliance with the CBD. However, *ex situ* conservation methodologies have been extensively employed in agro biodiversity management by the Govt. R & D institutions like the NBPGR. Seed storage is the best-researched, most widely used and very convenient mode of *ex situ* conservation. Standards for seed storage in gene banks have been developed and recommended by FAO and IPGRI for their international adoption (Genebank Standards 1984. FAO/IPGRI, Rome). Further, a protocol to determine precise seed storage behavior of unknown species has been given by IPGRI. Field gene banks are used for the conservation of clonal crops where seed is recalcitrant or rarely produced. Major constraints to field gene banks include cost and natural hazards of farming such as pests, diseases, drought, flood, cyclone etc. Alternative methods followed are *in vitro* (on nutrient gel) conservation and cryopreservation (in liquid Nitrogen at a low temperature up to minus 196 degree centigrade).

These two methods of conservation; *in situ* and *ex Situ*, have their own merits and demerits which are worth evaluating before embarking a particular form or a combination of these two forms for conservation. The benefits and costs of these two methods of conservation of agri diversity are listed in the table1 below:.

Table: 7

Comparative Benefits And Costs Of Two Categories Of Conservation of Agri. Diversity

EX SITU CONSERVATION	*IN SITU* CONSERVATIOM
Benefits/Advantages	
1 **Assured supply** of genetic resources for; a) future breeding / crop improvement programs, b) to evolve varieties to face future risks like climatic change, and, c) for re-introduction of the varieties if required 2. **Increased agricultural production** through improved / high yielding varieties. 3. **Transactions/exchange of genetic resources** conserved in the gene banks under the provision of national and international acts/agreements.	**1. Evolutionary benefits** in terms of variability which can develop in land races in response to biotic and a biotic stresses, selection and exchange among farmers and through interaction effects under *in situ* condition. **2.** N**on marketed benefits** (such as the availability straw) and **qualitative advantages** (such taste and culinary benefits) **3. Ecological services** from agro biodiversity **4. Conservation benefits** to farmers and communities which could have accrued through national and international acts/agreements
Costs / Disadvantages	
1. High **cost of conservation and losses** in genetic resources during *in situ* conservation 2. Increased **risks and instability** in agriculture production due to relay on HYV 3. **Ecological costs** of agro-chemicals used for HYVs 4. **Burden on state's exchequer** in the forms of subsidy, support, insurance etc. given for HYVs.	1. Risk of Extinction 2. Reduced production

A. *Ex Situ* Conservation: Assured supply of genetic resources that are stored in the 'gene banks', for plant breeding/crop improvement programs, is the first and foremost benefit of *ex situ* conservation of plant genetic resources. This can facilitate for the increased agricultural production through improved/high yielding varieties. The *Ex situ* conservation of resources also helps in the transactions/exchange of genetic resources conserved in the 'gene banks' under the provisions of national and international acts/agreements. However, there are several costs or disadvantageous; both direct as well as indirect associated with the *ex situ* conservation of plant genetic resource (PGR). The direct cost of *ex situ* conservation of PGR includes the cost of maintaining the elaborate structure like the NBPGR and the loss of PGRs as well as decline in their viability during the storage under in vitro *ex situ* conditions. The *ex situ* conservation has an over dependence on the high cost (in vitro) technologies and consequently the requirement of finance is also very high. Technical failures and or lack of finance may lead to the loss in

physical quantity and or deterioration in the viability of PGRs stored in the gene bank. Even a developed country like USA could not provide an adequate safeguard against such failures and prevent the loss of PGR. It was reported that in the US National Seed Storage Laboratory, (Fort Collins), the largest gene bank in the world, of the total germplasm collection, only 28 percent seeds were found to be healthy and fit for further breeding (Shiva et. al. 1994). Hence, this loss due to technological inadequacies and failures may be more severe in a country like India.

The indirect costs of *ex situ* conservation include the benefit foregone such as the evolutionary benefits, the non marketed benefits and the ecological services from the *in situ* conservation, as a result of large scale shift over to the HYVs. Other indirect 'costs' of relaying too much on the HYVs are the subsidies and incentives given for its promotion, ecological costs of intensive use of green revolution technologies, and the increased fluctuations and consequent production risks associated with the HYVs. These are elaborated under the subsequent sections 3.1 and 3.2**.**

B. *In situ* Conservation: There are both direct as well as indirect benefits of *in situ* conservation of PGRs for a country like India. The direct benefits include evolutionary benefits in terms of enhanced variability, 'non market' benefits (such the availability of straw), qualitative advantageous (such as taste and culinary benefits), ecological services from the agro biodiversity and the conservation benefits to farmers and communities. These benefits are further elaborated in the subsequent sections. *In situ* conservation is not free from disadvantageous. Unnoticed extinction is one such serious problem which may arise due to over dependence on *in situ* conservation of agro biodiversity. The dry land farmers and the indigenous communities who conserve and use the ago biodiversity are spread at the remote regions in the country side. The development of roads, communication and other infrastructures are also inadequate in these region. These may act as the bottlenecks in the flow of information of agro biodiversity, such as a unique variety. Added to this, there are several factors explained in the section 3.2 that are working against the very survival of agro biodiversity in the farmers' fields. Under these circumstances, an un noticed extinction of agro biodiversity becomes inevitable which in fact is a serious limitation of over dependence on *in situ* conservation of agro biodiversity in a country like India. This comparative evaluation of advantageous and disadvantageous of these two distinct forms of conservation is very essential before evolving the policies and programs related to Dom. Bd. in India.

III. VALUES AND CAUSES OF LOSS OF DOM. BD.

This section deals with the various values associated with the Dom. Bd., major threats causing its losses and the consequences of the loss of Dom. Bd.

3.1 Values of Dom. Bd.

The value of biological diversity is difficult to define and estimate, nevertheless, some discussion of the issues involved is very essential. Economists recognize two main types of value: *use value* and *nonuse value* associated with the bio-diversity. Use value is attached to the *utilitarian benefits* which may accrue directly or indirectly to the person or group associated with bio-diversity. The direct use value of bio-diversity can be of 'consumptive' in nature such as the taste and palatability of a native food or productive like the use of PGRs for breeding purpose or non-consumptive type like pest and disease resistance in the native varieties. The bio-diversity as a genetic resource, has immense value in the future called 'option' value. This may be for future breeding or any other purposes depending the requirements in the future. The non-use value is the 'intrinsic' value independent of its use; direct or indirect, present or future. This value is attached by the individuals for its sheer existence. The 'sacred groove' is an example for this category. The cultural or religious values like the use of *Haalublu* paddy variety for house swarming ceremony in the old Mysore region in Karnataka is also an example for non-use value associated with the Dom. Bd. It is very important to note that these values have more validity when the dom. biodiversity is conserved under the *in situ* condition.

3.1.1 Non Marketed Benefits

A local variety of food crop, say an indigenous rice variety, provides several indirect, non marketed use values such as taste, palatability, cooking quality, disease and drought resistance, supply of more fodder and so on. A study conducted by *Navadanya* (1994) indicates that dry land farmers growing paddy and *Ragi* in South India have more preference for the indirect 'non-market' benefits than for the yield of grain. The table below highlights the results of the study conducted at the Thally region in Karnataka and TN boarder in South India.

Table: 8

Farmers' Preference For Non-Marketed Benefits From Agro Biodiversity

Attributes	*Local variety*	*HYV*
Yield	Moderate	High
Drought resistance	Good	Very Low
Fodder	More	Very low
Taste	Excellent	Not good
External inputs Requirement	Very less	High
Disease attack	Less	High
Weeds	Less	More
Tillers	More	Less
Storage capacity	High	Less
Shattering	Nil	More
Duration	Long	Medium

A few of the indigenous rice varieties cultivated by the farmers of South India along with their non-marketed and qualitative attributes are given in the table below:

Table: 9

Examples for Farmers' Varieties Having Non-Market and Qualitative Traits

Local Name of the Variety	*Non-marketed / qualitative traits*	*Region*
Rathnachudi, Rajmiudi	very good cooking quality	Thalli region of Karnataka
Salu Batha , Doddabairanellu	good taste, nutritious and rich in Vitamin	
Kichadi Samba, Madumalige, Doddidbatta, Doddabairanellu	high fodder yield	
Kuzhiyadichan, Neelan Samba	good for lactating mother as it is found to increase milk	Kattankalathur block of Tamilnadu
Koomvalai, Thooyamallee, Vaigunda, Sigappu Kuruvikar, Kappakar, Muttakar, Seegarsamba	rice is suitable for making south Indian dishes like *Idly, Dosa* and *Biryani*	
Periyavari, Thooyamallee,	straw is good as roofing purpose	
Dhinkkiyasali	best for thatching	Garh, Madhupur region, Orissa

Source: Compiled from Ramprasad, (2002)and Arumugaswamy et al., (2001)

India is having the largest cattle population in the world. This places a high demand on the straw yield, which is effectively fulfilled by the indigenous varieties of field crops at the farmers' level. For instance, the traditional rice varieties have a straw to grain ratio of around 1.50 (i.e. for every kilogram of rice yield, the yield of straw is 1.50 kilogram) which is much lower in the case of dwarf and short duration HYVs of paddy (Shiva, 1995). Here it is not only the quantity of the straw, but also the quality of the straw which is better in the case of local varieties. For example, straw of *Beli Munduga,* a rice variety is having good taste hence preferred more by the cattle in *Thalli* region of

Karnataka. In addition, the straw is also used as cited in Table for several other purposes, as the material for thatching, roofing of *kuccha* huts and a range of other purposes depending on the quality of the straw. For instance, the straw from a particular rice variety called *Dhinkkiyasali* in Orissa is long, stiff and leafy, and hence is very good for thatching purposes. These differential straw - grain ratio as well as their quality attributes among the traditional rice varieties are capable of generating comparatively higher preferences that vary from farmer to farmer (Kshirsagar et al., 2002).

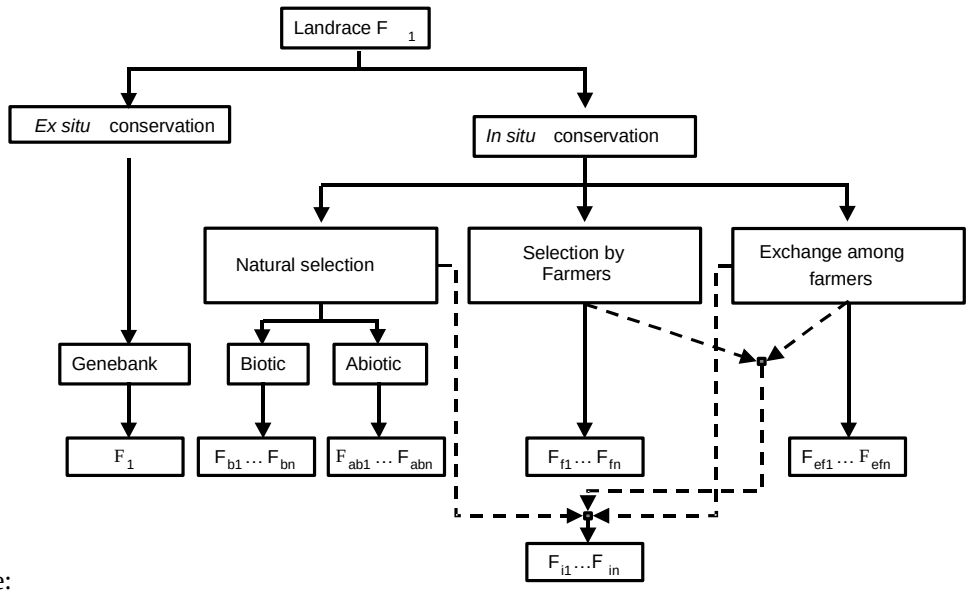
Indian people, cutting across social and economic status, are very sensitive to quality attributes such as the taste, aroma, softness, digestibility, keeping quality and culinary benefits of a particular food grain variety. Due to thousands of years of selection and cultivation, farmers could respond to theses preferences effectively. For instance the rice variety that cooks faster, expands more after cooking and is tender, sweet with aroma is most preferred by the consumers in India. In addition traits such as the storage quality determines the demand by the consumers. The people of Orissa have a peculiar preferences for leftover rice (after dinner) which is slightly fermented for the next day's breakfast. This rice is mixed with water to prepare a most common breakfast item called *Pakhala* which in fact accounts for almost one third of rice consumption in rural Orissa. As traditional rice varieties outperform the HYVs in almost all the quality traits, they have higher preference by the consumers of all categories of India. According to the study by Kshirsagar et al. (2002), the farmers who rated the traditional varieties as "superior" in comparison with HYVs ranges from 58 % for aroma, 72 % for cooking quality, 78 % for keeping quality and 86 % for taste.

Similarly, the home gardens too are catering to the different intra household requirements which are 'non marketed' in nature. These are in terms of food, materials for building construction, health, energy, and culture (i.e., religious and ritual needs). Even for items such as fuel wood and other tree products for which many societies were usually depending on non-agricultural lands and forests, home gardens catered a major part of these requirements wherever they are sustained. The mid-land Keralites had been acquiring items such as salt, fish and clothes by bartering garden products even much before the circulation of money in that society (Shanthakumar 2002). Even in the case of livestock, the breeding goal of pastoral nomads is not primarily to increase the meat and milk yield. Rather they consider local requirements such as survival under high environmental risks, draftability, good mothering instincts, ability to walk long distances or climb steep slopes, aesthetic preferences and even loyalty to the owner ! <u>There is an urgent need to develop an appropriate methodology to value these 'non-marketed' benefits of Dom. Bd. and internalize the same while envisaging the policies and programs to promote it.</u>

3.1.2 Evolutionary Benefits: The agro biodiversity conserved on farm provides a mechanism through evolutionary process for generation of variability within crop genetic resources. The variability (both genotypic and phenotypic) which develops in a farmers' variety is in response to biotic and abiotic stresses, selection and exchange among farmers and through interaction effects under on farm management conditions. This is depicted in the figure below:

Figure 1:

Evolutionary Benefits From On Farm Conservation of Agri.-Diversity



Note:

F_1 = Existing farmers' variety
$F_{b1}..F_{bn}$ = Farmers' varieties evolved in response to biotic stress
$F_{ab1}…F_{abn}$ = Farmers' varieties evolved in response to abiotic stress
$F_{f1}…F_{fn}$ = Farmers' varieties evolved in response to farmers' selection
$F_{ef1}..F_{efn}$ = Farmers' varieties evolved in response to exchange among farmers
$F_{i1}…F_{in}$ = Farmers' varieties evolved in response to interaction effect

The rich diversity in a crop like rice with a high degree of variability within and among the varieties can be solely attributed to the evolutionary process that took place in the farmers fields over the years. The researchers in the past have empirically captured the variability in crops like indigenous rice cultivars in India. In addition to yield and straw, physiological characters as well as agro-morphological features such as the duration of the crop, plant height, inflorescence length, number of panicles and seeds, seed weight, features of spikelets, kernel, aroma and so on were studied by employing the statistical techniques such as the co-efficient of variation, analysis of variance (ANOVA) and cluster analysis. Salient findings of a few important studies focused on PGR in rice are summarized below:

1. Hore and Sharma (1991) analyzed the variability in the land races of rice collected from north east regions of India. These varieties exhibited the features of (a)

high degree of adaptability capable of growing at a depth of 5-6 meter water to high annual rainfall to severe drought conditions; (b) protein content varied from 6 to 14 % and amylase content varied from 0 to 29.5 %; (c) high level of resistance to blast diseases and pests such as gall midge and stem borers. The researchers attributed this variability mainly for the geographical variations and the prevalence of ethnic diversity in the region. There are 67 different ethnic groups using these varieties in the region.

2. Interestingly, a few varieties introduced from outside, have not only adopted well in the region but also have enhanced their variability over the years. For instance an indigenous rice cultivar codified as C14 - 8 is introduced to Bay Islands from erstwhile Bhurma about a century back has spread to 80 % of the rice growing region by enhancing its variability in its agro-botanic features (Mandal and Parmanik, 1999).

3. Hore (1999) in another study on rice germplasm diversity in Arunachal Pradesh, further elaborated the link between agro biodiversity and diversity in the socio cultural aspects of the ethnic communities. According to the researcher, it is the deliberate selection strategy of the communities to minimize the risk, stabilize the yield to enhance 'harvest security' under the situation of low level of technology and resources coupled with the objective of promoting the 'diet diversity' that has resulted in the variety and variability in rice germplasm in the region.

4. Chuuhan and Bhattacharya (1999) studied the variability among 35 traditional rice cultivars collected from Uttar Pradesh and Bihar states. Their study focused on the variability in 12 agro-morphological features and high density grain index among these cultivars. They found, statistically significant results which highlighted the high degree of variation among all the features studied. The researchers found 9 traditional varieties possessing desirable traits such as weight of panicles and grains, length of panicles and kernels, which could serve as good donors for future crop improvement programs.

5. A study by Chaudhuri et al., (1999) focused specifically on variability in the case of salt tolerant indigenous rice varieties in West Bengal. Their study used 18 such salt tolerant indigenous varieties for randomized block experiments with two replications. Normal crop production and input management practices were followed. Variability with respect to eight agro-morphological characters which include plant height, seed weight, duration of plants, number of grains per panicle

and time taken for 50 % flowering in these cultivars was analyzed. The result not only points out statistically significant variation with respect to the selected morphological traits among theses 18 varieties, but also within the same variety. For instance, the yield has varied significantly from variety to variety, implying the variability in the yield across the varieties. But, the same variety has also exhibited variation in the yield between two replications, which implies the inherent genotypic variation within the variety. Even the morphological traits, which are unique to a particular variety such as height, duration and flowering period have exhibited variability, not only across the varieties but also within the varieties, between the replications.

The cases presented above clearly demonstrate the dynamic nature of on farm management of agro biodiversity in providing a mechanism for the evolutionary process within the plant species, with the result of increased variability within varieties over the years. This is the most fundamental source of information and knowledge and the main resource for further crop improvement and breeding programs. This is the greatest benefit of on farm conservation and the use of agro biodiversity, an aspect which requires further focus while evolving policies and program on '*in situ* conservation of *agro biodiversity* in a county like India.

3.1.3. Yield Advantages: A HYV is designed to produce more of physical output say, grains per plant or unit area. When such varieties are planted in a large scale, it is quite natural that the total output obtained is relatively higher compared to the local varieties. Most of the varietal improvement programs have been focusing mainly on this aspect of increasing the 'physical output' from the agricultural crops. But, the argument that the indigenous varieties are low yielding was contested long back in India. In Thondai Mandalalam region, Chengalpet district in Tamil Nadu, a paddy yield of 8,400 kg per ha was recorded during 1764-1774 (Dharampal, 1990). Shiva et al. (1994) indicated that the traditional rice varieties of Garhwal region of the Himalayas yielded a grain output of 7,200 kg, along with a straw yield of 10,400 kg/ha. This was compared very favorably with the prevailing HYVs such as Saket, which yielded a grain output of 6,200 kg and a straw yield of 6,400 kg/ha in the region. The table below provides estimates of average yields of prominent indigenous rice varieties in two traditional rice growing states; Tamil Nadu and West Bengal of India. The indigenous rice varieties from West Bengal are salt tolerant varieties, collected and maintained by two research institutes, the Chinsura Rice Research Station and the Central Soil Salinity Research

Institute, West Bengal (Chaudhuri et al., 1999). Indigenous varieties from Tamil Nadu, on the other hand are conserved in the fields of 300 farmers, spread over 20 villages of Kattankalathur region. This was promoted by a Chennai based Non-Governmental Organization: the "Center for Indian Knowledge System".

Table: 10

Yields of Indigenous Rice Varieties and Their Comparison

	Indigenous varieties *in kg/ha*	***Highest among the sample*** *in kg/ha*	***State average*** *in kg/ha*	***Total rice production*** *in million tons*	***Proportion to national production*** *in %*
Tamil Nadu	3,117	4,310	3,481	7.53	8.4
West Bengal	2,723	3,490	2,237	13.76	16.34
Punjab	---	---	3,347	8.72	9.72
All India	---	---	* 1,986	89.68	** 9.72

Note: *: country average; **: proportion to total Indian food production

Sources: Compiled from Chaudhuri et al., (1999), Arumugasamy et al., (2001) and DES, (2002)

In Tamil Nadu, nearly 94 % of the rice growing area is supplied with secured irrigation. Assuming that mostly HYVs are grown under secured irrigation, the state average yield of 3,481 kg/ha represents the average yield of HYVs of rice in Tamil Nadu. In that case, the average yield of indigenous varieties is not only comparable (just 10 % lower than the HYVs), but the highest in the sample out-performs the state average by almost 25 %. In West Bengal, the area under irrigation in rice crop is just 26 %. Hence, the state average yield of 2,237 kg/ha reflects the average of local and indigenous varieties of rice in West Bengal. However, the average yield of traditional varieties is the "experimental" average produced systematically by following the normal cultural practices. Hence, the productivity of indigenous varieties compared to state average is higher by about 22 % and the highest yield of the sample is higher by almost by 56 %, when compared to the state average.

It is very important to note that the average yield of indigenous varieties from both the states works out to 2,920 kg/ha. This, when compared with the average yield of Punjab, the heart land of green revolution, is lower by just 15 % and higher by almost 25 %, when compared to the all India average yield of rice. The average of the two highest yielding indigenous rice varieties from West Bengal and Tamil Nadu comes to 3,900 kg/ha. This is the highest paddy yield compared to any averages, including that of Punjab.

However, there are inbred conventional HYVs of rice which have giving an yield of 5,900 kg/ha in Tamil Nadu and 5,100 kg/ha in West Bengal (Janaiah, 2002). This is under the conditions of secured irrigation and proper input management. Indigenous varieties, with assured irrigation water and sufficient external inputs all have the "potential" to perform on par with the HYVs. However, their performance under such favorable conditions is yet to be evaluated. In addition, the superiority of straw, in terms of both quantity and quality is also relevant here.

The yield of both grains as well as straw of indigenous varieties can statistically be explained through the agro-morphological features associated with them. A regression equation was fitted to study the variation in yield (both grain and straw) of indigenous rice varieties from Tamil Nadu and West Bengal mentioned above (Prakash and Virchow, 2003). The results are summarized below:

a) Indigenous rice varieties are capable of yielding not only a good quantity of grains, but also a high amount of straw. Surprisingly, the grains and straw have a significant, but mutually complimentary (positive) bearing with each other. They move in unison in enhancing the "overall yield", fulfilling the requirements of both human as well as livestock population.

b) In spite of the inherent genetic variability and heterogeneity in agro-climatic conditions in the growing regions, these indigenous varieties have exhibited a great degree of stability both in its grain as well as straw yield. This was revealed through a lower Co-efficient Variation (CV) value. Relatively, the straw yield is more stable compared to the yield of grains.

c) Plant life or duration has a positive impact on the yield of grains. This is contrary to the general case with the HYVs, where the short duration varieties are known to yield more when compared to the tall varieties. The plant height, as expected, has a significant and positive impact on the yield of straw. However, its impact, though non-significant, is positive on the grain yield. The straw yield is also influenced positively by the length of the inflorescence.

Having found the stability and consistency of the yield of indigenous varieties against the features which are inherent with in them, it is very crucial to assess their response for the external factors such as the application of fertilizers, providing irrigation water and so on. Such an attempt on a macro scale is definitely going to strengthen the

argument that, the productivity of indigenous varieties is in no way inferior to that of the HYVs. Prakash and Virchow, (2003) have tried several options to show how modern agricultural development is not hindered, but even supported by 'on farm' management of "old" varieties, which have got comparative advantages in many areas. This has got immense policy implications to promote *agro biodiversity* on a large scale so that all the other 'non marketed' benefits, associated with it are reaped without compromising the objective of higher production of food grains.

Box: 6

***"Mysore Mallige"* – A Noteworthy Farmer's Variety**

It is also noteworthy to mention that there are significant initiatives at the grassroots level, going on to evolve a 'low external input dependent' rice varieties capable of adopting to a larger area in the dry regions. One such significant initiative is evolving a local paddy variety called "Mysore mallige", by a farmer Sri Lingamadaiah from Karnataka. This variety is not only capable of adopting to a larger area without any dependence on the inorganic chemical inputs, but also could produce an yield of 9,000 kg of grain per hectare! This variety has already spread to 30 % of the rice growing region of Channapattana taulk in Karnataka. Mr. Lingamadaiaha's achievement was recognized and supported by the National Innovation Foundation of India (NIF,) and the President of India honored him with a cash prize of one lakh rupees during December 2002.

3.1.4. Instability and Ecological Costs of HYVs: However, the argument above is not intended to deny the contribution of HYVs in achieving the much needed self sufficiency in food production in India. With their genetic uniformity, the comparative advantage of HYVs is their capacity to produce more in the short run. To meet immediate food security objectives in a country like India, the contribution of HYVs for higher production cannot be underestimated. However, the ecological problems in the long run as a consequence of large scale mono-cropping of HYVs have to be taken into account as well.

Furthermore, the problems such as the inability of HYVs to adapt easily to the local ecosystem, their over-dependence on the external sources of inputs leading to risks and instability in production have already become causes for serious concerns in India. Farmers have been clearly perceiving the inability of HYVs in effectively withstanding the stresses; both biotic and abiotic, compared to indigenous varieties in different parts of India. As per the study by Kshirsagar et al. (2002), nearly 94 % of farmers chosen for the study perceived that the traditional rice varieties, are superior in facing the flood situation in Orissa. It was 92 % for water submergence, 88 % for pest attack and 76 % in facing the drought.

These risks associated with high yielding rice varieties, leading to production instability at different levels were empirically estimated. Ninan and Chandrashekar (1991) have pointed out that the crop yield variability in case of rice has increased by 35 % after the achievement of green revolution in India. Another study by Saha (2001) points out that the production 'risk' (as measured by variance) is almost 300 % higher for HYVs of rice, compared to the traditional varieties of West Bengal. The study further points out that, the variability or risk in the yield of HYVs of paddy was unrelated to the use of inputs, especially the marketed inputs like fertilizers. A study by Prakash and Pearce (2000) indicates that the yield of HYVs of paddy, even under secured irrigation condition has exhibited variability in Karnataka. The instability as measured through standard deviation was almost 247 % higher than that of indigenous varieties. The local paddy varieties, on the other hand, when supplied with sufficient irrigations, have exhibited much lower instability or almost stable yield. These results clearly point out that, the modern HYVs are the most important factors responsible for the risk and instability in the production food grains in India. This variability at the crop yield level, when passed on to the production at the aggregate level, assumes a serious proportion in creating severe problems in the supply of essential food grains in India. These are the

major consequences of replacing agro biodiversity from the farmers' fields in our country. In this background, it is also important to acknowledge the role of agro biodiversity in providing 'insurance' service through stability effects as discussed earlier.

In addition, the conservation of Dom. Bd.. also helps to fulfill various equity obligations aimed towards women, marginalized sections, future generations and non human beings. Conservation of Dom. Bd.. takes care of the livelihood security of the marginalized majority in the rural areas. This, obviously strengthens the intra generation equity concern associated with the conservation of Dom. Bd.. Section 2.2.4 deals with the benefits of Dom. Bd.. in catering to women's 'need' for such nutritional security, taste and palatability in food, aesthetic and cultural needs, requirements for primary health care to children and others during the critical period. Conservation of Dom. Bd.. also ensures its availability and access to future generations. In addition, requirements of livestock (ex; fodder), animals, bees and birds are also met through the conservation of Dom. Bd.. and hence, concerns of 'non humans' is also addressed. And above all, as bio-diversity is closely linked to the culture and lifestyle of rural masses and indigenous communities, its conservation has a bearing on strengthening of cultural values.

If all these 'real' benefits of Dom. Bd.. are properly assessed, acknowledged, valued and made to reflect in the market transactions, its value may increase much higher, even higher than that of the modern high yielding crop varieties or livestock breeds. But, the present markets, institutions, political set up and the value system fails to capture and fully reward these benefits. These failures result in the systematic under valuation, leading to sub optima; less than the socially desired level of conservation and supply of Dom. Bd.. in a country like India. This issue is focused mainly in the report.

3.2. Causes For the Loss of Dom. Bd..

Several factors such as the technological revolution brought by modern 'man made' plant varieties and livestock breeds became the major cause for the loss of Dom. Bd.. Failures in the market and policy arena to effectively value the benefits as well as services rendered by Dom. Bd.. and internalize the same; the effects of labor market; degradation of genetic resource base and several such other factors that are responsible for the loss of Dom. Bd.. are discussed below.

3.2.1 Technological Revolution

Introduction of Hybrids/HYVs in agriculture, exotics in fish, honey bees and other categories, promotion of cross breeds in livestock, have acted as the most fundamental cause for the loss of Dom. Bd.. in India. At present, more than 60 percent of the gross cropped area, occupied by five major cereal crops: paddy, wheat, maize, jowar and bajra is under HYVs. Hybrids/HYVs are fast spreading across time and space in India. This, in a way, provides an idea about the replacement of agro biodiversity. The green revolution (GR) technologies along with the incentive system as well as extension services coupled with the development of irrigation and other infrastructures, have mainly aimed, due to socio-political compulsions, at the promotion of HYVs in a country like India. The table below gives the growth of key GR technologies in recent year (2000) in India.

Table: 11

Growth of Key GR Technologies in India

GR Components	*Use in quantity*	*Growth or Position*
1. Fertilizer – total	**184 lakh tons**	
a. Nitrogenous	65 percent	***827 % growth in three decade***
b. Phosphatic	26 percent	
c. Potash	11 percent	
2. Certified seeds	**83 lakh quintals**	
a. Cereals	64 percent	
b. Pulses	6 percent	***47 % growth in one decade***
c. Oilseeds	15 percent	
d. Fibers	4 percent	
e. Potato	10 percent	
f. Others	1 percent	
3. Electricity for agriculture	**91277 Mil.kwh**	***21 % growth in one decade***
Proportion to total	31 percent	
4. Pesticides (tech. Grade)	**49,000 tons**	***102 % growth in three decade***
5. Area under irrigation	**83. 6 Mil. Ha.**	***121% growth in three decades***
Proportion to total	40.6 percent	
a. Paddy	51 percent	
b. Wheat	86 percent	
c. Jower	6.7 percent	
d. Bajra	5.3 percent	
e. Maize	21 percent	
f. Ragi	10.2 percent	
6. Tractors	**1.4 million**	***5.3 % of world (IV position)***
7 Area under HYV		
a. Paddy	**74 percent**	**476 % growth in three decades**
b. Wheat	**86 percent**	**255 -ibid-**
c. Jower	**83 percent**	**1025 -ibid-**
d. Bajra	**72 percent**	**350 -ibid-**
e. Maize	**57 percent**	**620 -ibid-**
f. Ragi	**40 percent**	**-4 % growth in two decades**

Source: DES (2000)

A perusal of the table clearly indicates that there was a remarkable growth in the use of almost all the key input components of GR during the past decades in India. Consequently, the area under HYVs in all the major food crops has increased enormously, except in cases of 'inferior' millets like ragi. From the economic perspective, all these implies to 'productivity gains' through the development or modernization of agriculture. As this process of modernization of agriculture is not yet completed, the promotion of HYVs has remained on high agenda. As a result, the uncontrolled loss, through the extinction of the precious indigenous varieties continues unabated in India. So is the case of livestock diversity, where in the introduction of cross breeds is causing equal damage on indigenous breeds. Even in the case of other categories of Dom. Bd.., introduction of 'exotics' (like *Apis mellifera* in honey bees) is causing similar damages. Commercial applications of agri biotechnology promoting production of hybrids in crops and cross breeds of livestock, in this background, can 'potentially' pose a major threat to the very survival of bio-diversity.

Box: 7

Commercial Agri Biotechnology - A 'Potential' Threat to Agro Biodiversity

Though biotechnology is a very ancient technology, it is the modern bio-technology which generates new social, ecological , economic and political risks and tensions. The tissue culture, one of the vital components of modern agri bio-technology could introduce and perfect 'uniformity' within a variety. The genetic engineering on other hand is capable of extending this process of installing the "uniformity" across species or/and genera. For example, by installing the genetic component of Bacillus thurengensis (Bt) to enhance the pest resistance in crops belonging to different species, say corn, cotton and Soya; genetic engineering in fact, has introduced ' genetic proximity' among these crop species. All these crop species; hitherto unrelated are now made to possess one common feature: the Bt. Thus, being capable of introducing uniformity both horizontally (with in the varieties through tissue culture) as well as vertically (between the species through genetic engineering), modern agri biotechnology posses not only a deep contradiction with the very essence of bio-diversity, but also pose a potential threat to the very survival of the bio-diversity.

It is important to note that this decline in Dom. Bd.. has occurred in spite of several benefits and associated 'values' which are discussed in the previous sections. There are several other equally important factors causing the loss of Dom. Bd.. are discussed below:

3.2.2 Neglect of Agro-Ecosystem Approach

As discussed in the previous section, 'non-marketable' nature of several benefits and services, associated with the Dom. Bd.. is the main reason for its neglect. Over emphasis on

the command area and other agricultural systems, which have assured sources of irrigation has resulted in the mono-cropping of HYVs in a large scale. These irrigated systems have responded well to the political compulsion of producing more to feed the growing population. However, it is important to realize that, to address the long run conservation and sustainability objectives, a holistic 'Agro Eco System' (AES) approach of agricultural planning and development is essential. Neglecting such an approach is also an important reason for the loss of Dom. Bd.. in India.

'On farm' conservation of agro biodiversity is influenced by over emphasis of planning on the irrigated farming system rather than on the wider agro-ecosystem of watershed. Under assured irrigation condition, economic consideration becomes paramount for farmers and under such circumstances, the focus is tilted more towards mono cropping and HYVs to produce more of market oriented products, rather than the promotion of agro biodiversity. Conway and Barbier (1990) concept of agro – ecosystem (AES) analysis is very useful in this respect, which highlights the nature and the emphasis given in different agricultural systems/units. This is explained in the table below:

Table: 12

Agro-Ecosystems: Their Nature as well as Features

Agro ecosystems	*Nature of the system*	*Emphasis*
1. Farming system		
a. Irrigated	Economical	Marketable output and private benefit
b. Rain fed	Subsistence mostly	Livelihood, non marketable needs
c. Homestead garden	Household and subsistence	Household / nutritional security
d. Tribal	Ecological and cultural	Livelihood
2. Firm – hi tech/corporate	Commercial and export	Higher Profit
3. Village watershed	Ecological and geographical	Conservation and sustainability
4. Regions;		
a. Agro Ecological zones	Ecological and geographical	Micro Planning & conservation
b. State	Geographical and political	Administrative and Macro Planning
5. National	Political and geographical	Administrative and Macro Planning
6. International	Global	Global concerns: trade and climatic change

A perusal of the table gives sufficient indications that the conservation as well as the use of agri diversity depends on the type of agro ecosystem unit emphasized for development. Hence, focusing on an 'ecological unit', such as the watershed, which has an in build thrust for 'conservation', may also help to conserve agri-diversity also. This may be through the cultivation of local and traditional varieties, following mixed cropping, planting agro-forestry and so on. But in

practice, this is not happening totally. A study by Sripadmini *et. al*. (2001) made a comparison of the cropping pattern before and after the watershed development program in Shimoga district, Karnataka. The study indicates that the watershed development program has resulted in the substantial increase in irrigation (232 %) and cropping intensities (205%) leading to an additional profit of around 23 thousand rupees per farm. Even the crop diversification has increased, as seen in the table. This could be possible by introducing not only the HYV crops, but also new commercial crops like arecanut, floriculture and mulberry. The watershed development program mentioned above, from the point of view of economic efficiency, is a success.

Table: 13

Cropping Pattern Before And After Watershed Program in Karnataka

Area in acres (gross)

Crops	*Pre-project*		*Post-project*		*% change in area*
	Area	*Proportion*	*Area*	*Proportion*	
IRRIGATED CROPS					
Vegetables	4.0	2	27.0	14	575
Coconut	-	-	7.7	4	*New crop*
Mango	-	-	0.5	0.2	*New crop*
Banana	-	-	0.8	0.4	*New crop*
Chrysanthamum	-	-	3.0	1	*New crop*
Arecanut	-	-	4.0	2.4	*New crop*
Mulberry	-	-	3.5	2	*New crop*
Papaya	-	-	0.5	0.2	*New crop*
Crossandra	-	-	1.5	0.8	*New crop*
RAINFED CROPS					
Sunflower	3.5	3	15.5	8	343
Cotton	7.0	5	18.8	10	168
Groundnut	16.5	12	21.3	11	29
Jowar (with sesamum /sajje,)	36.0	26	36.5	19	1
Ragi (with red gram/ navane)	65.0	47	48.5	25	-25
Horse gram	4.0	2	2.9	2	-29
Total	**136**	**100**	**192**	**100**	**41**

Source; Sreepadmini et. al. (2001)

(Veg=Chillies+field bean+brinjal+tomato+onion)

New crop = New Introduction due to water availability/recharge from watershed development programme

The results may also show greater diversification of crops as a result of the watershed development program. However, the program remains more questionable from diversity linked to human needs point of view, and in particular, the needs of women and children. In the course of development, not only the traditional crops like *Ragi* which was enhancing the food and nutritional securities of the poor has been neglected, even horse gram which was supplying fodder for livestock was replaced. This is the common feature of most of the watershed development programs undertaken by the government with active involvement of SAUs and extension department. Hence, the point of concern is not diversity of crops, but the loss of important place of local/traditional varieties and the crops that provide nutrition/food security.

3.2.3 Over-riding Market Consideration:

The above result highlights that the selection of an appropriate unit/system alone is not sufficient to promote agro biodiversity. The factors such as the over-riding market consideration, results in the over emphasis on the production of those agricultural or livestock products which have market values such as grains, milk or meat. These need to be analyzed properly. As the focus on market consideration increases, agricultural/livestock production becomes more mechanized and commercialized. The ultimate result is the neglect of the products of Dom. Bd.. once again. For instance, in Kerala, as the program for milk production has gained predominance, cattle breeds like the Vechur, which are not known for their milk production abilities were neglected. Commercialization necessitates more specialization and homogenization of agriculture and livestock production. Swanson (1991) argues that the economics of scale backed by the laws of specialization, is the main root cause of loss of diversity on agricultural lands. The laws of specialization put forth by Adam Smith is intended to increase homogeneity in production method and processes. Hence, according to Swanson, there is an inbuilt 'trade off' between the diversity and productivity in the laws of specialization. The increased use of capital in agriculture further necessitates the process of specialization. This leads to an increased application of chemicals, machinery and other modern agricultural technologies to produce large quantities of a homogenous product. Thus, the productivity gains of specialized agriculture comes hand in hand with the loss of diversity in agriculture.

Farm machines like tractors or power tillers are developed to work in the fields that are planted uniformly with a single or few similar crops. The plant protection chemicals are fine tuned to eliminate all pests and diseases of single or similar crops. Instead of looking

into ‘host specific’ pesticides for each and every pest and disease, it is very economical to develop a ‘broad spectrum pesticide’ that kills a range of pests attacking a single or a few crops. All these worked in tandem to cause a deep impact on the displacement of diversified multiple/mixed cropping systems, rich in agro biodiversity with the mono cropping of modern HYVs. Mechanization of agriculture and the introduction of tractors, harvesters, threshers and grinding mills have displaced many draft breeds of cattle like *Ongole* and camels in different parts of India. Canal irrigation, which has resulted in a shift in cropping patterns and consequent mechanization, has threatened the *Nagaur* and other camel breeds, which were previously used for draft purposes in Rajasthan. In this way, overriding market consideration leading to mechanization and specialization became the fundamental cause for the loss of Dom. Bd..

3.2.4. Policy and Market Failure

It is not merely the over riding market consideration but the inability to address several forms of market and policy ‘failures’ which is the root cause for the loss of Dom. Bd.. The basic issue of market failure is that the level of diversity that farmers are motivated to maintain in their land is much lower than the level desired by the society as a whole. For the society as a whole, all those benefits like evolutionary service, ‘non-marketed’ and qualitative benefits, insurance and equity services of agro biodiversity, discussed earlier are very important. The farmers, who cultivate agro biodiversity, get returns only for those tangible items such as grain yields for which there is a price premium. These ‘failures’ lead to the under valuation of ‘total benefits and services’ of Dom. Bd.. and consequently results in its negligence. This in fact resulted not only in less returns to the farmers and communities who under took conservation of agro biodiversity but also a sub optimal supply and eventually disappearance of precious landraces from farmers’ field. These failures are explained below:

1. **Failure of the market** to appropriate the value for the ***‘genetic information’*** embodied in the agro biodiversity, enhanced through the ***evolutionary process***, which is used for breeding purposes and transference of the benefits of breeding to those who conserved the agro biodiversity.

2. **Failure of the market** to appropriate the value for the ‘***insurance service or stability benefit*** provided by the agro biodiversity and transfer the same to those who conserved it.

3. **Failure of the market** to capture the ‘***non-marketed and ‘qualitative’ benefits*** as well as ***option value*** (for future breeding and uses) associated with the agro biodiversity.

4. **Policy failures – Policies** that unable the appropriation of value from the flow

of ***genetic information*** from agro biodiversity. This, in a broader context, pertains to the inability of the present ***intellectual property rights (IPR***) regime to transfer the benefits of breeding to farmers and communities who have conserved agro biodiversity.

5. **Policy distortions** in the form of '***crop insurance'*** and ***input subsidies,*** which are given to modern HYVs to promote specialized agriculture/ monoculture and ***'output subsidy'*** through ***'administered support prices'*** for the products of the same. These have created an 'artificial' advantage for HYVs vis-à-vis local/indigenous varieties.

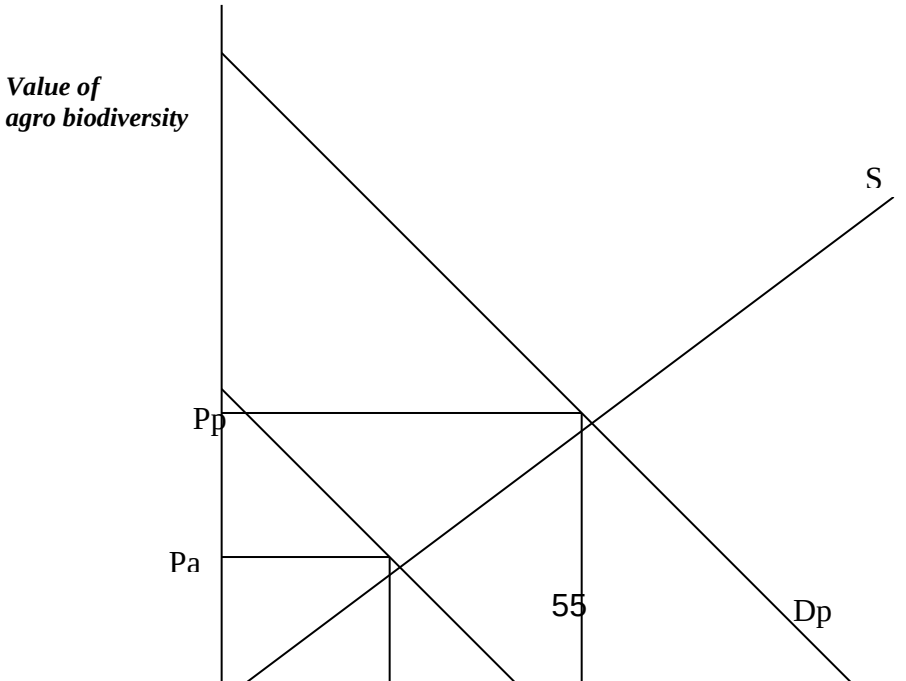
6. **Policy failures** in terms of ***high discount rate,*** which favors the present profit over future option value and hence discriminates the conservation of agro biodiversity. Similarly, '***higher exchange rate***' which encourages over exploitation of natural resources for high tech agriculture production and export.

7. **Policy failure to** apportion a premium *for* ***ecological services***, ***existence values, equity benefit*** (ex. food security) and so on, **provided** by agro biodiversity to those who conserve it.

The figure below depicts thematically these failures. The supply curve 'S', which represents the quantity/volume of ago-diversity say, an indigenous rice variety conserved and grown in the field, is assumed to be linear and positively sloped. The topmost demand curve 'Dp' reflects the potential demand for agro biodiversity in the absence of any form of failures or disadvantages mentioned above. Consequently, the Qp and Pp are the equilibrium (optimum) quantity and equilibrium price respectively. However, various forms of failures discussed earlier make the demand curve shift downwards, ending with the actual demand curve 'Da' for *agro biodiversity*. This leads to not only a much reduced and sub-optimal supply 'Qa' of agro biodiversity, but also an unfair price 'Pa' and benefit to those who conserve and supply it.

Figure 2:

Various Forms Of 'Failures' Associated With Agro Biodiversity



3.2.5. Market too could Promote Dom. Bd..

The market need not be construed always as an obstacle to promote agro biodiversity. Markets too can sustain and even promote diversity and this can take place due to several factors. A more apparent reason is the increasing demand for multiple and diversified products like those produced at home gardens or tribal agricultural systems. It can be seen that the demand for such products has high-income elasticity, unlike food grains, whose demand may become stagnant as income grows. This is due to the fact that people consume more of such diverse products like fruits, nuts, honey etc. as their income grows, where as, there may not be any significant increase in the amount of food-grain consumption after reaching a particular level. For example, a typical home garden in modern day Kerala could sell a large number of products such as, coconuts, plantains, bananas, pepper, cashew nuts, mangoes, jack-fruits, tamarind, and so on to local, national and international markets (Shanthakumar, 2002). Consumers who start eating non-staple commodities, such as fruits, tend to move (as they go up in their income ladder) towards the consumption of a diverse set of fruits, rather than the mass-produced fruits of standard features. The products of Dom. Bd. such as nutritious millets, native egg, local honey and so on could easily be included in to this category. The highest level of this 'new food pyramid' known for the consumption of organic or naturally grown products is fast spreading across the globe. One of the preconditions for this to happen is the correction of distortive policies and programmes mentioned above which promote unsustainable agriculture.

Box: 8

Consumers' Willingness to Pay More

The consumers or those who avail the benefits of Dom. Bd.. such as taste, palatability, 'purity', culinary benefits and so on are in fact willing to pay a price premium for the same. For instance, studies by Arun (1995) and Poornima (199) indicate that the consumers in metro cities like Bangalore are willing to pay a higher price for organic products ranging from 67 percent for vegetables to more than 200 percent for fruits. Very importantly, the

education has emerged as the crucial and significant factor in expressing the level of premium for organic products in these studies. But the most important precondition is that the consumers must be guaranteed of the quality and genuineness of the product.

3.2.6. Income, Labour and Capital Market effects

These factors too affect either the supply or the demand for the products of Dom. Bd.. and hence, its conservation. As the income of those who hitherto depending on Dom. Bd.. for their food security increases, their preference for the so called 'superior' cereals such as rice also increases. This income induced changes in consumption patterns of those who are associated with Dom. Bd.. reflects in market signals and can alter the demand for the products and services of Dom. Bd.. For example, the reduction of Jack-fruit and tapioca varieties in Kerala and other places in the South coast can be attributed to the reducing importance of them as a semi-staple food (due to the growing preference for rice and wheat). Signals leading to the reduction in the demand for the products of bio-diversity emanate not only from commodity markets, but also from labour markets. The shortage of labour force and the consequent increase in wage rates, higher opportunities for the family labour in non-agricultural occupations have severely affected the maintenance of homestead farms, which cultivate seasonal crops such as black gram, sesamum, betel-vine, and coarse cereals in costal regions of South India. This has led to the non-availability of a large number of traditional varieties of such crops in these regions. It is also noted that labour shortage prompts farmers to grow more labour-saving perennials such as coconuts. It is not only the cost or non-availability of wage labour but also the inability of the family members to spare their time on supervising affected the cultivation or nurturing of these crops in the kitchen gardens.

Like the labour market, the **capital market** too influences the nature of cultivation and hence, the diversity in the home gardens and other places. It is noted that the availability of finance (through loans) might induce farmers to cultivate cash crops, which are in high demand. This may reduce the diversity, depending on the specific circumstances and market signals. Development of capital market and insurance mechanisms also might result in the reduction of the risk-bearing role of diversified agriculture or the savings role performed by the trees in homestead farms or other traditional systems. (Shanthakumar, 2002)**.** These are also important factors causing the loss of Dom. Bd.. However, the solutions to arrest their impacts are not easily available.

3.2.7. Resource Degradation and Other Factors

Degradation of the resource base is the most 'proximate' cause for the loss of Dom. Bd..

These arise mainly due to ineffective implementation of rules and regulations which dealing with such situations. Few such cases along with other factors causing the loss of Dom. Bd. are briefly mentioned below.

A. Destruction of habitats and forestry: Encroachment and consequent privatization of 'common pool' resources such as *"gomala"* land is the most serious cause for the loss of Dom. Bd., especially the livestock diversity in India. When the natural habitats such as grazing lands, pastures and other common pool resources of local livestock breeds are degraded or encroached and converted to other purposes, not only these animals are endangered but communities depending on them also loose their livelihood bases. The cases of indigenous milk breeds like *Rathi* and the pastoral groups such as *Ratths* and the *Sahiwal* in the regions of Himalayas are a few such examples. Denudation forestry especially that of flowering trees has adversely affected the substance of local bees population. Growing human and livestock population is threatening the ecological imbalance of agro-ecosystem, especially arid and rain-fed systems. Excessive use of agro-chemicals, over exploitation of ground water is severely affecting the irrigated agro-ecosystems. Indiscriminate use of pesticides and weedicides on agricultural crops has also affected the local bee population for their source of nectar.

B. Pollution of Water sources: Negative impacts of anthropogenic activities such as the increased discharge of municipal wastes and industrial effluents are virtually threatening the survival of coastal agro-ecosystem. These pressures are affecting the fresh and brackish water systems there by threatening the cultured fish species in India. Indiscriminate use of pesticides in crop production, fishing gears like gillnets, alvinets, dragnets, etc., with small mesh size, unplanned removal of water for agriculture and other activities from the water bodies resulting in exposure of tank margins and destruction of breeding and shelter grounds of local fish fauna are the other major threats to the survival of cultured fish species.

C. Other Factors: i) Continuous unrest in parts of the Kashmir valley has disrupted traditional migratory routes of herds. This affects the Tharparker, Sahiwal, Rathi and certain breeds of goat and sheep of the Himalayas. ii) Natural calamities like cyclones, earthquakes, droughts and floods can also lead to the loss of species and their numbers. Farmers are forced to sell their valuable draught animals/cattle/buffalos of defined breeds due to chronic drought –like situations. These animals invariably end up in the

slaughterhouses.

IV. STAKE HOLDERS, MAJOR INITIATIVES AND THE GAPS

This section enlists the main stakeholders of Dom. Bd.., major initiatives undertaken by various categories within them and the major 'gaps' identified in their initiatives.

Dry land farmers, including tribal and women within them, individual livestock owners, communities of livestock herders, fishermen and others, who depend directly or indirectly for their livelihood on Dom. Bd. are the **primary stakeholders**. Scientists, Government research and development (R&D) bodies, farm organizations and NGOs, who work for the conservation of Dom. Bd.. or speak on behalf of the primary stake holders, are the **secondary stake holders**. Industry and corporate sectors, which commercialize the R & D efforts, international agencies and the donors who help the conservation of Dom. Bd.., are the **tertiary stake holders**. The 'stakes' of secondary and tertiary stake holders need to be clearly defined. Any stakes claimed by them while commercializing the Dom. Bd.. or related knowledge and technologies through IPR system need to be viewed cautiously so that interests of primary stake holders and their sovereign right is not compromised.

4.1 Primary Stakeholders

Being the primary stake holders, conservation and sustainable use of Dom. Bd.. are the most desired role they are expected to play. The property right is very crucial for the conservation and management of a natural resource in a sustainable way. Unlike with the other forms of bio-diversity, the issue of "property rights" in Dom. Bd. is resolved to some extent. The primary stake holders have the 'rights' either individually or collectively over the particular form of Dom. Bd. with which they are associated. In the case of farmers, if the land right is confirmed, they have more or less 'private property rights' over the agro biodiversity they conserve in their land. Pastoral communities in a way have a 'collective rights' over the livestock breeds or species they conserve. However, due to the prevalence of various forms of 'failures' and threats discussed earlier, the primary stake holders could not reap the benefits of property rights which they exercise over the Dom. Bd. they conserve.

4.1.1 Dry Land Farmers: The traditional farmers in the dry and rainfed regions are in a way the 'de facto' *in situ* conservators of agro diversity in a country like India. So is the case of tribal and indigenous agricultural communities. Farmers in these region grow diverse indigenous/traditional/local crops and varieties not merely due to the inadequate

development of irrigation, non availability of sufficient resources and modern agricultural technologies, but also for location specific socio/cultural advantages. The resource poor dry land farmers using *agro biodiversity* are having several constraints to manage the same in a sustainable way so as to ensure its availability for future use. Institutional supports are inadequate for small and subsistence farmers in the dry regions to conserve and use agro. diversity. So is the case of communities associated with the native livestock breeds. Though the recent policy initiatives, in this respect such as the Biodiversity Act 2000 and Plant Variety Protection and Farmers' Act are the steps in a right direction, they are yet to be operationalized. There is no incentive for large and commercial farmers to conserve and use *agro biodiversity* especially under the assured irrigation conditions.

4.1.2. Women: Women are the original custodians of agro. diversity and are playing an important role in its conservation. This gender division of labor has its own implication on the management of agro biodiversity in sustainable and equitable way. Women in different parts of India have been proving their ingenuity in the conservation of agro biodiversity mainly for intra household food and nutritional security, as well as cultural purposes.

Box: 9

Women and Agro Biodiversity Conservation

Jyothi, a woman in a remote village in Western Ghats regions of Chikkamagalore district of Karnataka has conserved hundreds of local varieties of vegetables, flowers and medical plants in her kitchen garden. Jyothi was honored with SRISTI Sanman award at IIM Ahmedabad for her efforts in the conservation of agro biodiversity. Another farmwoman Nagaratna is having immense knowledge of more than 50 wild plant species for their food, medicinal and other benefits in the same region (Tejaswini, 2001). Another 70 years old farmwoman, Puteeramma is conserving three indigenous varieties of ragi (finger millet), two paddy varieties, four sorghum varieties in addition to local varieties of castor, same (little millet), kodo millet (Navane), huchellu (niger), green gram, field bean, horse gram, sesamum, safflower and bajra, in her 10 acres of dry land farm in Dharmapuri district, Tamil Nadu. GREEN Foundation honored Putteramma as Beejamatha (seed mother) during 1999 for her efforts in conserving indigenous varieties.

In Marathwada of Maharastra, women headed communities are very successful in bio-diversity conservation efforts both at farm as well as on community lands (GREEN Foundation, 1999). In spite of their significant contribution for conservation of agro biodiversity, a comprehensive agrarian reform to assign property rights to women over land and other natural resources is yet to be materialized in India.

4.1.3. Self Motivated Ecological' Farmers: In spite of many disadvantages there are a few self motivated ecological farmers who have initiated the conservation and use of native crop varieties and livestock breed diversity in their farms in different parts of India. For instance, Mr. A.P. Chandrashekar, in his 13 acres farm ***Indraprastha*** near Mysore, Karnataka is cultivating 338 different varieties crops belonging to more than 40 species. The unique biodiversity in his farm is not only helping him to maintain the soil fertility without much pests and disease attack but also getting an assured income with immense satisfaction to entire family (Hittalagida, 1995). The details of agro biodiversity in his farm is given in the table below:

Table: 14

Agri Diversity in Indra Prastha

Crop Species	Number of plants /Area	Number of Varieties
I Commercial Crops		
1. Coconut	500	6
2. Areca nut	1100	10
II Fruit crops		
3. Banana	4000	17
4. Sapota	60	3
5. Mango	70	16
6. Orange	45	3
7. Guava	8	5
8. Coffee	500	5
9. Jack fruit	30	15
10. Lemon family	41	11
11. Jambolanum	12	5
12. Pomegranate	50	2
13. Papaya	30	2
14. Pineapple	15	3
15. Indian gooseberry	6	3
16. Sour fruits	15	7
17. Butter fruits	25	3
18. Cherry	10	4
19. Other fruits	67	21
20. Root crops	5	13
III Vegetables	1 acre	
21. Leaves	-	12
22. Field bean	-	9
23. Other vegetables	-	17
IV Aromatic Plants	In garden	24
V Medicinal plants	-	40
VII Grass	-	5
VIII Flower	In garden	
27. Jasmine		15
28. Palms	-	10
29. Others	-	50
IX Trees	87 types	
30. Local	500	-
31. Teak	200	-
32. Silver oak	50	-
33. Bamboo	-	
34. Neem	50	-
X. Food Crops		
35. Paddy	¼ acre	2

Similarly, another farmer, Mr. Killur Devarao, in South Kanara, a coastal district in South India is conserving more than 33 indigenous paddy verities in his 4 acres land. Attempts such as ***"The Organic Farming Source Book***" (The Other India Press, 1996) and ***"Sustainable Agriculture in Asia"*** (ANGOC, 1997) have tried to document systematically such farmers' lead organic initiatives in different parts of India. Though these self motivated ecological farmers are ably demonstrating the superiority of bio-diverse agriculture facing such a powerful market forces and distorted policies which are biased against such a system, their initiatives are isolated and sporadic in nature confined to a few cases in India.

4.1.4. Communities of Livestock Herders: Similarly, there are communities of livestock herders all across the country, practicing a specialized livestock rearing. The list of such important nomadic pastorals involved in the conservation of different livestock species and breeds is given below.

Table: 15:

Pastoral Groups Conserving Native Livestock Breeds or Species

Name of the communities	***Breeds/species their conservation***
Todas of Nilgirls	Toda Buffalo
Irulas of Thalavadis	Toda buffalo
Van Gujjars of Himalayas	Local buffalo
Raikas in Rajasthan	***Naricattle, Marwadi*** and ***Merwadi*** camel (one humped) ***Bagalisheep, Sonadi Boti Tepli*** sheep***,*** ***Kali*** and***, Majjetti*** goat
Rabaris in Gujarat	***Gir*** and ***Kankrej*** cattle
Rath Muslims in Rajasthan	***Rathi*** and ***Sahiwal*** cattle
Ehtnic Communities of Tamil Nadu - ***Naicker, dayar Pallar*** and ***onar, Moopar, Reddiyar*** and ***Thevar*** in Tamil Nadu	***Malaimadu*** cattle breed ***Umblacherry*** cattle breed
Pallar in Tamil Nadu	**Vembur**, ***Meicherry, Sandynella, Kachakatty and Karuppu sheep***
Dhangar gowli in Maharastra	***Deccani*** sheep
Dhangar gowli in Karnataka	***Dhangar*** cattle breed
Gaddis in Shiwalik Hills	***Gaddi*** sheep/goat breed

These communities are working under economic and ecologically marginalized situations. Development of infrastructure such as roads, communication and electricity is inadequate in these regions. These limitations act as bottlenecks in the flow of information on the unique diversity of animal resources conserved in such places.

4. 2. NGOs initiatives

Several non-governmental organizations (NGOs), working at the grassroots have made significant initiatives in the conservation (both *in situ* and *ex Situ)*, of native crop varieties and livestock breeds in different parts of India. These initiatives, in addition to conservation, are attempting to strengthen the equity, gender, food security and cultural dimensions of Dom. Bd. by mobilizing the positive response of the civil society. These initiatives are trying to accomplish these objectives through collective actions and mutual co-operation among the primary stake holders. A few such significant NGO initiatives are mentioned briefly below:

4.2.1. ***Navadanya*** (meaning nine seeds) is an initiative to provide a platform and support to save biological diversity as well as environmental activism in India. Dr. Vandana Shiva's Research Foundation for Science, Technology and Ecology, New Delhi supports these initiatives of Navadanya. Since 1987, *Navadanya* has been working to save seeds, promote chemical free organic agriculture, create awareness about the hazards of genetic engineering and defend people's rights for food and food sovereignty in the face of globalization. It has pioneered the movement to save seeds in India. Over the last decade, by working with local communities and organizations, it has established 20 seed banks in seven states, serving 10,000 farmers and has conserved more than 1500 rice varieties, hundreds of millet, pulses, oilseeds and vegetable varieties in India. In march 1999 *Navadanya* spearheaded, a movement called ***Bija Swaraj*** (Seed Sovereignty) by involving over 2500 groups to defend farmers' rights over the seeds in the context of corporate take over of seed production and distribution in India. In September 2000, it had organized an unique ***Beej Panchyat*** (People's Seed Tribunal) to give evidence of the crisis of Indian agriculture in the wake of globalization, which has pushed the small and poor farmers to commit suicide. Since 1991, *Navadanya* has brought to central stage, the adverse impacts of the free trade rules of WTO on biodiversity, food security and farmers' survival. It is also instrumental in implementing ***Bija Yatra*** **-** a nation wide campaign aimed at creating debate and awareness towards the decline in plant genetic resources and the threats of WTO's Intellectual Property Rights (IPR) regime on the seed system in India. *Navadany*'s important publications are: *Beeja* – a monthly newsletter, *Cultivating Diversity* (1993) and *Sustaining Diversity* (1994). Further details are available at the website: www.vshiva.net.

4.2.2 The GREEN (Genetic Resource, Energy, Ecology and Nutrition) **Foundation** (GF) is a grassroots organization working with the small and marginal farmers, farm women in a dry belt of Karnataka and Tamil Nadu boarder in South India. Seed conservation is its

major concern. To accomplish this, the GF has mobilized women through voluntary groups (*sangham*) in approximately 100 villages of the remote districts of Tamil Nadu and Karnataka. In addition, it is also undertaking collection, multiplication and exchange of seeds, community farming with women, crop improvement through Participatory Varietal Selection and publishing of a 'crop calendar'. It is also involved in documentation as well as supporting cultural values, spiritual beliefs and indigenous knowledge system associated with agro. biodiversity. Its important publications related to agro biodiversity conservation are: *On – Farm Conservation of Seed Diversity* – A guide to conserving agricultural diversity, *Beeja Samrakshakaru* – a compilation of seed savers involved in on farm conservation in the dry land regions of South India and *Hidden Harvest* – a community based biodiversity conservation. **The** GREEN Foundation website is www.greenconserve.org. The conservation details of GREEN Foundation are given in the table below:

Table: 16

Conservation Initiatives of GREEN Foundation

Crop Varieties	***In Situ Conservation***	***Ex Situ Conservation***
I. CEREALS		
1. Finger millet	60	20
2. Dry land paddy	42	14
3. Wetland paddy	30	12
4.Pearl millet	11	7
5.Sorgham	11	5
6. Maize	6	2
7. Little millet (Same)	11	5
8. Foxtail millet (Navane)	40	6
9. Kodo millet (Araka)	1	1
10. Proso Millet	2	2
II VEGETABLES		
1. Beans	41	
2. Peas	13	
3. Greens	7	
4. Brinjal	6	
5. Tomato	5	
6.Chilli	4	
7.Gourds	22	
8.Others	6	
III PULSES		
1. Redgram	3	
2. Greengram	4	
3. Horse gram	2	
4. Black gram	2	
IV. OIL SEEDS	14	

Source; GREEN Foundation 2000

4.2.3 Deccan Development Society (DDS) is a two decades old grassroots organization, working with women's *Sangham* in about 75 villages in Andhra Pradesh. Most of the women are *Dalits*. Over the years, the DDS has evolved unique methods of empowering its

members to address the larger issues of food security, natural resource enhancement, health and education needs to them. It has founded the ***Andhra Pradesh Coalition in Defense of Diversity***, a coalition of over 150 civil society organizations from 22 districts of the State. The DDS is instrumental in evolving a unique campaign to muster the support for agro biodiversity through the ***Mobile Biodiversity Festivals*.** These festivals have dialogued with several thousands of farmers over the last three years in the subjects of ecological agriculture, seed control and organic markets. Through these festivals, the DDS has illustrated what the communities can do to reflect the rich agricultural diversity of their region in a celebratory fashion. Two main research publications of DDS are: ***Crops of Truth (2002)*** – farmers' perception of agro-diversity in the *Deccan* regions of South India and ***Agro-Biodiversity in Andhra Pradesh (2002)*** – a Farmers' Perspective. For more details, contact the website: www.ddsindia.com. The most significant accomplishment of DDS is developing an alternative Public Distribution System (PDS) by involving the women of Medak District, Andhra Pradesh.

Box: 10

Alternative PDS - The Achievement of Women of Medak District, AP

Since 1985, the Sanghams of DDS have brought back, under active cultivation, over ten thousand acres of degraded agricultural land, and raised their production from 0.5 million kgs. of grains per year to nearly 2.5 million kgs. Since 1996, they have developed and managed a radical, path breaking alternative Public Distribution System (PDS) based on the principles of local production, local storage and local distribution. About 1600 women participating in this PDS system have enhanced the productivity of nearly 2500 acres of land, to grow nearly 8000 quintals of extra sorghum per year. This has also meant the generation of nearly half a million extra wages in three years and the generation of new fodder for over 20,000 heads of cattle. This activity has translated into the production of nearly 1000 extra meals per each project partner family per year. Today, the village level Community Grain Funds, which the women in 32 villages were able to establish serves at critical hunger times, the food needs of the poorest and destitute in their communities in Medak district.

4.2.4 ***Anthra,*** is a non governmental organization working for animal health care, gender awareness and indigenous knowledge system in the states of Andhra Pradesh and Maharastra. The NGO is actively involved in *in situ* conservation and promotion of *Aseel* poultry breed in the *Adivasi* regions of East Godavari, Andhra Pradesh. Community efforts were initiated by *Anthra* to preserve important fodder and medicinal plant species for veterinary uses.

4.2.5. Center for Indian Knowledge Systems (CIKS) is a Chennai based organization involved in exploring and developing the contemporary relevance and application of traditional Indian knowledge systems, with the focus on agriculture and health care. The CIKS has conserved *in situ*, more than 35 indigenous rice varieties by involving 300 farmers spread over in 20 villages of the *Kattankalathur* region of Tamil Nadu. The agronomic details of these varieties are presented in the publication, ***Indigenous Rice Varieties***. The farmers were also motivated to conserve and grow these varieties in the local 'seed banks'. The CIKS website is www.ciks.org.

4.2.6. M. S. Swaminathan Research Foundation (MSSRF), Madras is attempting on farm conservation of medicinal rice varieties by involving tribal and rural women as well as men in Kerala and Orissa. For details see the website: www.mssrf.org.

Though these NGO initiatives have made a significant impacts on conservation of Dom. Bd. by mobilizing the stakeholders concerned, they are confined to a particular region or a particular form of Dom. Bd. or a particular issue related to Dom. Bd. Attempts to extend such experiments to other regions in the same state or to other states where similar socio, economic and cultural situations prevail are yet to be visualized.

4.3. Campaigns and Initiatives by Mass Organizations

There are several campaigns launched by NGOs and mass organizations to strengthen the voices of peasants, women and communities; the primary stakeholders of Dom. Bd. These campaigns and movements are effectively raising the issues related to the rights and control of these primary stakeholders over the bio-diversity, seed system and the food security associated with them in the context of the WTO and globalization. A few such significant initiatives are mentioned below:

4.3.1 ***Beej Bachao Andolan*** (meaning save the seeds movement) an initiative by a community of farmers leading to successfully to the conservation of several hundred of local varieties of rice, millet, pulses, vegetables, spices and herbs in Tehri Garhwal region, North India. This has initiated a quiet revolution in *in situ* conservation of agro biodiversity in India. The movement is also spreading the idea of community gene bank to involve farmers and women with them.

4.3.2. Andhra Pradesh Coalition in Defense of Diversity is instrumental in campaigning for ***Prajateerpu;*** a people's verdict emanated from a citizens jury workshop on food and farming future of Andhra Pradesh. This is a vocal campaign, in support of traditional farming methods, localized food system based on increased self reliance, low external input agriculture, indigenous knowledge and traditions, the re-localizations of food production, markets and local economies. The Andhra Pradesh Coalition in Defense of Diversity, the Institute for Development Studies, the International Institute for Environment and Development, UK, the National Biodiversity Strategy and Action Plan and University of Hyderabad organized the workshop jointly from June 26 to July 1, 2001 at Medak District Andhra Pradesh.

4.3.3. The Diverse Women for Diversity (DWD) is an international eco-feminist movement, co-founded by *Navadanya*, is campaigning to defend biological and cultural diversities and to keep food security in women's hand. Its 'statement' on biodiversity calls upon governments to abolish patents on life, recognizes community rights and strengthens the Convention on Biological Diversity. In association with various farmers' organizations, the DWD organized the ***Beej Panchayat,*** People's Seed Tribunal at Bangalore in 2000. In this tribunal, small farmers from India and across the world gave evidence of the crisis in agriculture as a result of globalization. For further details contact the website: www.diversewomen.org.

4.3.4. Gene Campaign is a Delhi based NGO working on the issue related to bio-resources, IPR, indigenous knowledge, farmers and community rights in 17 states of India. It's focus is more on the enhancement of livelihood security for rural and *Adivasi* communities. It is helping the Governments and others in formulating policies and drafting legislation on bio-diversity, agri-diversity, IPR and other related issues. The Gene Campaign in association with the Center for Environment and Agriculture Development has drafted an alternative treaty to UPOV and has provided a forum for developing countries to implement their farmers' and breeders' right. Website: www.genecampaign.org

4.3.5. Peasant Organisations: Several peasants' organizations, since the early 90s have been ably mobilizing farmers support against the adverse implications of liberalization and WTO on Indian agriculture. These organizations could not only raise various issues starting from patent on seeds, genetically modified crops to the entry of multinationals in to Indian agriculture but also theoretise their discourse as a fight against neo-globalisation and neo-liberalization (Prakash 2000). The ***Karnataka Rajya Raitha Singh*** (Karnataka State Farmers' Organization - KRRS) is one such forefront peasant organization in the country.

The KRRS has organized a massive rally on October 2nd, 1992 and has launched a ***Seed Satyagraha*** to ascertain the right of peasantry on their seed system. In the very next year, in association with several mass organizations from the Third World countries, the KRRS organized a convention and pressed for collective intellectual property rights over Third World biological resources. In 1997, another massive farmers' convention was organized at Bangalore and a Charter of Farmers' Rights over the resources was passed. During 2000, the KRRS in association with ***La Via Campesina,*** a federation of more than 100 farmers organizations across the globe co-hosted an international conference of farmers at Bangalore. The convention in its *Bangalore Declaration*, reaffirmed its commitments to confront and defeat the global agenda of neo-liberalization (Deccan Herald, 2000). During the convention, various issues related to genetic resources and the rights of farmers as well as communities were discussed in length and a comprehensive proposal on farmers' right was evolved. The KRRS is currently mobilizing the farmers against the adverse impacts of commercial applications of biotechnology in agriculture. Similarly, the ***National Alliance of Peoples' Movement*** is taking up the issues of fishermen and other marginalized sections in different parts of India. In spite of their success in mass mobilization of farmers and other primary stakeholders, a broader coalition among the NGOs, grassroots organizations and others to influence the policy making process pertaining to conservation and use of Dom. Bd. has not yet been materialized.

4.4. Documentation and Dissemination Initiatives

Hundreds of rural journals/newsletters/periodicals in local vernaculars like *Adikepatrike* in Kannada are providing enough space to Dom. Bd. of different parts of India. Journals like ***Indian Journal of Plant Genetic Resources***, in English are publishing regularly scientific articles on plant genetic resources. In addition, there are several significant initiatives by both NGO and Gos, which are particularly aimed at the systematic documentation and dissemination of Dom. Bd. in India. Few such initiatives are discussed below:

4.4.1 Honey Bee Network (HBN): This is centered on a quarterly English newsletter – *Honey Bee,* started in the year 1989 by Prof. Anil. K. Gupta of Indian Institute of Management, Ahemdabad. The HBN's main aim is to document and disseminate Dom. Bd. and the associated grassroots innovations, informal knowledge, technology as well as the institutions systems in local vernaculars. The Honey Bee's philosophy stands for the people to people networking, cross cultural exchange of information and assure the knowledge providers that they are not remained anonymous and impoverished by sharing

their knowledge. The network promotes publication in six local language quarterly newsletters in different parts of India. These regional versions are: *Num Vali Velamani* (Tamil), *Hittalagida* (Kannada), *Lokasrvani* (Gujarati), *Sujhbujh* (Hindi), *Makhir* (Pahari), *Vhayan* (Bengali), *Inikarshakan Samsarikatte* (Malayalum) and *Amar Akha Pakha* (Oriya). In addition *Abeja* is published in the Spanish language. These different versions have editorial freedom but each version is expected to publish a significant portion (up to 60 percent) translated from other languages in order to facilitate cross cultural exchange of ideas and knowledge. The documentation details in *Hittalagida* since 1995 is given below:

Table: 17

Documentation Details in *Hittalagida*

Documentation Particulars	***No. of entries***
1. Indigenous methods of plant protection	144
2. Indigenous seed treatment methods	83
3. Animal husbandry and ethno veterinary practices.	133
4. Farmers' Innovations - equipment's and implements.	28
5. Indigenous methods of controlling vertebrate and invertebrate pests.	10
6. Biodiversity:-	
a) Local seeds varieties	**118**
b) plant varieties	**30**
c) traditional/native crops	**56**
7. Dry and wet land farming technologies.	27
8. Tribal agricultural systems - practices and customs.	2
9. Indigenous meteorological prediction methods	6
10. Indigenous/ traditional "institutions" - such as rituals, customs, proverbs, sacred grooves and community actions.	44
11. Review of literature on indigenous and traditional agriculture.	12
12. Native medicinal plants used in human health care.	113
13. Indigenous food items, native fruits and vegetables.	32
14. Bio-diversity contests, scouting of gross root innovations.	5
15. Scientific analysis and validation of indigenous technologies.	5
16. Indigenous crop production and organic farming methods	37
17 Native wisdom in every day farming.	101
18 Profiles of organic farmers	18
19 Traditional tools and equipments	7

To provide an institutional support to HBN, a society called SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions) was established in 1993. The Honey Bee data base of innovations and traditional knowledge associated with biological diversity contains more than 23,000 entries. The details are available in the home page: **http://www.sristi.org**. The HB Network is following various innovative methods such as agricultural fairs, *Shodhayatra* and bio-diversity contests for students for scouting and documentation.

Box: 11

Contest Involving School Children on Kitchen Garden Diversity

A contest by involving the students from eight high schools in the Western Ghats regions on kitchen garden diversity was conducted in 2001 in Karnataka. This has brought out the information and seed material of four thousands of local varieties conserved by the rural women along with the immense knowledge of bio-diversity among the rural students. More than 11,500 entries came from 232 students of eight schools in this contest. These entries were on five categories related to kitchen garden diversity. The categories are native vegetables (40 % of the total), flowers (22 %), fruits (20 %), medicinal plants (11 %) and others (7 %). On an average each students has the knowledge of 55 plants that are grown in the kitchen gardens of the western ghat region (Hittalagida, 2001). This contest was organized as a part of Using Agricultural Diversity Research Award of International Development Research Center (IDRC), Canada, implemented by South Asia Network on Food, Ecology and Culture (SANFEC) granted to Hittalagida Network in Karnataka.

The HB Network was instrumental in creating the GIAN ***(Grassroots Innovations Augmentation Network)*** an institutional mechanism to hasten the process of converting grass- root ideas and innovations in to a prototype, product and enterprise. The first GIAN established at Gujrat in 1997 has a tremendous experience of incubation support to grassroots technologies.

4.4.2. Community/ People's Biodiversity Registers (C/PBRs) are documents of people's knowledge of biodiversity and their perceptions about its usage, besides efforts for its conservation and sustainable utilization. These registers are compiled at the level of villages or *Panchayats.* The C/PBRs are aimed at providing the recognition and rewards to people and/ or villages, to implement their plans for the conservation of biodiversity with the protection of people's IPR. The C/PBR tries to promote the flow of information and benefit in an open and transparent fashion. The C/PBRs have been recognized as 'Local Biodiversity Chronicles' (LBC), as the basis for equitable access, benefit sharing and for 'prior art' while scrutinizing the application related to IPR applications under the Indian Biological Diversity Act 2000.

The Foundation of Revitalization of Local Health Traditions (FRLHT; www.frlht-india.org) launched a program in 1995 in this respect. Indian Institute of Sciences (IISc), Bangalore popularized it during 1996 to 98, with funding from World Wide Fund for Nature (WWF-India) under the Biodiversity Conservation Prioritization Project (BCPP). The IISc has coordinated a nationwide network involving 14 colleges, two universities, two schools and

13 NGOs. Some 350 researchers, 200 village youth assistants, 1000 knowledgeable villagers actively participated in data collection and compilation in 52 village clusters from 7 states, representing wide spectrum of ecological and socio-economic conditions in India. In Karnataka, NGOs like *Nagarika Seva* Trust and *Vruksha Laksh Andolana* are preparing registers in 100 villages, with partial government support. In western Karnataka, *Nagarika Seva* Trust is not only documenting the registers, but also supporting to revitalize the sacred grooves, *Naga vanas* and fish conservation ponds, by involving schools and educational institutions. The Center for Ecological Studies, IISc, Bangalore has planned for a Bio-diversity Information System along with massive involvement of ecologists, school and college teachers, students, NGOs and individuals to prepare 300 C/PBRs all over the country. For details contact website: http://ces.iisc.ernet.in/hpg/cesmg.

In Andhra Pradesh, the DDS is instrumental in the compilation of women driven agro biodiversity registers in 300 villages. The AP Coalition, in Defense of Biodiversity has played an active role in the preparation of more than 500 C/PBRs in the Kerala state. Similarly, in Kerala, 86 registers have been compiled by Kerala *Shastra Sahitya Parishad* under the government sponsored `People's Planning' Campaign for Decentralized governance'. Other NGOs like Gene Campaign, the GREEN Foundation and the MSSR Foundation are also promoting the C/PBRs in different parts of India.

4.4.3 Electronic Bulletins: Several electronic bulletins in recent days are effectively creating awareness and understandings about alternative/organic agriculture and policies on Indian agriculture as well as food security. Two such initiatives are ***The AgBioIndia bulletins*** **(http://www.agbioindia.org),** New Delhi and the ***Centre for Alternative Agricultural Media (CAAM)*** **(www.farmedia.org),** Dharwad, Karnataka**.**

4.5. Government R & D Initiatives:

The Govt. R & D institutions coming mainly under the Indian Council of Agricultural Research (ICAR) setup including the state agricultural universities are involved in the collection and *ex situ* conservation of Dom. Bd. since independence. The National Bureau of Plant Genetic Resources (NBPGR) and the National Bureau of Animal Genetic Resources (NBAGR) are two prominent institutions in this respect.

4.5.1. The National Bureau of Plant Genetic Resources (NBPGR) is an organization in the ICAR system, setup in the year 1976. This is a nodal organization in India to carry out planning, conducting, promoting, coordinating and leading all activities concerning the

collection, introduction, exchange, evaluation, documentation, conservation and sustainable management of domesticated biodiversity with a view to ensure their continuous availability for use of breeders and other researchers in the country. The Bureau functions from the headquarters in New Delhi, with a network of 11 regional stations/base centers spread over different phyto-geographical zones of the country. Indian National Plant Genetic Resource System operates through NBPGR with a strong linkage with 40 national active germplasm sites and 131 other cooperators. The activities of NBPGR can be categorized into exploration/collection, evaluation and finally conservation.

A. Exploration: The Primary step to *ex situ* conservation approach is exploration. The procedures are aimed at the comprehensive recovery of genetic variation available within the species, with no reference to the relative frequency of the genes. However, the exploration trips may be multi-crop or mono-crop oriented. Sufficient knowledge about the crop botany, taxonomy and agronomy is essential for successful explorations. Since inception, NBPGR has undertaken more than a thousand explorations and collected more than a lakh accessions thereby. The collections have been from all the phyto-geographical regions of the country covering all major & minor crops and their wild relatives. This was accomplished in collaboration with other ICAR Institutes, state agricultural universities, other organizations such as the Council of Scientific and Industrial Research (CSIR), the Department of Science and Technology (DST) and the NGOs. Additional emphasis is being given to the complete passport data as well as documentation of indigenous knowledge. Emergency explorations to rescue germplasm from the regions affected by natural calamities such as cyclone-hit areas of Orissa were also undertaken.

B. Evaluation: The germplasm evaluation is a chain of activities involving multiplication, characterization, actual evaluation and documentation of the germplasm collected. Evaluation of all major and minor crop groups is carried out by NBPGR. More than seventy such evaluation 'catalogues' have been prepared on a number of crops. More than 100 varieties across the range of crops evaluated have been released directly for cultivation.

C. Conservation: Conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present the generations, while maintaining its potential to meet the needs and aspirations of future generations. Conservation approaches of agro bio diversity are categorized, as discussed in the section 2.2.5, into two forms: on-site (*in situ*) and off-site (*ex situ*). The gene bank at NBPGR holds the fourth largest *ex situ* collection in the world with more than two lakh accessions, belonging to nearly 200 species

as *base collections* at -20°C. It has a capacity to hold more than a million accessions with laboratory facilities to carryout research activities. In addition, it has the capacity for 2.5 lakh cryo preserved materials, a cryo bank with holdings of nearly 1300 accession and an in vitro tissue culture bank with 867 accession capacity. The gene bank was established as an out come of FAO's agreement on International Undertaking of Plant Genetic Resources (IUPGR). The bureau at the later stage expanded to the Indian National Plant Genetic Resources System (IN –PGRS), comprising of 11 regional stations and 30 National Active Germplasm Sites (NAGS) located at different parts of the country. The five year mission mode project; *Jai Vijyan* National Science and Technology Mission was initiated to fulfill the obligation of conservation and sustainable use of agro biodiversity in accordance with CBD and other international agreements. The NBPGR follows all international norms for seed conservation and the monitoring of seed viability and health is on top priority.

- ***In vitro* conservation:** More than a thousand accessions belonging to tuber & bulb crops, spices & industrial plants, fruits, medicinal & aromatic plants have been conserved through this method by NBPGR.

- **Cryopreservation:** The NBPGR cryobank has the capacity to conserve more than 30,000 accessions. More than three thousand accessions, belonging to 140 genera have been cryopreserved. These include orthodox, intermediate and recalcitrant species. This required the development of successful protocols for the storage of seeds, embryonic axis, pollen, shoot tips and meristem cultures.

- **Field gene bank:** The NBPGR regional stations maintain the field gene bank of perennial crops belonging to their respective zones. Ranchi station has the field gene bank for tropical fruits like bael, palash, jamun, jackfruit, aonla etc; Jodhpur station maintains pomegranate, jojoba etc; Shimla operates as field gene bank for temperate fruits such as apple, almond, apricot etc. National Active Germplasm Sites, spread over the country maintain *active collections* under medium term storage at 4°C.

D. Exchange, Distribution and Transaction: The NBPGR is making all efforts to ensure that plant genetic resources of economic or social interest, particularly for agriculture are explored, preserved, evaluated and made available for public and scientific purposes. As on March 2001, the NBPGR has a total collection of 1,45,167 germplasm, belong to economically important agri-horticultural crops, through 1035 explorations

undertaken at different parts of India. Such a large collection enabled the NBPGR to distribute the genetic materials internally and exchange from other countries. During the past 25 years, the NBPGR exported 76,566 accessions of different agricultural and horticultural crops to 85 countries. This includes cereals, pulses, oilseeds and other pseudo cereals. The rice with 26,229 accessions is the single largest crop genetic resource exported during this period. In exchange, on reciprocal basis, India imported a huge 16.66 million samples of seed/planting materials from 125 countries across the world. Some of the new crops imported in this background are the kiwi fruit (from New Zealand), sugar beet (from EU), buffalo guard and soybean (from USA), sunflower (from Russia) and winged bean (Indonesia). During the same period, 3,12,822 samples have been supplied to the internal users in different government R & D institutions, state agricultural universities, private seed companies, NGOs and progressive farmers. Within that almost 60 percent forms wheat and remaining crops include rice (13,679 accession), barley, minor millets, pulses, oilseeds, fiber crops, fruits, vegetables and so on (Dhillon et. al., 2001).

E. *In situ* conservation: In fact, it is only in the recent past that the Government R & D institutions have realized the importance of *in situ* conservation as complimentary to the *ex situ* conservation of agro biodiversity and some initiatives have been undertaken in India. For instance, the Government of India has established a citrus gene sanctuary in Garo Hills of Meghalaya for *in situ* conservation of both wild as well as domesticated citrus species. The NBPGR has identified 14 such sanctuaries in different parts of India. Even the international research bodies like the International Crop Research Institute for Semi Arid Tropics (ICRISAT) is attempting to maintain genetic resource on farm in a limited way in south India.

4.5.2. The National Bureau of Animal Genetic Resource (NBAGR) at Karnal Haryana is focusing on the conservation of native breeds of livestock and poultry germplasm in country. A separate bureau for fish genetic resources exists at Lucknow. National research centers for Camel (Bikaner, Rajasthan), for Mithun (Jharnapani, Nagaland) and for Yak (Arunachala Pradesh) are also established for conservation purposes in different parts of the country.

4.5.3. The National Innovation Foundation of India (NIF) was established in March 2000 by the Department of Science and Technology, Government of India. The main objectives are to recognize and promote grassroots innovations and biological diversity, conserved by farmers, women, indigenous communities and other disadvantaged sections

of society. It is, in a way, a culmination of decade long experiments of the Honey Bee Network and provides an institutional framework at the national level to spread its philosophy. In addition to unaided grassroots green technologies, the NIF is also recognizing and promoting the innovations of new crop varieties by farmers and communities. It aims at the development of a National Register and a database of innovators and to link local innovators with science and technology experts in both public as well as private sectors.

To accomplish its objectives, the NIF is conducting an annual national competition to scout and honor grassroots 'green' innovators. In its first competition, the NIF has received about 1000 entries from all over the country, containing more than 1600 examples of grass root innovations, traditional knowledge based innovations and innovations of plant varieties. Out of which, 22 innovators have received national awards and 11 were conferred with the state awards. In addition, two students awards, 11 special consolation and 22 consolation awards were given at a function held during November 2002 at New Delhi. For the second competition, 6228 entries, having 13,533 innovations were received. The NIF's second awards function was held on December 17-18, 2002 at New Delhi and the Hon'ble President of India, Dr. Abdual Kalam conferred the awards. The NIF gives awards in seven categories: plant variety, farm implement & general machineries, energy, livestock management, agricultural practice, idea and community knowledge with attractive cash prizes of Rs. one lakh for the I prize, Rs 50,000 and Rs. 25,000 for the II and the III respectively. Awards given for innovations of crop varieties in the I and II national competitions are given below:

Table: 18

NIF Awards for Crop Variety Innovations (I COMPETITION)

Sl. No.	***Name of the Innovator***	***Innovation***	***Prizre***	***State***
1.	Mr. Rejimon Joseph and Mr. Sebastain Josph	**Cardamom variety – *Njallani***	First	Kerala
2.	Mr. C. Rajendran	**Paddy variety – *"Chinna Ponni"***	Second	Tamil Nadu
3.	Mr. D. Punjabhai Patil	**Pigeon pea – *G.D.P.-1***	Third	Gujarat
4.	Prof. P.R Krishna Prasad	**Perennial Brinjal with round the year fruiting**	Consolation	Karnataka
5.	Mr. T.M.C Antony	**New Nutmug Variety**	Consolation	Kerala
6.	Mr. Jose Madhavath	**Propagation in Pepper**	Consolation	Kerala
7	Mr. K.R. Duraiswamy	**Crossing in Coconut**	Consolation	Tamil Nadu
8.	Mr. R.B. Harkhani	**Grafting in Lemon**	Consolation	Gujarat
9.	Mr. Roy Scaria	**High Yielding Plantain**	Consolation	Kerala
10	Mr. L.R. Murani	**New Sesamum variety – *Adarsha – 8***	Consolation	Gujarat

11	Mr. Lingamadaiah	**An unique paddy variety – *Mysore Mallige***	First	Karnataka
12.	Mr. Abraham Mathew	**Nutmug variety with larger and heavier fruits**	Second	Kerala
13	Mr. Harishchandra Shetty	**Latexless Jack fruit – *Sompady Jackfruit***	Third	Karnataka
14.	Mr. Narayana Bhat	**Dwarf High Yielding Arecanut variety**	Consolation	Karnataka
15.	Mr. Jay Prakash Singh	**New Rice, Wheat and Pigeon Pea varieties**	Consolation	Uttara Pradesh
16.	Mr. J.K. Patel	**Hyacinth Bean Variety**	Consolation	Gujarat
17.	Mr. Alibhai Abhvani	**Chilli Variety – *Resham Patto***	Consolation	Gujarat

There is also an award category for the scouts who help to discover these innovators. The Honey Bee network is playing a very important role in this respect and the ***Hittalagida Network*** has received the First scout prize for scouting such significant innovations in the II national competition.

The NIF is actively promoting GIANs ***(Grassroots Innovations Augmentation Networks)*** in different parts of India. It has already set up GIAN-North, GIAN-North East and expanding the scope of GIAN-Gujarat to Maharastra and Goa.

Prior Informed Consent: NIF is committed to protect the IPRs of each innovator and traditional knowledge holder and thus would abide by the innovator's opinion. Once an entry is found to fulfill the initial criteria of inclusion in the database, NIF would send a consent form to all the innovators specifically to seek their written consent and choice of conditions for dissemination of their product/process/idea. NIF will strictly follow the condition advised by the innovator. The innovators must decide whether they would like to disclose their innovations to others or not, and if so whether with any restriction or without restrictions. The consent form is being improved to facilitate this process. An innovator may decide among various options for scaling up of technology through commercial, or non-commercial means. The form will provide a model of benefit sharing among five stakeholders, that is innovator, his/her community, innovator's fund, research and development professionals or institutions which add value to innovation and the institution, which facilitate the whole value chain. The innovators can indicate their agreement with the suggested terms of shares of various stakeholders, or indicate preference for alternatives terms. This would be a major experiment on a countrywide scale for getting prior informed consent from every knowledge provider.

4.6. Government Policies and Programs

As mentioned in the section earlier the policies and programs of Governments, related to agriculture, horticulture and livestock are biased more towards HYVs of crops or cross breeds in livestock in India. The stage/year wise evolution of the institutions, policies and programs in this respect is given below:

4.6.1 Pre – Independence Era

A. **Institute of Agricultural Research (1905):** By recognizing the need for new and improved methods of cultivation, the Colonial British rulers established this institute at Pusa Bihar.

B. **Royal Commission on Agriculture (1928)** provided a firm foundation for coordinated research and effective administration in agriculture.

C. **Indian Council of Agriculture (1929)** is the outcome of the recommendation of the Royal Commission on Agriculture.

4.6.2 Post -Independent Era

A. **Grow More Food Campaign (1952)** aimed at the attainment of self-sufficiency in food grains and meet the shortfall in other agricultural commodities as a result of partition of the country.

B. **Grow More Food Enquiry Committee Report (1952)** prescribed to establish "community development projects".

C. **National Extension Service** system was established on October, 2 1953.

D. ***Panchyati Raj*** **System (1958)** was introduced as per the recommendation of *Balwant Raj* Mehata committee to encourage the participation of people and develop rural leadership to involve actively in the rural reconstruction and agricultural development programs.

4.6.3 Post Green Revolution Era

A. **Agricultural Universities** were established in order to accomplish trio objectives - agricultural education, research and extension in different states of free India. The *Govinda Ballabh Pant* University of Agricultural Science and Technology at Pantnagar, Uttara Pradesh was the first such university established in the year 1960.

B. **Intensive Agricultural District Program (1960)** also called as the "package program" was aimed at the promotion of new technology adoption by ensuring the availability of credit, markets and inputs in selected districts having assured irrigation facilities.

C. **High Yielding Varieties Program (1970-71)** aimed at the spread of HYVs in wheat, paddy, maize, sorghum and bajra in selected 100 districts to begin with. Later, the program was spread to other areas and crops also

D. **Command Area Development Program (1974)** was an integrated area development program taken up in selected irrigation commands of various states.

4.6.4. Livestock Policy

The earliest attempt to evolve a set of policy directives for livestock development was undertaken by the Royal Commission on Agriculture. The breeding strategies over the years in a sense reflected the overall policy objectives set out through the five year plans . The livestock development policies have been focusing mainly on increasing the milk production and supplying it to the urban centers. Though the breeding policy during the first two five year plans were aimed at producing a population of dual purpose milk and draught animals, there was no operational plan/scheme to improve the quality of draught and dual purpose animals. However, there was a clear shift in the breeding strategy from the third 5 year plan (1961-66), with emphasis on developing crossbred cattle for increasing the production of milk. During the V five-year plan (1974-79), there was a comprehensive review of the livestock sector by the National Agriculture Commission, which came up with an assessment of the problems and the prospects of animal husbandry in India.

In this way, the focus of policies and programs of the government of India till recently was more on the promotion of HYVs of crops and crossbreeds in livestock. However, in the recent years, there is some policy shift to encourage conservation and the use of dom. bd in India. The National Agricultural Policy, (NAP) 2001 is one such important policies.

4.6.5. The National Agricultural Policy (NAP), 2001

It was formulated by Ministry of Agriculture, Government of India and states to attain over the next two decades "a growth rate of four percent excess in agriculture based on efficient use of resources and conservation of soil, water and bio-diversity, that is sustainable technologically, environmentally and economically"**.** The very first chapter is devoted for the sustainable agriculture with abiding importance on improvement of land resources, watershed development and the development of rain fed agriculture which occupies almost two third of our country's cropped area. A more focused reference on Dom. Bd. is found in paragraph 9 of the NAP, which states that "erosion and narrowing of the base of India's plant and animal genetic resources in the last few decades has been affecting the food security of the country". Few strategies envisaged under NAP to achieve the goal are:

a) Survey and evaluation of genetic resources and safe conservation of both indigenous and exogenously introduced genetic variability in crop plants, animals and their wild relatives will receive particular attention. A time bound program to list, catalogue and classify country's vast agro-diversity is mentioned.

b) Sensitization of the farming community for balanced and conjunctive use of biomass, organic and inorganic fertilizers, to follow integrated nutrients and pest management (INM &

IPM) and proper on farm water management.

c) Encouraging the farmers to participate in community management of irrigation and to take up farm and agro-forestry. Landless laborers in addition to farmers are also involved to develop pastures/forestry program on public waste lands by giving financial incentives and entitlement to the usufruct of trees and pastures.

d) Equal importance is also accorded for the conservation of traditional knowledge of farmers and the tribal communities. In this respect, the policy document intends to make a concerted effort to "pool, distill and evaluate traditional practices, knowledge and wisdom and to harness them for sustainable agricultural growth."

The policy document has also focused on the "maximization of benefits from exports of agricultural products in the face of the challenges arising from economic liberalization and globalization**"**. In this respect, focus made on two issues merits careful attention. They are: (a) the use of bio-technology to evolve new resistant varieties and food crops (i.e. genetically modified crops) with higher nutritional values while addressing the bio-safety measures. And, (b) development of 'lease market' and 'contract farming' for land to increase the size of the holding, making provision for cultivation for agri-business purposes and encourage private sector participation for accelerated technology transfer, capital inflow and assured market (paras 35 & 37). Over emphasis on these programs may dilute and eventually sideline the concerns expressed on the issues related domesticated bio-diversity in the earlier chapters of NAP. Hence, a careful and balanced approach is required in this regard.

4.6.6. Current Policies on Bio-diversity and Plant Varieties:

The genetic resources were considered as the "Heritage of Mankind" in the earlier days. However, the dawn of 21st century has seen a paradigm shift; due to several global agreements such as the 'Convention on Biological Diversity' (CBD), the 'International undertaking on Plant Genetic Resources' (IUPGR) and the GATT, in the whole thinking and approach on the transaction and exchange of plant genetic resources.

A. **The Convention on Biological Diversity (CBD)** which reaffirms the national sovereignty over the PGRs has helped to establish the 'state ownership' in the place of open access (free heritage of mankind) over the (PGRs). The CBD stresses upon the importance of *in situ* conservation of PGR and recognizes the role of indigenous and local communities in developing, preserving and maintaining knowledge, innovations and practices embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity. The CBD advocates for a 'prior informed consent' and mutually agreed terms and conditions while making use of the PGR. This has to ensure an equitable sharing of not only monetary benefits but also the

benefits of research and development from the use of PGRs between conservers and the users. The CBD empowers the state to effectively own and undertake exchange, distribution and transaction of PGR so as to get a fair return to the primary stake holders who conserve it. The sovereign right to state over the PGR may help to address the issue of improper property rights to some extent. However, in a country like India, agro diversity is being conserved by farmers, women and indigenous communities, and hence, assigning the property rights to them is very essential.

B. The International undertaking on Plant Genetic Resources (IUPGR) has sought to consider the issue of access to PGR on mutually agreed terms, including the *ex situ* conservation, which was not addressed adequately by CBD. Very importantly, it raised the issue of Farmer's Right, Plant Breeder's Right and benefit sharing while giving a clear focus on the conservation and sustainable use of agro biodiversity. There is also a concern expressed here to ensure that the IPR system is supportive of and not counter to the spirit of CBD (Gautam et. al., 2000).

The signing of GATT and subsequent creation WTO has compelled the Govt. of India to come out with an effective sui generic system to protect the interests of plant breeders in India. The CBD and IUPGR together on the other hand, have provided the guidelines to enact rules, regulations and laws so that its authority over PGR is upheld. In this way, agro biodiversity has become a core component of the national biodiversity conservation and legislation program in India. In response to these developments, two important acts were framed recently in India. They are the National Biodiversity Act 2000 and Plant Variety Protection and Farmers' Rights Act 2001.

C. The Biological Diversity Act (BDA) 2000: is a part of Government of India's follow up to the international Convention on Biological Diversity. The Act regulates access, transfer and IPRs over the PGRs, along with deciding the fees and royalty. There is also sufficient focus on the issues related to equitable sharing of benefit from the use of PGRs on a mutually agreed terms and conditions between the users and conservers or benefit claimers. It provides a platform for the sharing of benefits through various ways, which includes transfer of money or technology, joint R & D, the IPR ownership and creation of the venture capital fund. The act envisages the creation of biodiversity fund at local, state and national levels to be utilized for the conservation of PGR and sharing of benefits with the conservers. Here, every proposal for transfer of PGR abroad will have to be screened before granting the permission for such a

transaction.

Box: 12

The Biological Diversity Act (BDA), 2000

For implementation purposes, the BDA 2000 provides for a National Biodiversity Authority, which consists of both government and non-government members. This will be situated at Chennai, South India. At the state level there will be a State Biodiversity Board to oversea the use and conservation of biodiversity. At local levels, Biodiversity Management Committees will have the role to regulate the transfer, use and conservation of PGR as well as the knowledge associated with it at the individual and community levels.

As the NBPGR is the largest *ex situ* conserver of agro biodiversity in the world, the BDA - 2200 provides an institutional framework for the 'lawful' transaction of the PGR in India. The 'lawful' transaction, from the point of view of natural resource economics, may not always be an efficient transaction. However, the BD Act 2000 is more concerned with the conservation and sustainable use of the PGR and not its commercial exploitation. As millions of dry land farmers, women and indigenous communities are involved in the conservation of agro-diversity, a fair and equitable transfer of benefits arising out of its utilization is an equity obligation which is also crucial for India. This involves issues related to Farmers' Rights and IPR, which are addressed under another act; the Plant Variety Protection and Farmers' Rights Act, 2001 passed recently in India.

D. Plant Variety Protection and Farmers' Right (PVP FR) Act 2001: Indian parliament has passed this act in order to fulfill the commitments made in the agreement on TRIPS under WTO. It is intended to come out with an 'effective' *sui generis* legislation to protect the interests of those who either evolve or contribute to evolve a new plant variety in India. It's main purpose is to ensure the protection of the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new varieties. In this respect, it is also intended to protect plant breeders' right to stimulate investment for research and development, both in private and public sectors for the development of new varieties. The Act is supposed to facilitate the growth of the seed industry and ensure the availability of high quality seeds and planting material to farmers.

Box: 13

Plant Variety Protection and Farmers' Right Act 2001

The Act envisages for the establishment of an Authority to Protect Plant Varieties and Farmers' Rights, an Appellate Tribunal for Plant Varieties Protection. This also defines the rights of farmers and breeders, elaborates methods for registration of plant varieties and essentially derived varieties, methods of sharing of benefits and procedures to deal with infringements, offences and penalties, which may arise in the execution of the said Act.

The Trade Related Intellectual Property Rights (TRIPS) in the matters related to the protection of new plant varieties, espouse the sprit of private property rights as envisaged by the Europe based Union for the Protection of (new) Plant Varieties (UPOV) convention. Under the 1991 UPOV convention, not only exclusive property (patent), known as the Plant Breeder's Right was upheld but it was also extended to the seeds saved and used on the farms (what is known as farmer's privilege). This in essence, discounted the contribution of farmer not only as a 'breeders' but also as the conservers of PGR. This attracted the wrath of the peasant organizations, NGOs and other sections of the civil society in India, in response of which the present PVP & FR Act was evolved accordingly. Though the attempt to define and synergies the relationship between the CBD and the UPOV is going on, the apparent contradiction between these two in the area related to the property rights on the PGR still persists. As discussed earlier, the main focus of the CBD is the conservation and use of PGR, which envisages the state ownership on the PGR where as, the UPOV's focus is only on the varieties evolved by the use the PGR, for which, it's emphasis is on the exclusive private property rights. Though the PVP & FR Act could not address these contradictions, its focus is weighed more towards the conservation and benefit sharing aspects of the CBD rather than encouraging the 'private profitability' motives of UPOV in the use of PGR. In sum, the PVP & FR Act has to offer more for *in situ* conservation rather than to the ex Situ,.

The PVP&FR Act intends to uphold the 'rights' of the farmers and communities who conserve the agro biodiversity. This act also provides a mechanism for sharing of benefits from the use of PGR indirectly through a 'gene fund'. Through breeders rights, it ultimately facilitates for the commercial production and supply of HYVs of seeds to benefit the farmers of India. The envisaged 'farmers' rights' on the other hand also encourages the breeding and crop improvements at the farmers level and facilitates for the supply of 'farmers' varieties also. The cases of *Mysoremallige,* a farmer's paddy variety which is popular in Karnataka (see Box 6) may became prominent under this act.

E. The World Trade Organization (WTO)'s Agreement on Agriculture: Its disciplinary Clauses along with the structural adjustment policies initiated by the government may compel India to reduce/remove the distortionary subsidies and supports given to HYVs. Its GREEN Box provisions, on the other hand, may be useful to support the *in situ* conservation of agro biodiversity in India. This provides, what is commonly referred under WTO discourse, 'the level playing ground' for local/farmers' varieties with the HYVs.

V. PROPOSED STRATEGY AND ACTION PLAN

Based on the various issues addressed, threats falling on dom. bd., major initiatives by the stake holders and the gaps noticed in this regard, the following **STRATEGIES AND ACTION PLANS (SAPs)** are identified to conserve and use Dom. Bd in an equitable and sustainable way in India. In addition, key recommendations emerged in various workshops and seminars such as NAAS – NBPGR workshop (1997), International Conference on ***Ethno-veterinary Medicine Alternative for Livestock Development,*** held in Pune (1997) and other occasions are also considered.

The action plans are categorized as ***immediate to short term*** (to be achieved with in two years), ***medium term*** (with in 5 years) and ***long-term*** (up to 10 years) based on the **time period** and the ***policy, program, building of institution, R&D efforts*** and ***other means*** based on the **mode of achieving a particular action plan. Responsibilities** are assigned to the ***government, R&D institutions, NGOs*** and ***others*** to implement a specific action plan. The SAPs are designed so as to integrate domesticated biodiversity with agricultural productivity, household security and the livelihoods of farmers/pastorlists and other grassroots communities, depending on dom. bd.

STRATEGY 1

COLLECTIVE EFFORTS TO ENHANCE THE ACCESS OF PRIMARY STAKE HOLDERS, ESPECIALLY OF WOMEN, TO LIVELIHOOD SOURCES:

The primary stakeholders, due to their low socio-economic status are individually weak in ' bargaining'. Hence, collective actions are very crucial to enhance the capability of the primary stakeholders to conserve and derive the full benefits of the conservation to achieve food and livelihood security objectives in a sustainable way.

Action 1: **Strengthen and Extend Ongoing Initiatives:**

- Such as *Community Grain and Gene Fund* program of DDS Hyderabad, *Seed Sangha* of GREEN Foundation Bangalore and *Beej Bahao Andolan***,** Garhwal.
- A **General Guideline and Action Plan**' to strengthen and extend such initiatives in other places to undertake similar initiatives are needed.
- Identify/recognize NGOs/partners in other places.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Institution	Government (central) Ministry of agriculture with the support of the NGOs like DDS and GREEN Foundation

Action 2: **Encourage Women's Co-Operatives:**

- To conserve and exchange Dom. Bd
- Consolidation of fragmented holdings to promote women's co-operatives. Distribute surplus land to woman and promote co-operatives in the agro biodiversity rich regions.
- Co-operatives can be encouraged on region specific local crops / verities which merit special attention from the point of view of conservation, as mentioned in section 2.2.3.
- Involve women's groups such as Self-help groups (e.g. *Mahila Samakhya* in Uttaranchal which is working with *Beej Bachao Andolan*) to conserve agro biodiversity collectively.

- Special subsidy, technology, credit and incentive packages exclusively for the women's co- operatives promoting agro biodiversity.

Action Plan

Time period,	*Mode*	*Responsibilities*
Immediate to Short run	Policy followed by institution	Ministry of Agriculture (central) With key NGOs

Action 3: **Extension Through Women Workers:**

- Who are drawn preferably from within the community.
- This will help to empower through information, knowledge and technologies.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program	Government (state)/Agriculture Department

Action 4 : **Plant Multi Purpose Tree Species:**

- in the avenue sides and other 'common pool' lands.
- Like jack fruit other species that serve the purposes of fuel wood, fodder, food and **Give** Usufruct (*Patta*) Rights to Women and Poor**.**
- This can be ideally taken up in the Western Ghats and the Coastal regions of South India.
- State forest departments to multiply and supply in a large scale, such tree species.
- Karnataka Forest Department has planned a massive river and canal beds afforestation program, which can be ideally made use to enhance the access and achieve the food security of the poor in the locality.

Action Plan

Time period	*Mode*	*Responsibilities*
Long term	Program followed by Policy	Government (State) – Departments of Forestry and Revenue jointly

STRATEGY 2
INSITU CONSERVATION, IMPROVEMENT AND EXCHANGE:

An elaborate arrangement to in situ conservation along with participatory crop improvement for the direct exchange of plant genetic materials among farmers/communities themselves is required. The in situ conservation is very

consistent with equity, security and cultural values, associated with Dom. Bd Further improvement and exchange of the genetic resources needs to be undertaken with active involvement of the primary stakeholders who conserve them.

Action 1: **National Action Plan for Participatory *in situ* Conservation and Development:**

- Along the lines of the FAO's Global Plan of Action for Plant Genetic Resources for Food and agriculture.
- Training and orientation to extension agents and NGOs on participatory variety improvement, selection and breeding, involving the individual farmers and communities.
- Evolve a mechanism to involve women, while taking the decision about the selection of crops and varieties for participatory breeding.
- Orient the *Krishi Vigyan Kendras* for this purpose and link them to relevant NGOs and community organizations (e.g. DDS Hyderabad).
- **A National Level Workshop** to start with, where farmers and communities doing innovative works along these lines are given a prominent place.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program	NGOs with R&D Institutions like NBPGR /NBAGR

Action 2: A 'Controlled' In situ Conservation System:

- For varieties endangered by extinction.
- In a specific land area for each variety by involving selected farmers
- Farmers should be compensated for the yield or monetary loss in cultivating the endangered variety.
- Through a flexible and self-targeting market incentive mechanism as discussed in section 2.2.5.
- Can be attempted first in rice for such unique varieties having medicinal properties.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program	NBPGR/SAUs along with State Dept. of Agril and key NGOs

Action 3: **Develop Agri. Diversity Catalogs:**

- Which include crops to be conserved *in situ* in different parts of the country along with their special features, consumptive/use values and other non-marketed benefits.
- Associated 'informal knowledge and technology system' must be given a special attention in this respect.
- Catalogs suitable to different agro ecological regions and socio cultural communities need to be developed.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program	NGOs with R&D Institutions – ICAR, IVRI and SAUs

Action 4: **Create Agri Diversity Exchange System:**

- To facilitate the exchange of genetic materials along with crop improvement techniques and associated informal knowledge systems.
- Among innovative farmers and communities so that they can learn from each other.
- Encouraging *Seed Fairs/Melas* and Creating a Website on all initiatives, both formal and informal, to conserver agri diversity in India.
- Farmers and communities need to be empowered to exercise control over exchange and use of genetic resources.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program and Policy	NGOs with State Govt. – Department of Agriculture/Horticulture

STRATEGY 3
INTEGRATING DOM. BDCONCERNS INTO FOREST AND ENVIRONMENTAL POLICIES:

Policies and programs related to forestry and environment have not given adequate emphasis on Dom. Bd. There are several mutually supportive linkages, as discussed in the section 2.2.1, among forestry, environment and Dom. Bd. In order to strengthen these linkages, it is necessary to integrate Dom. Bd concerns into forest and environmental policies and programs.

***Action 1: A* National Action Plan on Underutilized/Wild Food Crops:**

- To undertake research, documentation, conservation, use and exchange by giving priority to specific locations, like Himalayas and Western Ghats regions.
- **An Interactive Workshop,** to begin with to sensitize ongoing initiatives such as; *The All India Coordinated Research Project on Under utilized and Unexploited Plants* of ICAR so as to address the equity, gender and sustainability concerns.

Action Plan

Time period,	*Mode*	*Responsibilities*
Immediate to Short term	Program	NGOs with Ministry of Forest & Environment, ICAR

***Action 2:* Promoting the Domestic Cultivation of Wild Relatives:**

- Wild foods, vegetables, fruits, medicinal plants, ornamental plants like orchids initially in the surrounding kitchen garden / homestead farms of the region.
- Initial focus can given to the cultivation of wild relatives of food crops around Western Ghats forestry region.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium	Program	State Agriculture/Horticulture together

***Action 3:* A National Action Plan for Tribal/Forest dwellers' Agriculture:**

- To undertake a detailed documentation of agriculture of tribal/forest dwellers along with the associated indigenous knowledge and technology system in its cultural and ecological contexts.
- To give more attention to *in situ* conservation of agro biodiversity in sensitive regions such as Western Ghats, Himalayan regions, NE regions, Andaman, Nikobar and other islands.
- Equal focus on *jhum* or shifting agriculture so as to retain its positive aspects on agro biodiversity and cultural sensitivity, while tackling the negative side.
- To suggest reforms in forest policy/laws so as to protect the livelihoods of tribal/forest dwelling agricultural communities.
- A National Level Workshop to start with.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	NGOs with Ministry of Forest & Environment, ICAR and SAUs

Action 4: **Include Tested Herbal Healing Practices in Health Care Delivery:**

- For both human and animal primary health care systems
- Training and orientation of govt. health staff, community health workers in utilization of medicinal plants.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	Ministry of Health and Agriculture (Central) along with State Health Departments and NGOs

STRATEGY 4

PROTECTION AND PROMOTION OF NATIVE APICULTURE:

Native honeybees symbolize a perfect interface among agro biodiversity, forestry and ecosystem diversity. In spite of this, the native apiculture did not find the place it deserves in the polices and programs aimed at the development of the sectors mentioned above. Hence a separate strategy to protect and promote the native apiculture is required.

Action 1: **Maintain the Native Strains in Pure Form:**

- like *Apis cerana*, without any contamination.
- Strict control against the introduced exotic species, such as *Apis mellifera*, which are suspected to cause diseases such as Thisac brood on our native strains.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	R&D followed by Program	Ministry of Forestry and Environment (Central) along with State Govts. and SAUs

Action 2: **Large Scale Promotion of Apiculture:**

- In both rural as well as urban areas at the locations suitable for beekeeping in India (given in the Appendix VI)
- Supply beehives through public as well as private bee nurseries.
- Co-operative initiatives such as the ***Karnataka Beekeepers Associations*** must find special attention in this respect.
- Demonstration apiaries to be setup followed by promotional activities in non-traditional but potential areas.
- **Shifting the responsibility** of promotion of apiculture from Dept. of Industry & Commerce to Depts. of Forestry/Agriculture/Horticulture.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program and institution	Ministry of Forestry and Environment (Central) along with State Govts. and SAUs

Action 3: **Training youths from tribal and forest dwelling communities:**

- To promote apiculture.
- To take up apiculture as a small-scale enterprise.
- This must be followed by adequate financial support.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	Ministry of Forestry and Environment (Central) along with State Govts.

Action 4: **Large Scale Planting of 'bee trees':**

- While taking up forestation programs both in rural as well as urban areas.
- Adjacent to water bodies including tanks, riverbeds, dams and command areas, which holds water perennially must find a special attention in this regard.

Action Plan

Time period,	***Mode***	***Responsibilities***
Long term	Program	Ministry of Forestry and Environment (Central) along with State Forest Deportments

STRATEGY 5

AGRO ECOSYSTEM BASED PLANNING AND DEVELOPMENT:

Agro ecosystem based planning helps to harmonize conservation values with those economic issues that may arise while conserving and using of dom. bd.

Action 1: **Agro Ecosystem Based Crop and Livestock Planning:**

- Watersheds can be taken as an ideal unit for planning and development.
- The responsibility of planning of natural resources, including CPRs should be assigned to *Gram Sabhas*
- The customary rights of indigenous communities such as *adivasi* on natural resources and CPR should be ensured.
- Local varieties and breeds need to be incorporated into farming systems under watershed development.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Program and Policy	State Department of Agriculture and Forestry

Action 2: **Assign Top Priority to Land Care and Management Systems:**

- Conserve prime farmlands for agriculture by protecting them from conversion to other uses, often for short-term gains.
- Prevent the loss of the biological potential of the soil (desertification) by taking effective measures to check the different kinds of soil erosion.
- Restore the degraded land by providing incentives, based on agro forestry and other arable practices.

Action Plan

Time period,	*Mode*	*Responsibilities*
Long term	Policy and Program	State Department of Agriculture and Revenue Department to prevent conversion

Action 3: **Treat Water As a Social Resource:**

- Develop strong public policies for regulation of water use; especially surface and ground water uses.
- Improve traditional rainwater harvest and underground storage methods.
- Support sprinkler and drip irrigation to improve water use efficiency. Adopt conjunctive use of surface and ground waters for irrigation (ensuring thereby more crop for every drop).
- Provide incentives for recycling of rainwater and home-used (waste) waters by developing and enforcing building by laws for compulsory provision for this purpose.

Action Plan

Time period,	*Mode*	*Responsibilities*
Immediate to Short term	Policy and Program	Ministry of Forestry and Environment , Water Resources (Central) along with State Govts.

Action 4: **Conserve Living Aquatic Resources:**

- Restoration of tanks for multiple uses in South India.
- Regulate the land use in coastal areas.

Action Plan

Time period,	*Mode*	*Responsibilities*
Medium term	Policy and Program	Ministry of Forestry and Environment (Central) along with State Govts.

Action 5: **Research to Anticipate the Likely Consequences of Climate Change**

- Especially on Agriculture.
- Explore the funding source to undertake systematic research.
- Evolve mechanisms for coping with them.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	R & D	ICAR and other R & D institutions along With SAUs

STRATEGY 6

CONSERVATION OF ANIMAL GENETIC RESOURCES:

As mentioned in the section 2.2.3, the indigenous livestock breeds are more vulnerable to reach the 'critical' stage/number below which, if population falls, the restoration is impossible. Keeping these in view, the following general actions are suggested to conserve animal genetic resources in India.

Action 1: **Systematic Survey and Assessment of the Indigenous Livestock Breeds:**

- Focusing more on undefined / unrecognized local breeds.
- These breeds have to be defined according to a set of standards and the genetic characteristics need to be documented accordingly.
- Assess the Safe Minimum Level of Population as per the FAO guidelines mentioned above
- A data bank with periodic updating and publications is required. The information should form part of an integrated and ongoing exercise

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program and R & D	IVRI/NBAGR along with State Veterinary Colleges/Department and NGOs

Action 2: **Ensuring of Pure Lines and Conservation:**

- Ensuring of pure lines of local cattle breeds - keep track of 'true' herd populations as some breeds are dispersed and migrating.
- Prevent the loss of valuable germplasm, due to chronic droughts.
- Ensure the collection and preservation of good quality semen and embryo.

- Take up conservation well before they reach 'critical stage'. Both *in situ* and *ex situ* conservation are essential. Conserve germplasm in the form of semen and embryos as well as preserve live animals by looking into the severity of their survival.
- Periodic assessment of the impacts of uncontrolled cross-breeding of local breeds with exotics.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	R & D and Program	IVRI/NBAGR along with State Veterinary Colleges/Department and NGOs

Action 3: **Periodic Monitoring of Threatened Breeds**

- like *Ponganur, Vechur, Ongole , Amrithmahal and Krishna valley* cattle breeds.
- Monitoring in this respect should cover the following items:

  a) population size;

  b) characteristics -performance and genetic;

  c) status of conservation;

  d) efficacy of management of existing breeding farms.

  e) exotic levels used in crossbreeding;

  f) status of common grazing land;

  g) Indigenous knowledge associated with livestock breeding and

  h) Special features like use of Amrihmahal cattle milk for gastritis treatment.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	State Veterinary Colleges/Department and NGOs

Action 4: **Increased Role for Developmental Agencies like NABARD:**

- In supplying credit for research and multiplication of pure breeds.
- To facilitate inter- disciplinary /departmental interactions with regular training and orientations.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	NABARD with State Governments

STRATEGY 7

SPECIFIC LIVESTOCK BREEDING PRPGRAMS:

A livestock breed improvement program must help to conserve and make the breed fit well to the local climate, cultural and economic conditions. Multi-purpose breeding rather than a specialized single purpose breeding (as practiced in the developed countries) should be followed in our country. The breeding strategy must complement the multipurpose farming systems, in which livestock, crop and tree production are integrated to produce food, fiber, energy, fuel and wood while maintaining the soil fertility and overall sustainability of the system.

Action 1: **Promote Herd Societies:**

- Herd Society can play a major role in the breed improvement. Farmers, labors**,** women and local NGOs could together participate in these societies.
- This can act as an agency for monitoring all activities relating to a particular breed including genetic improvement, conducting cattle shows, identifying the areas of research and to act as a liaison between Government, research institutions, organized farms and the farmers.

Action 2: **Selective Breeding to Meet the Desired Goals of Farmers and Communities:**

- This could be for milk, draught or dual purpose in cattle.
- Ssuitable for specific agro ecological tracts particularly in the dry and arid tracts.
- Meet the needs of poor and marginal farmers to have improved draught power.
- Involve farmers, labors, women, pastoralites and local NGOs

Action 3: **For Small Ruminants**

- Follow "Open Nucleus Group Breeding" program with all required facilities and controlled management.
- Involve the local community.

Action 4: **For Poultry** –

- Improved village-level disease management strategies should be developed that will reduce mortality and rebuild valuable populations of poultry breeds.

- Location specific programmes to conserve and popularise the indigenous breeds like *Aseel, Kadakanth, Chittagang, Maly* and other breeds in different parts of India.
- As Bangalore weather is best suited for the conservation of poultry breeds, existing Central Poultry Training Institute and Veterinary college at Bangalore can be upgraded for this purpose.
- Follow ex-situ conservation and multiplication of indigenous breeds and distribute them to farmers, NGOs and others in different parts in India.

Action Plans for 1 to 4

Time period,	***Mode***	***Responsibilities***
Medium term	R & D and program	IVRI, NDRI, State Govts Veterinary Colleges and NGOs

Action 5: **For Canine**

- Conserve indigenous dog breeds such as ***Rampur, Mudhol*** and Himalayan breed.
- Strengthen ***Dog Breeding Unit*** at Madras.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	R & D and program	IVRI, concerned State Govts Veterinary Colleges and NGOs

Action 6: **For Other Animals**

- There is an urgent need to study and document the status of indigenous breeds of horses, camels, pigs, donkeys, yaks , *Mithun* and ducks.
- Prepare **A National Action Plan** to take up remedial measures so as to arrest their degeneration.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	IVRI and Other Institutions like National Research Centers for Camel & Yak along with NGOs

STRATEGY 8

GRAZING AND FODDER DEVELOPMENT:

Adequate opportunities for grazing and supply of fodder are the essential pre requisite to conserve indigenous livestock population. Increasing the supply of fodder from agriculture, non agriculture as well as the wild sources,

restoring the traditional CPR institutions such as the Gomala (grazing) lands are the two essential required action plans in this respect.

Action 1: **Increased Supply of Fodder and Feed for Livestock:**

- Supply of fodder and feed can be increased through:

  a) Supporting the local verities of food crops high in fodder content.
  b) Enhancing the area under fodder cultivation on marginal and wastelands.
  c) Involving local communities in the regeneration and management of such lands.
  d) Improving the quality of straw with better harvesting and storage methods.
  e) Encouraging the production of feeds from agro processing wastes.

- Systematic documentation and study of traditional forage and forage species, used by livestock rearing pastoral communities;

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	R&D Program	IVRI and NDRI along with State Departments of Agriculture and Livestock

Action 2: **Strengthen Village Grazing lands "*Gomala"* as CPR Institution:**

- Strict legal action against the encroachment of the CPR lands. Ensure that fodder grazing lands of villages are not diverted for any other uses.
- Institutionalization of indigenous management knowledge governing the CPRs.
- Empowering fully the ***Panchaythi Raj*** institution to take control over the CPRs in India.
- Strengthen the status of village grazing lands -*Orans, Kurans, Gochar , Gomala* in different states.
- Revitalize and strengthen the traditional livestock management institutions like ***Ghoshala*** and Public livestock sheds ***Doddi***

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Policy	Ministry of Forest and Rural Development (Central) w State Government – State Revenue Department

STRATEGY 9

CONSERVATION OF CULTURED FISH DIVERSITY:

Fresh water bodies like rivers, ponds and tanks are the main sources of indigenous cultured fish species in India. Several government departments are managing these water bodies, which have poor coordination and give rare attention for conservation of cultured fish species. Hence, cultured fish species

are the neglected item under fish fauna.

Action 1: **Enhance the Availability of Seeds:**

- Seeds of indigenous carps, catfishes and other food fishes.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	State Fishery Department along with Fishery Colleges or R & D centers

Action 2: **Research Studies:**

- To assess the status of indigenous fishes.
- Their composition and breeding behavior.
- Information on anthropogenic activities and their impact on the indigenous fish fauna.
- Studies to specify the region, species and periods during which, the harvesting of certain species should be strictly regulated/prohibited.
- Study the impact of declaring a particular fish species under Wild Life Protection Act on the income and livelihood of communities depending on it.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	R & D	Fishery Colleges and R & D centers like Nation Bureau of Fish Genetic Resources at Luknow

Action 3: In situ **propagation of desired *ichthyo:***

- Rehabilitation of depleted/extinct fish germplasm.
- Sustainable development of wetlands.
- System approach to create niches for *in situ* propagation of fishes and nursing ground enrichment with bio-reefs and artificial reefs.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	State Fishery Department along with Fishery Colleges or R & D centers.

Action 4: **Strengthening the Community Based Management:**

- Through training and technical assistance to fisher folks.
- Adequate credit and marketing facilities.
- Motivating to follow collective, norms, rules and customs such as restrain the fishing during the brooding period.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	State Fishery Department along with Fishery Colleges or R & D centers. Active involvement of NGOs.

Action 5: **Include Endangered species Under Wild Life Protection Act**:

- Rehabilitation of the poor, whose livelihood is affected.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Policy	Central Govt. – Min. of Forestry and Environment

STRATEGY 10

Development of SUPPORTIVE TECHNOLOGIES FOR DOM. BD:

Blending various technology systems is required to conserve and promote the use of dom .bd. in equitable and sustainable ways. The actions required in this respect are:

Action 1: **Liberal Promotion of Time Tested and Compatible Technologies:**

- Indigenous Agriculture Knowledge and Technologies (IAKTs).
- Ethno Veterinary medicines (EVMs).
- Watershed development and dry farming technologies with special focus on soil and water conservation.
- Organic farming technologies - composting and vermi composting, bio-fertilizers, bio-pesticides.
- Intergraded pest and nutrient management.
- Agro/Farm Forestry.
- Emerging technologies such as natural farming, Parma culture and bio-dynamic farming.

Action 2: **Selective Use of Conventional Breeding and Vegetative Propagation:**

- So that varieties /breeds evolved will relay more on internal resources and IAKTs/EVMs.
- They remain under the control of farmers, women and the community.
- Encourage participatory plant/livestock improvement methods.

Action 3: **Very Careful and Restrictive Application of Bio-technology:**

- Mostly for conservation purposes when the species/variety/breeds are at the verge of extinction.
- To control pests and diseases where all other measures have failed.
- For eradication of deadly weeds causing harms to ecosystem.
- Enforcement of rigorous bio-safety measures preceded by a transparent and systematic Environmental Impact Assessment are a must in all these cases.

A broader consensus thorough public debate and discussion, involving farmers, environmentalists, scientists, NGOs and other stakeholders, regarding the pros and cons of commercial application of bio-technology in agriculture and ways and means to ensure a "social control" over it are very essential.

Action Plans for 1, 2 & 3

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	R&D followed By program	ICAR with the help of SAUs and actively involving the key NGOs

STRATEGY 11
INFORMAL KNOWLEDGE AND TECHNOLOGY SYSTEMS:

Conservation and use of Dom. Bd had been influenced historically, by two strains of informal knowledge and technology systems: ***Indigenous Agricultural Knowledge and Technologies (IAKTs) and Ethno Veterinary Medicines (EVMs)****. There are a mutually supportive roles and interplay as discussed in the section 2.2.2 among informal knowledge and technology systems , dom. bd and bio-diversity. These mutually supportive roles have to be harnessed effectively to evolve eco-friendly, culturally compatible, low cost technologies for sustainable development.*

Action 1: **Systematic Documentation and dissemination:**

- Of IAKTs and EVM of both individuals as well as communities with due acknowledgement to see that knowledge providers are not remained anonymous.
- In local vernacular in a decentralized manner.
- Indigenous and Traditional Institutions, which protect IAKTs and EVM should

also be focused.

- The framework of documentation to be evolved by/with farmers, healers and communities.
- The cross cultural dissemination initiatives such as the *Honey Bee Network* need be strengthened further and extended to other languages in different regions.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	Key NGOs like SRISTI /DDS / GREEN Foundation/ANTHARA with the support of Min. of Agriculture/ICAR/IVRI/SAUs

Action 2: **Systematization and Scaling up of IAKTs and EVMs**

- Whenever required for a larger application.
- Ensure that they remain under community control.
- Conservation of supportive biodiversity and ethno botanicals is also crucial.
- The GIAN (Grassroots Innovations Augmentation Network) experiment, initiated by the NIF and SRISTI is worth extending to IAKTs/EVMs also.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	Key NGOs like SRISTI /DDS / GREEN Foundation/ANTHARA/SEVA with the support of NIF and Min. of Agriculture/ICAR/IVRI/SAUs

Action 3: **Promotion of Healers' Associations and Networks:**

- To give legitimacy to local veterinary healers in different parts of the country**.**
- Ensure them the access to the resources – land, credit and supportive biodiversity.
- Ethno-Veterinary Network for 'under privileged' animals like camels, donkeys and pigs
- To eradicate deadly disease such as the *trypanosomosis* and *mange* in camel.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	Key NGOs like ANTHARA/SEVA with the support of Min. of Agriculture /ICAR/IVRI/SAUs

Action 4: **Debate and Legislation on IPR related to IATKs and EVM**

- In the context of WTO to understand the intricacies
- A National Debate on IPR related to IATKs/EVM and their Digital Documentation

- To resolve apprehensions as well as confusions and to arrive at a consensus .
- To see that the farmers, women and the communities, the original custodians of IATKs/EVMs, will get maximum possible benefits.
- The methodology of ***Prior Informed Consent*** (PIC) and the National Registry, evolved by National Innovation Foundation are worth examining in this respect.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Policy	Key NGOs like Honey Bee Network, Research Foundation, Gene Campaign, Forum for Biotechnology and Food Security with support of Min. of Agriculture and other Depts.

STRATEGY 12
MARKET AND POLICY REFORMS:

These reforms are required to correct various forms of 'failures' in the policy and market arenas, which come in the way of appreciation and proper valuation of various 'forms' benefits and services provided by Dom. Bd discussed in the section 3.2.4. These must result in the higher values for Dom. Bd and ultimately higher benefit to those conserve them leading to optimum production and supply of the products and services of Dom. Bd in India.

Action 1: **Subsidy and Price Support for the Products of Dom. Bd:**

- As promotion of agri diversity doesn't create any forms of environmental hazard, these subsidy and price support can even be negotiated under WTO rules.
- To begin with, product and process specific subsidies and price support can be envisaged in crops such as *Ragi,* Jower, other millets, gain *Amaranthas* and livestock products such as native eggs as well as native chicken which have high implications on equity, food/livelihood security of the poor.
- Price support and procurement of these items can effectively be linked with the present public distribution system (PDS) for people both 'below poverty line' (to enhance nutritional security) as well the 'above poverty line' for taste, palatability and other attributes of native food items. .
- Initiatives such the Deccan Development Society's alternative Public Distribution System need to be strengthened and extended to other regions with similar situations in India.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Policy	Min. of Agriculture Govt. of India

Action 2: **Incentives for Conserving of Dom. Bd.:**

- Awards and Rewards for those who involve in agro biodiversity conservation.
- As followed by the GREEN Foundation, Bangalore (micro level attempt) and National Innovation Foundation, New Delhi (macro attempt) can be considered.
- Incentives, both material and non material forms at individual as well as collective levels can be envisaged, as shown in the table below:

Forms of Incentives

Target of Incentives		***Material***	***Non-Material***
	Individual	Royalty	Award
	Collective	Trust fund	Heritage promotion and Institutional support

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Policy	Min. of Agriculture (Central) along with NIF and other Institutions

Action 3: **Declare 'Ecological Farms' as Biodiversity Heritage Spots**:

- Farms of self motivated, innovative ecological farmers like;

  Narayana Reddy (Bangalore rural),
  Chandrashekar A.P (Mysore) ,
  Bhaskar Save (Gujarat) and
  others in different parts of India,

  need to be focused immediately.

- With all financial and policy support and incentives.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Policy	Min. of Agriculture (Central) along with concerned state governments and key NGOs

Action 4: **Institutional Credit and Insurance:**

- Reorientation of the agricultural financing programs so as to encourage those who conserve Dom. Bd
- Present 'area specific' crop insurance scheme needs to be modified as it is designed to protect the mono-cropping of HYVs in a large scale such as a 'command'.
- To protect *agro biodiversity*, a 'farm' or 'crop' specific approach is needed.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Policy	The NABARD along with Min. of Agriculture Government of India

Action 5: **Publicity and Propaganda:**

- Especially for consumptive (taste, palatability) and nutritional values of Dom. Bd
- By making use of govt. owned mass media; TV and Radio
- To highlight the local food recipe, native food, fruits and vegetable regularly.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	State Publicity Departments to take initiatives in Regional Mass Media, DD and AIR with the Involvement of State Agril. and Hort. Departments and key NGOs

Action 6: **Cooperative Marketing and Traditional Food Resorts:**

- To establish an effective linkages of producers (of products and services of dom. bd.) with the rural poor as well as urban consumers.
- Traditional Food Resorts - similar to *Vishala* in Ahmedabad and Easy to access, inexpensive ***Jhunka/Bhakar*** joints of Maharashtra.
- With active role for private: both individual as well as corporate sectors.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Program	State Agriculture Marketing Dept. along with Tourism Development Departments (Central and State)

Action 7: **Avoid Concentration in Seed Market:**

- In the hands of a few private firms and multinational corporations.
- Bio-technology along with IPR could further increase concentration.
- Strengthen the current public sector institutions like National/State Seed Corporations.
- Encourage co-operative marketing on the lines of AMUAL, specifically for seeds and planting materials.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Policy	Min. of Agriculture along with concerned state governments

STRATEGY 13

EDUCATIONAL REFORMS TO INCLUDE DOM. BDCONCERNS

Education curriculum on biological and agricultural sciences for the students at the schools and college levels needs to be modified and reoriented so as to

include various values and benefits, along with the equity, cultural and ethical dimensions of Dom. Bd To create an interest and respect of diversity in young minds, innovative methods are called for.

Action 1: **Create Curiosity in Students' Mind:**

- Innovative methods like ***Biodiversity Contests*** (followed by Honeybee network, IIM Ahmedabad) and ***Contests on Kitchen Garden Diversity*** (conducted by *Hittalagida* Network, UAS Bangalore) are worth examining in this respect.
- Create a "Bio-Diversity Contest Fund" in each state to conduct contests, quizzes, essay writing and other such competitions in agricultural universities and other traditional universities

Action Plan

Time period	***Mode***	***Responsibilities***
Immediate to Short term	Program	The State Education Department with the help of Agriculture and Horticulture Departments, SAUs Key NGOs like Honey Bee Network and DDS have to be actively involved.

Action 2: **Syllabus Modification:**

- Include IAKTs and EVM into Agricultural/Veterinary Curricula.
- Sensitize students in terms of equity, security, ethical and cultural aspects of dom.bd.
- A committee of experts to provide a broader framework for syllabus modification at the national level and each state to have separate committees to follow it up.
- The key NGOs working on dom. bd to be actively involved in this process.
- A National Level Workshop to discuss the broader framework of syllabus modification.

Action Plan

Time period,	***Mode***	***Responsibilities***
Medium term	Policy and Program	The State Education Department with the help of Agriculture and Horticulture Departments. The ICAR along with SAUs to provide overall guidelines

Action 3: **Maintain Niche Diversity Center in Schools and Colleges:**

- By developing "school farms/gardens" as repository of biodiversity of their locality.
- Take the help of State horticultural and agricultural departments, village youth and women clubs.

- A ***Students' Bio-diversity Registry*** in each school to record the bio-diversity prevailing in the village/region has to be maintained.
- Adequate attention should be given to record associated indigenous knowledge, technology and institution system.
- Establishing kiosks in schools, creating websites of dom. bio diversity in rural junior colleges and high schools.
- Encourage ***Students' Shod Yatras*** to identify and understand the local diversity and the associated informal knowledge system by learning from the elders, women and surrounding local 'experts'.

Action Plan

Time period,	***Mode***	***Responsibilities***
Immediate to Short term	Program	The State Education Department with the help of Agriculture and Horticulture Departments, SAUs Key NGOs like Honey Bee Network and DDS have to be actively involved.

Action 4: **Training and Reorientation for Scientific Community:**

- Training and reorientation in decision making process at the institutional levels.
- A significant portion of the scientific/academic community working on Dom. Bd under ICAR and other research and education institutions will have orientation and training regularly.
- Reorientation on the issues of equity, gender, food security, ethics, sustainability, culture and the informal knowledge, technology and institutions supporting dom. bd.

Action Plan

Time period	***Mode***	***Responsibilities***
Immediate to Short term	Program	The NBPGR/NBAGR, other national and state level scientific institutions involved in R & D on Dom. Bd

Action 5: **Alternative Methodology to Value the 'Total Benefits' of Dom. Bd.:**

- Our present methodology is too Western and is unable to accommodate the 'Third World Perspectives'
- Such as the equity, security, culture and gender perspectives associated with dom. bd.
- Total benefits and services of Dom. Bd. need to be valued and incorporated in to Agricultural GNP and National Accounting.

Action Plan

Time period	*Mode*	*Responsibilities*
Medium term	Program	The ICAR in association with SAUs and other social sciences/economic institutions.

5.2. Prioritization and Follow Up:

5.2.1 **Prioritization:** The TWG has formulated 57 Action Plans to achieve 13 broader Strategies in order to conserve and use of Dom. Bd in an equitable and sustainable way in India. Nearly 65 percent of these actions are classified as 'Medium Term' as they require a duration up to 5 years for implementation. Similarly, next 30 percent action plans require 'immediate to short term' (up to two years duration) and the last five percent are long duration actions. To implement these actions, in nearly 58 percent cases clear programs mostly by the state and central governments are required. In 22 percent cases policy reforms are required. To implement 15 action plans R & D initiatives and in 4 cases building of 'institutions are called for.

As the time and resources available to implement these action plans are limited they have to be pursued in a prioritized way. Though prioritization is a subjective exercise, by looking in to specific socio-economic context of a country like India, livelihood security of the people and the ecological security issues associated with Dom. Bd. can be taken as two bottom lines, in this respect. In addition, other criteria such the time period (which need be implanted immediately) and cost effectiveness (which require relative smaller resources such as 'the development of national action plans, conduction workshops) have to be considered while prioritizing the actions related to above mentioned two sub themes. There are a few actions which are addressing the possible negative implications of items such as biotechnology and IPRs, on Dom. Bd. and consequently on the above mentioned two priority objectives. And finally, actions on policy reforms and building of institutions will have a long term implications on the conservation and use of Dom. Bd All these criteria are taken in to account while prioritizing the actions which address the above mentioned two top priority objectives. As these two objectives are closely interlinked, many actions prioritized overlap with each other. Table below gives such prioritized actions along with the possible agencies to implement the same.

Table:

Prioritized Action Plans along with the Proposed Implementing Agencies:

A) ON LIVELIHOOD SECURITY OBJECTIVE		
Sl No	***Action Plan***	***Implementing Agency***
1	**Strengthen and Extend Ongoing Initiatives**	Central Ministry of agriculture with the support of the NGOs like DDS and GREEN Foundation
2	**Encourage Women's Co-Operatives**	Min. of Agriculture With key NGOs
3	**Plant Multi Purpose Tree Species:**	Government (State) – Departments of Forestry and Revenue jointly
4	**Create Agri Diversity Exchange System**	NGOs with State Govt. Department of Agriculture/Horticulture
5	**Plan on d Food Crops**	NGOs with Ministry of Forest & Environment, ICAR
6	**A National Action Plan for Tribal/ Forest dwellers' Agriculture**	NGOs with Ministry of Forest & Environment, ICAR and SAUs
7	**Periodic Monitoring of Threatened Livestock Breeds**	State Veterinary Colleges/Department and NGOs
8	**Promote Herd Societies:**	IVRI, NDRI, State Govts. Veterinary Colleges and NGOs
9	**Increased Supply of Fodder and Feed for Livestock**	IVRI and NDRI along with State Departments of Agriculture and Livestock
10	**Strengthen Village Grazing lands "*Gomala*" as CPR Institution**	Central Govt. with State Government – State Revenue Department
11	**Strengthening the Community Based Management for Cultured Fish**	State Fishery Department along with Fishery Colleges or R & D centers, active involvement of NGOs
12	**Systematization and Scaling up of IAKTs and EVMs**	Key NGOs like SRISTI /DDS / GREEN Foundation/ANTHARA/SEVA with the support of NIF and Min. of agriculture ICAR/IVRI/SAUs
13	**Promotion of Healers' Associations and Networks**	Key NGOs like ANTHARA/SEVA with the support of Min. of Agriculture /ICAR/IVRI/ SAUs
14	**Debate and Legislation on IPR related to IATKs and EVM including the application of agri. bio-technology**	Key NGOs like Honey Bee Network, Research Foundation, Gene Campaign, Forum for Biotechnology and Food Security with support Of Min. of Agriculture and other Depts.
15	**Subsidy and Price Support for the Products of Dom. Bd**	Min. of Agriculture Govt. of India
16	**Institutional Credit and Insurance**	The NABARD along with Min. of Agriculture Government of India

(B) ECOLOGICAL STABILITY OBJECTIVE		
17	**Maintain the Native Strains in Pure Form**	Ministry of Forestry and Environment (Central) along with State Govts. and SAUs
18	**Large Scale Planting of 'bee trees'**	Ministry of Forestry and Environment (Central) along with State Forest Deportments
19	**Agro Ecosystem Based Crop and Livestock Planning**	State Department of Agriculture and Forestry
20	**Assign Top Priority to Land Care and Management Systems**	State Department of Agriculture and Revenue Department to prevent conversion
21	**Treat Water As a Social Resource**	Ministry of Forestry and Environment , Water Resources (Central) along with State Govt.
22	**Conserve Living Aquatic Resources**	Ministry of Forestry and Environment (Central) along with State Govts.
23	**Research to Anticipate the Likely Consequences of Climate Change**	ICAR and other R & D institutions With SAUs

5.2.2. Implementation and Follow Up:

Various central Ministries, R & D initiations, NGOs, State Developmental Departments, SAUs and others are considered as the possible agents to implement prioritized and other action plans mentioned above. The Central Ministry of Agriculture along with its R & D institutions such as NBPGR and SAUs together assigned the responsibility of implementing 25 or 30 percent of the action plans. Other Central Ministries such as Environment & Forestry, Rural Development, Health together assigned the responsibility to implement nearly 20 percent of the action plans. The key NGOs are also assigned the responsibility of implementing nearly 17 percent of the action plans and almost 30 percent for various state development departs such as agriculture, horticulture and others.

As the Central Ministry of Agriculture, Govt. of India and its R & D institutions such as ICAR as well as SAUs have to play key role, a committee under the Ministry of Agriculture can be set up to co-ordinate and oversee the implementation of various SAPs. In addition to the scientists from the concerned R & D institutions adequate representations should be given to the NGOs, farmers and communities associated with the conservation and use of Dom. Bd. The TWG on Dom. Bd. may be assigned the role of advocacy, guidance and evaluation of the progress in the implementation of various SAPs periodically.

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ANNEXURE - I

Full Description of the Process

I. BACKGROUND:

1. Dr. T.N. Prakash, Associate Professor and Editor of *Hittalagida*, Department of Agricultural Economics University of Agricultural Sciences, Bangalore was approached during the month of June 2001 by Sri P.V. Satish, Member, Technical and Policy Core Group (TPCG), The National Bio-diversity Strategy and Action Plan (NBSAP), Min. of Environment & Forestry (MoEF), Govt. of India, New Delhi to take over the responsibility of Co-coordinating **The Thematic Working Group on Domesticated Biodiversity**.(TWG on Dom. BD). Dr. T.N. was invited to attend the Midterm National Workshop on the Progress of NBSAP on June 13 – 15, 2001, at New Delhi. Dr. Prakash had actively participated in the workshop and acquainted himself with the NBSAP's mode of operation, guidelines and working principles in the workshop.

2. Consequently, a letter from Sri Ashish Kothari, Coordinator, TPCG, dated 14th July 2001 confirmed the appointment of Dr. T.N. Prakash as the coordinator of the TWG on Domesticated Bio-diversity. Dr. T.N. Prakash, on 19th July 2001 wrote to the Vice Chancellor, University of Agricultural Sciences, Bangalore and requested for permission to work as the coordinator of TWG on Dom. BD. The Vice Chancellor of UAS Bangalore, through. the order No AO/Est-IV(4/2001-02) dt. 27-08-2001 granted permission to Dr. T.N. Prakash to take up the responsibility of coordinating the TWG on Dom. Bd.

3 As per the letter of Sri Ashish Kothari, Dt. 14th July 2001, Dr. Prakash had interacted with the previous coordinator Dr. Ardhendu Chattergee and all the previous TWG members regarding the steps to be initiated to speed up the works of the TWG within the time limit prescribed by the NBSAP. Dr. Chattergee was kind enough to pass on the proceedings of the first meeting of TWG on Dom. BD held on September 29 2000 at DRDSC Calcutta

II. PROCEEDINGS OF THE MEETING OF 11TH AUGUST, 2001:

1. PARTICIPANTS: **The meeting was held in the Conference Hall, Veterinary College at the University of Agricultural Sciences, Hebbal, Bangalore. Ms. Vanaja Ramprasad of the GREEN Foundation, Bangalore had presided over this meeting**

2. and Dr. T.N. Prakash, the Coordinator conducted the meeting. The details of the participants and their background are given below:

Sn	*Name*	*Institution/Place*	*Background*
1.	**Dr. M.D.Subhash Chandran**	NBSAP, Western Ghat, Karnataka	**Local site Co-ordinator**
2.	**Mr. Shivanand Kalave**	**Sirsi, Western Ghat**	**Journalist**
3.	**Mr. R. Swaminathan**	**SEVA, Tamil Nadu**	**NGO**
4.	**Dr. D. Seenappa**	**UAS, Bangalore**	**Fishery Scientist**
5.	**Mrs. Rohini Reddy**	**SARRA, Andhra Pradesh**	**NGO**
6.	**Mrs. Shamala Murthy**	**SARRA, Bangalore**	**NGO**
7.	**Mr. Sadashiva R.**	**SARRA, Andhra Pradesh**	**NGO**
8.	**Dr. Tejaswini Sharma**	**Hittalagida, Bangalore**	**Plant Scientist**
9.	**Dr. Satish Chandra**	**Institute for Agril. Banking, Bangalore**	**Scientist cum NGO**
10.	**Dr. S.S. Surya Prakash**	**UAS, Bangalore**	**Agricultural Economist**
11.	**Mr. Aravinda Kumar**	**UAS, Bangalore**	**Research Fellow**
12.	**Mr. Gururaja Budhya**	**Technology Informatics Design Endeavor, Bangalore**	**NGO**
13.	**Dr. M.R. Jayashanker**	**UAS, Bangalore**	Veterinary Scientist
14.	**Dr. C.S. Nagaraja**	**UAS, Bangalore**	**Veterinary Scientist**
15.	**Dr. K.S. Prathap Kumar**	**UAS, Bangalore**	**Veterinary Scientist**
16.	**Dr. K. Satyanarayan**	**UAS, Bangalore**	**Veterinary Scientist**
17.	**Dr. M.R. Girish**	**TOE-NRE, Bangalore**	**Research Fellow**
18.	**Mr. C.J. Nagesh**	**UAS, Bangalore**	**Student**
19.	**Ms. M.N. Gayathri**	**UAS, Bangalore**	**Research Fellow**
20.	**Mrs. Rama Sateesh**	**TOE-NRE, Bangalore**	**Journalist**
21.	**Ms. Deepthi Elizabeth**	**UAS, Bangalore**	**Student**
22.	**Mr. Chitrashekher**	**Doddaballapur, Karnataka**	**Farmer**
23.	**Mrs. Vanaja Ramprasad**	**Green Foundation, Bangalore.**	**NGO**
24.	**Ms. K.K. Prasanna Rashmi**	**UAS, Bangalore**	**Student**
25.	**Ms. Daksha Hathi**	**Deccan Herald, Bangalore**	Journalist
26.	**Mr. Ravi Prakash**	**Kannada Prabha, Bangalore**	Journalist
27.	**Dr. K.P. Ramesh**	**National Dairy Research Institute**	Animal Scientist
28.	**Dr. M.G. Chandrakanth**	**Dept. of Agril. Economics, Bangalore**	**Natural Resource Economist**
29.	**Mr. P.S. Srikantha Murthy**	**UAS, Bangalore**	**Agril. Economist**
30.	**Mr. Krishnan Iyer**	**Bangalore**	**Corporate representative**
31.	**Mrs. Manju S. Raju**	**NBSAP, Bangalore**	**TWG Coordinator**
32.	**Mr. Shivaramulu**	**TIDE, Bangalore**	**NGO**
33.	**Mr. B.M. Ravi**	**UAS, Bangalore**	**Student**
34.	**Mr. B.K. Rohith**	**UAS, Bangalore**	**Student**
35.	**Dr. P.G. Chengappa**	**UAS, Bangalore**	Director of Instruction (Agri.),
36.	**Dr. R.S. Kulkarni**	**UAS, Bangalore**	**Prof. of Plant Breeding**
37.	**Dr. Shashidhar**	**UAS, Bangalore**	**Plant Scientist**

2. SUPPORT: Those who could not participate but had expressed their support and co-operations are: Dr.Madhav Gadgil, Steering Committee Member and State Nodal Agent, IISc, Bangalore, Dr.Darshan Shanker FRLHT, Bangalore, Mr.P.V.Satish, DDS, Hyderabad, Dr.R.S.Rana, Ex-Director, NBPGR, New Delhi, Prof. Anil Gupta, Steering Committee Member, IIM Ahmedabad, Dr.Gopal.K.Kadekodi, Coordinator Economic and Valuation of BD, Mr.Theodore. S. Bhaskaran, Veterinary Scientist, Bangalore, Dr.Ganeshaiah, Plant Scientist, UAS, Bangalore, Dr. Nitya S. Ghotge, ANTHRA, Pune, Dr. Sagari Ramdas, ANTHARA, Hyderabad, Dr. Ramachandra Bhatt, Fishery College, Mangalore, Mr. P. Babu & Mr.Vasu, ICRA, Bangalore, Dr. Channesh, IISc, Bangalore and Mr.Ashish Kothari, Coordinator, TPCG, Kalpavruksh, Pune.

3. It was decided to adhere in principle, to the ***Guidelines and Concept paper*** on Domesticated Biodiversity prepared by NBSAP to pursue the set objectives of the TWG. The proceedings of the first meeting of TWG held on September 29, 2000 at Development Research Communication Center, Calcutta was considered in this respect.

4. Due to the constraints of resources and time, it was decided to make use of the available information based on the ongoing or past works by resources persons in the concerned subject mater areas. Accordingly, the below list of resource persons was identified in the meeting to provide relevant information and key inputs.

Resource persons	***Main component***	***Sub components***
1. Dr. Vanaja Ramprasad	Agri-diversity	Dry land / *in situ* conservation based on experience of Green Foundation, TN
2. Dr. Jayashankar M.R & Dr. C.S Nagaraj,	Livestock	Milch animals Cattle (Amruthmahal), Buffalo & others from Karnataka
3. Mr. Shivananda Kalave,	Agri diversity	Decline of agri-diversity and farmers response in Westren Ghats
4. Dr. Seenappa & Dr.Ramachandra Bhatt	Fisheries	Cultured fish species
5. Dr. Satish Chandra	Agri-diversity	*Pigeon pea and other related crops*
6. Dr. K.S Pratap Kumar	Livestock	Poultry birds
7. Ms.Deepthi Elizabeth	Agri-diversity	Domesticated diversity-Kerala
8. Dr. Girish M.R.	Agri-diversity	Tribal agriculture – Soliga community in B.R. Hills, Karnataka
9. Dr.K.P. Ramesh	Livestock	Special features of indigenous livestock breeds
10. Mr. Vivekandan and Mr. Swaminathan	Livestock	Umbal cherry, Malaya madu – Cattle breeds in Tamil Nadu. And other breeds of Rajasthan and Gujarat
11. Dr. Shashidhar	Agri-diversity	Native Paddy varieties and impact of biotechnology on agri-diversity
12. Prof. R.S. Kulkarni	Agri-diversity	Existing measures and gaps in *Ex-situ* conservation of agri-diversity
13. Dr. Nitya s. Ghotge & Dr. Sagari Ramdas	Livestock diversity	Aseel poultry breed, Camels, Ethno-veterinary and Livelihood issues
14. Dr. P.V. Satheesh	Agri-diversity	AP coalition on agri-diversity and D.D.S. experience at Andhra Pradesh
15. Dr. Theodore Bhaskaran	Livestock	Pet Dog breeds
16. Dr. R.S. Rana	Agri-diversity	Status of Agri-diversity and current conservation measures under NBPGR and outside.
17. Honeybee Network and SRISTI	Agri-diversity	Status and role of indigenous knowledge in conservation, based on Honey Bee Network experiment at Gujarat
18. Rajeev Kethkar	Agri-diversity	*Ex-situ* conservation – NGO efforts in Maharastra
19. Dr. K.N. Ganeshaiah & Dr.Ardhendru Chatterji	Agro-ecosystem diversity	Agro-ecosystem diversity
20. Dr. N.S. Bhat	Apiculture	Honey Bee species
21. Dr.Channesh	Agri-Diversity	Biodiversity documentation through biodiversity registry
22. Mr.G.B.Lokesh	Agri-diversity	Watershed development programs
23. Mr.P.Babu & Vasu	Agri-diversity	Organic farming and other alternative systems
24. Hittalagida Network and Research Scholars, UAS, B'lore	Agri-diversity	Vegetables, fruits and crops not covered by others.
25. Ms.K.K.Prasanna Rashmi	Agri-diversity	Issues related to economics, food security.
26. Ms. Rama Sateesh	Dom.BD	Gender sensitivity and empowerment

<u>The above resource persons are requested to prepare a write up of 15-20 pages on the respective components and subcomponents and submit it along with good photos by the end September 2001.</u>

5. SPECIFIC GUIDELINES: While preparing the write up based on either a research work or on an NGO's activities or community's initiatives, it was suggested to incorporate the following specific aspects:

a) *Name, location and the agency* handling the project/initiative based on which the information is supplied. Geographical coverage and the extent of farmers and others involved through the project/initiatives, resources, both human as well as financial involved.

b) *Historical and cultural context* of the work.
c) Methodology to be followed for conservation; such as extension, training, demonstration, media, literature and informal methods such as bio-diversity contests (as in the case of Honeybee network), *seedmela* (of GREEN Foundation), biodiversity festival (by DDS Hyderabad).

d) Success of conservation; a number of varieties or livestock saved across the region and over time, benefits accrued to women, laborers and other weaker sections.

e) The Role of markets, price premium for the items conserved, demand pattern and quantity actually marketed, channels of markets.
f) . IPR issues ; geographical indicators (like Coorg coffee) or varietal features which merits patenting at the collective or community' level, any attempt to document this (say; bio-diversity registry or gene mapping).

g) *The Gap* between the expected output and actual results in the initiatives, reasons and remedies to fill the gap; measure in terms of technical, financial, policy and programs.

6. ACKNOWLEDGMENT AND ACCESS: It was assured that the contributions by different persons and institutions will be duly acknowledged in the final report and the materials and information generated in the process will be made accessible to those who require them. Sufficient care will be taken to interact with all concerned and the suggestions and comments will be appropriately incorporated.

III. IVOLVEMENT, INTERACTIONS AND VISITS OF CO-ORDINATOR:

Academic responsibilities and involvement of the coordinator in the related areas have immensely helped to get useful inputs, ideas and concepts to prepare the TWG final report. These responsibilities and involvements are: (a) Co-Principle Investigator, Team of Excellence in Natural Resource Economics – a project funded by ICAR to focus on research, training and teaching on economics of water, watershed and forestry. (b) Editor, *Hittalagida*, a Honey Bee Network publication in regional language. (c) Member Honey Bee Network and SRISTI Board, IIM Ahmedabad. (d) Regional collaborator, NIF, New Delhi.

The items not covered were addressed through visits, discussions and interactions in the seminars, workshops and other occasions, both within and outside the country, attended by the coordinator. A few such important visits/participation by the coordinator, which facilitated interaction with the resource persons and helped to get the useful inputs and information are:

1. Regional Workshop on Food Security in South Asia at UBNIG, Bangladesh, November, 2001.
2. Regional Conference on Innovations and Appropriate Technology: IPR aspects and the Transfer of Technology – Organized by the World Intellectual Property Organization (WIPO) at Lesotho, Africa Feb. 27 and 28, 2002.
3. Prajateerpu: A Citizen Jury/Scenerio Workshop on Food and Farming Future for Andhra Pradesh, May – June, 2002. at Pasthapur, AP.
4. Discussion meeting on draft report of TWG on Economic and Valuation of Biodiversity at Bangalore on July 22, 2002.
5. National Convention on Community Rights to Natural Resources and The Constitution, by organized Aug. 10 & 11, 2002, New Delhi.
6. Public Forum on Genetic Engineering, Agriculture and Farmers Rights Dec. 2, 2002 at

Hydrabad.

7. Finding a Common Ground – Organic Farmers from Canada in a Dialogue with India on 15, February 2003 at Bangalore.

IV. PROGRESS OF THE TWG:

Among the resource persons listed above, the following have provided the needed information and key inputs for the report.

Dr. Vanaja Ramprasad *(NGO)*, Green Foundation, Bangalore.

Dr. R.S. Rana *(Former Director)*, National Bureau of Plant Genetic Resources, New Delhi.
Dr. K.P. Ramesha *(Scientist – dairy)* National Dairy Research Institute, Bangalore.
Dr. Nitya S. Ghotge *(NGO),* ANTHRA, Pune.
Dr. Tejaswini Sharma *(Scientist)*, Hittalagida Network, Bangalore.
Dr. C.S. Nagaraja (*Scientist, Veterinary)*, University of Agricultural Sciences, Bangalore.
Mr. Vivekanandadan *(NGO)*, SEVA, Madurai.
Dr. Sunil Archak *(Plant Scientist)*, NBPGR, New Delhi.
Dr. N.S. Bhat *(Scientist, Apiculture)*, University of Agricultural Sciences, Bangalore.
Dr. Seenappa *(Scientist, Fisheries)*, University of Agricultural Sciences, Bangalore.
Dr. Ramachandra Bhat *(Economist, Fisheries)*, Fishery College, Mangalore.
Dr. Sagari Ramdas *(NGO)*, ANTHARA, Hyderabad.
Dr. Channesh *(Scientist)*, Indian Institute of Sciences, Bangalore
Dr. M.R. Jayashankar, *(Scientist – Livestock)* University of Agricultural Sciences, Bangalore
Dr. Pratap Kumar, K.S., *(Scientist, Poultry)* University of Agricultural Sciences, Bangalore.
Mr. Shivananda Kalave *(Journalist)*, North Kanara, Karnataka.
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In the meantime, state nodal agencies and other NBSAP partners were approached vid. Letter dated July 24, 2001 to get additional information and inputs on dom bd. from different parts of India. Extensive review of research reports and publications of the National Bureau of Plant Genetic Resources, New Delhi, other ICAR institutions, state agricultural universities and other GOs and NGOs related to dom. bd. was undertaken by the members of the *Hittalagida* network, Bangalore. Mr. Ashish Kothari, the Coordinator, TPCG was kind enough to provide a wealth of information and copies of the related work on dom. by other NBSAP partners through email.

CROSS CUTTING THEMS: The following sub thematic review /other NBSAP works were reviewed to address cross cutting themes and the issues were addressed appropriately in the TWG report on dom. bd.:

1. Research on bio-diversity – sub thematic review by Dr. Sunil Archak and Dr. Tejaswini.
2. Home Gardens and Biodiversity - sub thematic review by V. Shanthakumar.
3. Agricultural Biotechnology and Globalisation sub thematic review by Mr. Devinder Sharma.
4. Public Distribution System and Biodiversity - sub thematic review by Mr. P.V. Satheesh.
5. Nomadic Pastoralism and Biodiversity- sub thematic review by P. Vivekanadan.
6. TWG report on Economic and Valuation by Dr. Gopal K Kadikode

MIDTERM NATIONAL WORKSHOP: The coordinator submitted the Interim Report to NBSAP on June, 2001 and presented the salient findings of the TWG in the Midterm National Workshop of NBSAP held at Pasthapur, AP from 13-15, June 2001.

The Draft Copy of The Executive Summary along with the Full Set Of Strategy And Action Plans was circulated among all the members and others who provided inputs and was presented at the Final National Workshop of NBSAP held on 11-14, November 2002 at New Delhi. The final report was prepared by considering all the comments and suggestions of the members and other resource persons provided at different occasions and various points of time.

ANNEXURE - II

Members and others who provided inputs, critical comments and other assistance

1. Dr. Vanaja Ramprasad (NGO), Green Foundation, Banalore,
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ANNEXURE – III

Major crops with rich diversity in India:

Cereals	Oryza sativa, Triticicum aestivum and ssp. sphaerococcum, and Zea mays.
Millets	Coix lacryma-jobi (soft-shelled forms), Digitaria compacta, D. sanguinali Echinochloa colonum, Panicum sumatrense, Paspalum scrobiculatum, Pennisetum americanum and Sorghum bicolor.
Legumes	Cajanus cajan, Canavalia cathartica , Cicer arietinum, Cyamopsis tetragonoloba, Macrotyloma uniflorum, Lablab niger, Mucuna capitata, M. utilis, Vigna aconitifolia, V. mungo, V.radiata, V. umbellata and V. unguiculata.
Oilseeds	Brassica rapa ssp. campestris var. and var. toria, B. juncea, Carthamus tinctorius, Citrullus colocynthis, Eruca vesicaria, Guizotia abyssinic Linum usitatissimum and Sesamum orientale.
Fruits	Artocarpus heterophyllus, Citrus indica, C. latipes, Limonia acidissima, Garcinia indica, Manilkara hexandra, Mangifera indica, Zizyphus mauriti Musa spp. (AB, AAB group), M. balbisiana, Syzygium cumini,
Vegetables:	Alocasia cucullata, A. macrorhiza, Amorphophallus paeoniifolius,Capsicum annuum, Citrullus lanatus var. fistulosus, Coccinea grandis,Colocasia esculenta, Cucumis sativus, Cucurbita spp., Dioscorea spp, Lagenaria siceraria, Luffa acutangula, L. aegyptiaca, L. hermaphrodita, Moringa oleifera, Raphanus sativus, Rumex vesicarius, Solanum melongena and Trichosanthes cucumerina.
Medicinal and aromatic plants	Anethum sowa, Trachyspermum ammi, Croton tiglium, Cymbopogon flexuosus, C. martinii, Datura metel, Hydnocarpus laurifolius, Rauvolfia serpentin Strychnos nuxvomica, Saussaurea lappa, Vetiveria , zizanioides.
Spices	Amommum aromaticum, A. xanthioides, Curcuma amada, C. angustifolia, C.longa, C. zedoaria, Elettaria cardamomum, Piper longum, Zingiber officinale
Miscellaneous	Bambusa arundinacea, B. strictus, B. tulda, Cannabis sativa, Cephalostachyum capitatum, Cocos nucifera, Corchorus capsularis, Crotalaria juncea, Dendrocalamus hamiltoni, Dendrocalamus longispathus, Gossypium arboreum, Hibiscus cannabinus, Melocanna bacccifera, Neohouzeaua dullosa, Ochlandra travancorica,
Saccharum spp.,	Sinocalamus giganteus.

Source: Mehra and Arora, 1982.

ANNEXURE – IV

Main geographical areas rich in agri diversity & its wild relatives in India

Zone I: Arid region		
1.	Western plains, parts of Kathiawar peninsula, hot arid region	Wheat(salt tolerant, *dicoccum & durum*),barley, pearlmillet, sorghum, mango, jackfruit, ber, aonla, phalsa, Karonda, *Cordia*, *Capparis*, summer and winter vegetable, carrot, spinach, cucurbits, under utilized crops, M&AP, diploid cotton, wild and weedy relatives of crop plants of the region.
2.	North western Gujarat plains, hot arid region	Groundnut, sesame, summer and winter vegetables, carrot, spinach, cucurbits, onion, mango, M&AP, under utilized crops, wild and weedy relatives of crop plants o f the region
3.	Central, eastern and southern Rajasthan including Aravali ranges	Wheat, sesame, pearlmillet, sorghum, Brassica spp., pulses, summer vegetables, cotton, guar, ber, aonla, phalsa, fiber crops, M&AP, wild and weedy relatives of crop plants of the region
4.	South Kutchh and north Kathiawar, western Malwa plateau	Medicinal & aromatic plants, forage crops, legumes, grasses and under utilized crops
5.	Malwa region	Wheat, spices, underutilized crops, M&AP etc.
Zone II: South-west coastal region and A&N and Lakshadweep Islands		
6.	Andaman & Nicobar islands, Lakshadweep, hot humid to per humid	Rice, medicinal & aromatic plants, *Artocarpus* spp., coconut, mango, banana, minor fruits, Dioscorea, arecanut, dye yielding plants, wild and weedy relatives of crop plants and under utilized crops
7.	Western ghats, coastal plains, hot humid region	Tuber crops, arecanut, coconut, spices, mango, banana, turmeric, vanilla, jack fruit, cashew nut, medicinal & aromatic plants, dye yielding plants, wild and weedy relatives of crop plants and under utilized crops.
8.	Karnataka plateau, hot moist semi-arid region	Wheat, minor millets, sorghum, pearlmillet, sesame, groundnut, niger, pulses, chickpea, cotton, vegetable(summer and winter), chillies, grapes, mango, ber, banana, arecanut, tamarind, jackfruit, melons, aonla, cashew, medicinal & aromatic plants, safflower, castor, *Jatropha*, cotton, custard apple, sapota, coconut, spices and dye yielding plants, wild and weedy relatives of crop plants.
9.	Western coastal region	Rice, coconut, tuber crops, spices, vegetables, mango, banana, tamarind, jack fruit, cashew nut, medicinal & aromatic plants, and castor and wild and weedy relatives of crop plants
10.	South east coastal plains, hot humid to semi arid region	Rice, coconut, tuber crops, spices, jack fruit, vegetables, banana, aonla, mango, melons, medicinal & aromatic plants, cashew nut, castor, minor millets and groundnut and wild and weedy relatives of crop plants.
11.	Central and north Tamilnadu uplands	Vegetable (summer and winter), leafy vegetables, chillies, sword bean, medicinal & aromatic plants, cashew nut, castor, minor millets, tuber crops, rice and sesame and wild and weedy relatives of crop plants.

Zone III: Humid/moist tropical east coastal region		
12.	Chhatisgarh/ Mahanadi basin, eastern plateau	Wheat, sesame, niger, groundnut, *Brassicas*, linseed, winter vegetables, mango, jackfruit, rice, chillies, pulses, M&AP, under utilized crops and wild and weedy relatives of crop plants.
13.	Dandkaranya and eastern ghats, hot humid/ sub-humid region	Pulses(Kulthi and cowpea), sesame, niger, groundnut, vegetable (winter and summer), linseed, chillies, rice, minor millets, M&AP, under utilized crops and wild and weedy relatives of crop plants.
14.	Eastern ghats, hot moist sub-humid region	Maize, pulses(Kulthi and cowpea), sesame, niger, Brassicas, vegetable (winter and summer), linseed, chillies, rice, minor millets, jack fruit, banana, medicinal & aromatic plants, forage grasses and legumes, under utilized crops and wild and weedy relatives of crop plants.
Zone IV: North-eastern region		
15.	Sikkim Himalayas and Darjeeling hills	Cereal(maize, rice, barley), millets/minor millets (fingermillet, proso millet), medicinal & aromatic plants, temperate fruits and nuts (*Pyrus* and *Prunus*), under utilized crop plants (rice bean), tropical fruits (*Citrus spp., Musa spp*.), forage crops(legumes and grasses), fibre crops, cotton, jute, *Saccharum* spp., and wild and weedy relatives of crop plants of the region.
16.	Middle Brahmaputra plains and Meghalaya plateau region	Cereal(maize, rice),vegetables(leafy vegetables, cucurbits), Dioscorea, under utilized crop plants (rice bean, *Perilla*), tropical fruit(mango, *Citrus* spp., *Musa* spp.), forage crops(legumes and grasses), fibre crops, cotton, jute, *Saccharum* spp., and wild and weedy relatives of crop plants of the region.
17.	Arunachal Pradesh (subdued eastern Himalayas), warm to hot per humid region	Cereal(maize, rice, barley), millets/minor millets (fingermillet), *Coix*, medicinal & aromatic plants, temperate fruits and nuts (*Pyrus* and *Prunus*), under utilized crop plants (rice bean), tropical fruits (*Citrus spp., Musa spp*.), forage crops(legumes and grasses), ornamentals, orchids, bamboos, vegetables(leafy vegetables, cucurbits), *Colocasia* and *Dioscorea*, ginger and other spices, and wild and weedy relatives of crop plants of the region.
18..	North eastern hills of Manipur, Tripura, Nagaland, warm per humid region	Cereals(maize, rice), vegetables(leafy vegetables, cucurbits), *Dioscorea*, under utilized crop plants (rice bean, *Perilla*), tropical fruits (*Citrus spp., Musa spp*.), forage crops(legumes and grasses), fibre crops, cotton, jute, bamboo, and wild and weedy relatives of crop plants of the region.
Zone V: Central Himalayan Region		
19.	Kumaon and Garhwal hills of western Himalayas, warm sub-humid region	Cereal(maize, rice, barley), vegetables, M&AP, pseudocereal(buckwheat, amaranths),grain legumes, temperate fruits, wild and weed relatives of crop plants.
20.	Submontane region of Kumaon and Garhwal	Wheat(rust resistant lines), rice, maize, vegetables, brassicas, grain legumes, agro-forestry tree species, M&AP, wild and weedy relatives of crop plants.

21.	Montane and alpine region of Kumaon and Garhwal hills	Temperate fruits, vegetables, chillies, pseudocereals, *Cicer microphyllum*, tuber crops, medicinal & aromatic plants, grain legumes, rice(scented type), barley, maize, wheat, brassicas(brown and yellow sarson), forage legumes and grasses, minor millets, wild and weed relatives of crop plants.
22.	Terai and foot hills	Rice(scented types), tropical fruits, *Citrus* species
Zone VI: North-west Sub-Himalayan and High altitude Himalayan region		
23.	Western Himalayas, cold arid and warm sub-humid region(J.K.hills and plains)	Cereals(wheat, maize, rice, barley), pseudocereals(buckwheat, amaranths, Chenopods), minor millets(prosomillet, fingermillet), forage crops(legumes, grasses), medicinal & aromatic plants, temperate fruits and (walnut, *Pyrus* and *Prunus*), vegetables, grain legumes, *Cicer microphyllyum*, oilseeds(brassicas), turmeric, and wild and weedy relatives of crop plants.
24.	Leh/Ladakh/Lahaul and Spiti region of H.P.hills	Cereals(maize, wheat, barley), pseudocereals(buckwheat, amaranths, Chenopods), forage crops(legumes, grasses), medicinal & aromatic plants, temperate fruits and nuts, (*Pyrus* and *Prunus*), vegetables, grain legumes(lentil), *Cicer microphyllyum*, oilseeds(brassicas), turmeric, and wild and weedy relatives of crop plants.
25.	Mandi/Kullu Manali Region	Cereals(wheat, maize, rice, barley), pseudocereals(buckwheat, amaranths, Chenopods), forage crops(legumes, grasses), medicinal & aromatic plants, Temperate fruits and nuts, (*Pyrus* and *Prunus*), vegetables, chillies, grain legumes(lentil), oilseeds(brassicas), turmeric, ginger and wild and weedy relatives of crop plants.
26.	Shimla and Chamba region	Cereals(rice, wheat, barley, maize), pseudocereals(buckwheat, amaranths, Chenopods), forage crops(legumes, grasses), medicinal & aromatic plants, Temperate fruits and nuts, (*Pyrus* and *Prunus*), vegetables, chillies, grain legumes(lentil), oilseeds(brassicas), turmeric, ginger and wild and weedy and relatives of crop plants of the region.
Zone VII: North-west plains		
27.	Plains of Punjab and Haryana, hot semi-arid region	Sorghum, pearlmillet, Brassicas, ber, castor, cotton, forage grasses and legumes, karonda, citrus, jamun, melon, celery, grapes, pulses(kharif), maize, summer vegetables, M&AP.
28.	Ganga Yamuna doab and Awath plains, hot moist semi-arid region	Brassicas, cotton, forage grasses and legumes, mango, jamun, aonla, medicinal & aromatic plants, pulses(kharif), maize, summer and winter vegetables.
29.	Madhya Bharat plateau, Bundelkhand upland, hot semi-arid region	Aonla, bael and other minor fruits, chickpeas, chillies, Brassicas, forage grasses and legumes, guava, groundnut, medicinal & aromatic plants, pulses(rabi), safflower, wheat, rice, summer and winter vegetables.
30.	Western U.P. plains	Brassicas, cotton, forage grasses and legumes, mango, *Cucumis* spp., pulses(kharif), maize, summer and winter vegetables

Zone VIII: Sub-tropical/sub-humid region		
31.	Eastern plateau (Chota Nagar), hot sub-humid region	Horticultural crops, summer vegetables, medicinal & aromatic plants, rice, forage grasses and legumes, aonla, jackfruit, mango, bael, guava, neem, Acacia, tree species of industrial value, niger, linseed, Brassicas, wheat, minor millets, grain legumes(khesari), fibre crops (jute, kenaf and mesta), under utilized crops and wild and weedy relatives of crop plants.
Zone IX: Central Indian region		
32.	Western Maharastra, hot dry semi-arid region	Sugarcane, jamun, ber, winter vegetables, mango, medicinal & aromatic plants, forage grasses and legumes, jack fruit and other fruit species, *Coix* and wild relatives of crop plants.
33	Eastern Maharastra plateau, hot moist semi arid region	Lentil, khesari, pigeon pea, summer pulses, M&AP, forage grasses and legumes, jackfruit and other fruit species, mango, guava and other horticultural crops.
34.	Northern Maharastra region, hot semi-arid region of M.P.	Wheat, pigeon pea, chick pea, safflower, castor, winter vegetables, summer pulses, citrus, chillies, groundnut, cotton, M&AP and others.
35.	Southern Maharastra, Konkan, sub-humid region	Summer vegetables, M&AP, rice, jack fruit and other fruit species, castor, niger, *Vigna* spp. and others.
Zone X: South-east coastal region		
36.	Coastal Andhra Pradesh, eastern ghats (south), hot moist semi-arid region	Banana, cashew nut, castor, medicinal & aromatic plants, forage grasses and legume, horticultural plants, under utilized plants, minor millets, rice, cotton, mesta, vegetable crops, and wild/weedy relatives of crop plants.
37.	Telangana region	Medicinal & aromatic plants, horticultural crops, minor millets, pulses, coarse cereals, chillies.
38.	Rayalseema region	Medicinal & aromatic plants, horticultural crops, minor millets, pulses, coarse cereals, vegetables (kharif), wild relatives of crop plants.
39.	Bastar and Chhatisgarh region	Castor, oil seeds, medicinal & aromatic plants, horticultural crops, vegetable crops, cotton, wild relatives of crop plants.

Source: NBPGR (2000)

ANNEXURE – V

Agro – Ecological Zones with Their Features in Karnataka

Sl. No.	Agro-Ecological Zone	Characteristics	Crops and cropping system
1.	**North Eastern Transition Zone**		
	Bidar and parts of Gulbarga District	*Average annual rainfall:* 870 mm *Soil type:* Deep red lateritic and medium to deep black soils *Water holding capacity (per metre depth*): 17 to 22 cm in lateritic soils and 20-25 cm in medium to deep black soils *Length of growing period:* 90 to 120 days for lateritic soils, 125 to 150 days for medium to deep black soils Moisture stress on crops: Relatively low	**Black and lateritic soils (kharif season)** *Sequential cropping systems* Sunflower – chickpea/rabi sorghum Sesamum – rabi sorghum/sunflower *Inter cropping systems* Hybrid sorghum + pigeonpea (2:1) Black gram/gren gram + pigeonpea (4:2) Groundnut + pigeonpea (4:2) Sesamum + pigeonpea (4:2) **Black soils (Rabi season)** Wheat, rabi sorghum
2.	**North Eastern Dry Zone**		
	Raichur and Gulbarga districts	*Average annual rainfall:* 736.50 mm *Soil type:* Deep to very deep black soils and sandy clay loam to light ed sandy soils *Water holding capacity (per metre depth):* 18 to 20 cm for deep black soils, 25 to 27 cm for very deep black soils and 8 to 10 cm for sandy clay loamy soils *Length of growing period:* 125 to 135 days for black soils and 90 to 100 days for sandy to sandy clay loamy soils *Moisture stress on crops:* Higher due to more evapotranspiration and higher coefficient of variation in rainfall.	**Red soil and medium deep black soils** **(Kharif season)** Hybrid sorghum + pigeon pea (2:1) Sunflower + pigeonpea (2:1) Pearlmillet + pigeonpea (2:1) **Deep black soil** Chickpea + safflower (4:2) Rabi soghum
3.	**Central Dry Zone**		
	Entire Chitradurga district, parts of Tumkur, Chickmagalur and Hassan districts	*Average annual rainfall:* 606.8 *Soil type:* Sandy loam soil characterized with lesser depth *Water holding capacity (per metre depth)*: 10 to 15 cm *Length of growing period:* 90 to 100 days *Moisture stress on crops:* Severely stressed	Hybrid sorghum + pigeonpea (3:1) Fingermillet + pigeonpea (4:1) Groundnut + pigeonpea (8:2)

4.	**Northern Dry Zone**		
	Entire Bijapur and Bellary districts and parts of Belgaum, Dharwad and Raichur districts	*Average annual rainfall:* Very low average rainfall – 583 mm *Soil type:* Shallow (30 cm), medium (30 to 60 cm) and deep black (>60 cm) soils constitute 80% of the zone. Red loamy and sandy soils constitue 20% of the zone *Water holding capacity (per metre depth)*: 20 cm for deep black soils, 10 cm for medium deep, 7 cm for shallow black and 6 cm for red soils. *Length of growing period:* 90 to 120 days for medium to deep black soil, 75 to 80 days for shallow black to red loamy soils and 55 to 60 days for sandy to sandy loam soils. *Moisture stress on crops:* Crops experience severe moisture stress due to very low rainfall with higher coefficient of variation, desiccating wind velocity, higher potential evapotranspiration and less stored soil moisture	**Shallow black soils (Kharif season)** Pearlmillet + pigeonpea (2:1) Seteria + pigeonpea (4:2) **Medium deep and red loamy soils** Pearlmillet + pigeonpea (2:1) Spreading groundnut + pigeonpea (4:2) Bunch groundnut + pearlmillet (4:2) **Deep black soils** Rabi sorghum + chickpea (2:1) Chickpea + safflower (4:2) Coriander + safflower (4:2)
5.	**Eastern Dry Zone**		
	Entire Kolar and Bangalore districts	*Average annual rainfall:* 768.2 mm is received in two peaks, one in May and the other from September to October *Soil type:* Red loamy soils in major areas and few areas with lateritic soils *Water holding capacity (per metre depth)* These soils are shallow with low available water holding capacity of 14 to 20 cm *Length of growing period:* 90 to 120 days *Moisture stress on crops:* Higher degree of moisture stress is observed	*Sequential cropping systems* Sesamum – Fingermillet/horsegram Hybrid maize – Transplanted fingermillet *Intercropping systems* Fingermillet + pigeonpea (4:1) Groundnut + pigeonpea (8:2) Maize + pigeonpea (1:1)
6.	**Southrn Dry Zone**		
	Entire Mandya district and parts of Hassan, Mysore and Tumkur districts	*Average annual rainfall:* 730.7 mm *Soil type:* Red sandy loamy and black soils *Water holding capacity (per metre depth)*: 8 to 10 cm for red soils and 10 to 15 cm for black soils *Length of growing period:* 85 to 90 days for red soils and 100 to 125 days for black soils *Moisture stress on crops:* It is observed during July – August	**Red and black soils (Kharif)** Sunflower and mulberry *Intercropping systems* Hybrid sorghum + pigeonpea (3:1) Fingermillet + pigeonpea (4:1) Groundnut + pigeonpea (8:2) **Black soils (Rabi season)** Chickpea and Rabi sorghum

7.	**Southern Transition Zone**		
	Shimoga, Chikmagalur and parts of the Hassan and Mysore districts	*Average annual rainfall:* 875 mm *Soil type:* Major soils are latritic and red sandy loam *Water holding capacity (per metre depth)*: 18 to 23 cm *Length of growing period:* 90 to 150 days *Moisture stress on crops:* Due to well distributed rainfall with lower coefficient of variation and lower reference crop evapotranspiration these areas are seldom subjected to moisture stress	*Sequential cropping systems* Potato – Fingermillet/castor Sunflower – Horsegram Fingermillet – Bengalgram Hybrid maize – horsegram *Intercropping systems* Fingermillet + pigeonpea (8:2) Fingermillet + dolichos (4:2) Chili + hybrid cotton (1:1)
8.	**Northern Transition Zone**		
	Parts of Dharwad and Belgaum districts	*Average annual rainfall:* 749 mm with maximum of 1037 mm in Belgaum taluk and 838 to 623 mm in other talukas *Soil type:* Medium to deep black soils (40 to 45%) (>90 cm) and red soils in the remaining area *Water holding capacity (per metre depth)*: 25 to 27 cm for deep to very deep, black soils, 18 to 23 cm for medium deep, and 5 to 6 cm for shallow red soil *Length of growing period:* 125 to 150 days for black and lateritic soils, 90 to 100 days for red loamy soils and 75 to 80 days for clayey red soils *Moisture stress on crops:* Stress during July and August	**Medium deep black soils** *Sequential cropping systems* Potato – Wheat/Rabi sorghum Groundnut – Rabi sorghum/wheat Sunflower – Chickpea **Deep black soils** *Intercropping systems* Cotton + groundnut (1:2) Maize + pigeonpea (2:1) Chili + cotton + onion (1/2:1/2:2) Chickpea + safflower (4:2) **Alfisols and medium deep black soils** *Intercropping systems* Groundnut + pigeonpea (4:2) Sunflower + pigeonpea (2:1) Finger millet + pigeonpea (3:1) Chilli + cotton (1:1) Tobacco as a pure crop
9.	**Hilly Zone**		
	Kodagu, Uttar Kannada and parts of Shimoga, Chickmangalur, Belgaum, Dharwad and Hassan districts of Western Ghat and Malnad rgions	*Average annual rainfall:* 1000 to 3700 mm *Soil type:* Deep red clayey, gravelly, lateritic and brown forest soils *Water holding capacity (per metre depth)*: 18 to 20 c *Length of growing period:* More than 210 days	*Sequential cropping systems* Rice – chickpea Hybrid maize – chickpea *Intercropping systems of plantation crops* Arecanut + pepper + banana Cardamum + cocoa
10.	**Coastal Zone**		
	Uttar Kannada and Dakshina Kannada districts which include the coastal area of Karnataka	*Average annual rainfall:* Varies from 3000 – 3700 mm *Soil type:* Lateritic, red clayey, nongravelly and allvial soils are the major soil types *Water holding capacity (per metre depth)* *Length of growing period:* *Moisture stress on crops:*	*Sequential cropping systems* Rice – Groundnut Rice – Sesamum *Intercropping systems* Coconut + banana Coconut + pepper + banana Arecanut + banana Cardamom + cocoa

Source: Guled et al., 1997

APPENDIX – VI

Locations Suitable For Bee Keeping In India In Various States.

State	Distribution	
	Most suitable	**Moderately suitable**
Jammu and Kashmir	Doda, Anant nag	Kathna, Jammu, udampur, Rajouri, Poonch, Phulbarna, Baremulla, Srinagar, Kupwara
Himachal Pradesh	Kangra	Shimla, Chamba, Kinnaur
Punjab/Haryana	Gurudaspur, Hoshiarpur, Amritsar, Ludhiana, Sangrur, Patiala	
Rajasthan/Gujrat	Yamunanagar, Rothak, Jind, Ganganagar, Kutah	
Madhya Pradesh	Raigarh, Raipur, Bastar, Kathiwada, Jhabua	
Maharashtra	Mahabaleshwar, Bhimashankar	
Uttar Pradesh	Almora, Pithoragarh, Nainital, Deoria, Balia, Azamgarh, Jaumpur, Banaras, Dehradun, Saharapur	
Bihar	Samastipur, Muzaffarpur, Champaran, Dharbhanga, Vaishali, Saran	Ranchi, Gumla, Hazaribhag
Orissa	Koraput, Mayurbhanj, Phulbani, Koinjhar, Dhinkanal, Cuttack, Puri, Balasore	
Tamil Nadu	Madurai, North arcot, Tirunalvali, Salem, Dharmapuri, Nilgiris, Coimbatore, Ramanathapuram	
Kerala	Kannur, Trivandrum, Kozikode, Kasaragod, Malapuram	Idukki, Kottayam, Ernakulam, Trichur, Quilon, Pathanamthitta, Palghat, Alleppy, Wynad
Andhra Pradesh	East Godavari, Eluru, Krishna, Srikakulam, Vizianagaram, Vizag	Guntur, Prakasham, Nellore
Karnataka	Kodagu, Dakshina Kannada, Udupi, Shimoga, Hassan, Chikmagalur, Mysore, Uttarkannad	
North East India	Entire North Eastern Sates (majority of districts)	
West Bengal	Sundarban and several others	