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Assessment of exchange of crop in view of change climate and International Treaties

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Abstract

To meet the UN millennium development goal of reducing the number of hungry people to half by 2015, there is utmost need to breed potentially high yielding varieties to match up the requirement along with corrective measures to bridge the gap between the potential yield and yield harvested by farmers. The scenario has changed from free access to limited access of plant genetic resources (PGR) and therefore, it is important to understand the issues in view of national and international agreements, intellectual property rights (IPR'S), climate change conditions and expanded scope of breeders and farmers rights for developed genotypes. For efficient management of PGR, developing countries need to understand the implications of PGR related IPR'S as stronger IPR'S in developed countries could have harmful effects by reduced exchange of genetic resources from developed countries. Keeping in view the existing realities every possible effort should be taken for enrichment of crop gene pool by introducing them from each and every corner of the globe. Keeping these facts in view this paper describes the priorities for introduction and exchange of important crop groups / crops along with some of their potential wild and weedy relatives and thrust has been given to generate awareness among the workers engaged in the breeders /crop improvement works. Information provided in this presentation can be utilized by prospective crop improvement works to plan to meet out the national food security.

Key words

Biodiversity, Climate change, International treaties, Plant genetic resourse

Introduction

Studies done by FAO, IFPRI and FHWWI suggest that countries like China, India, Indonesia, Brazil and Nigeria would have half of the world's population (8 billion) by 2020 and will have serious food deficits. In India, despite increase in its population from 548 million in 1971 to 1.21 billion in 2011; the per capita net availability of cereals has not increased as set in the 1960s. It was 417.6 g day^{-1} in 1971 and still 436 g day^{-1} in 2008. To feed burgeoning population our food production has to grow at pace of 3.0 % annually, and by 2020 it should be of 280 MT (Singh and Kumar, 2009;Singh *et al.,* 2011). India has the potential to change its agricultural scenario by ever green revolution with effective inclusion of new and unexplored crops. Indian crop production system excels amidst several biophysical adversities due to diverse agro-climatic regions which comprise tropical, sub-tropical and temperate regions. In these types of climatic conditions, various kinds of crops including horticultural crops can be grown (Ahmed e*t al.*, 1974; Singh *et al.,* 2009 and Chandel, 1996). To produce more food with promotion of natural resources conservation, better crop selection having desired genetic make-up, appropriate cultural practices and timely socio-economic interventions are required (IARI, 1970; Khoshoo, 1996; Singh *et al.,* 2011).Wild relatives of crop plants represent a part of crops gene pool particularly resistant to biotic and abiotic stresses that have been the donors of many other useful traits. Quality seed is the key to successful crop production (Arora and Nayar, 1983; Arora and Chandel, 1972; Chatterjee, 1939; Harlan, 1976; Hawakes, 1977).With the advent of new techniques in the field of molecular biology, transfers of genes from wild to cultivated forms are now possible at will (Singh *et al.,* 2010; Harionarayana*et al.,* 1987; Mc Fadden, 1930). Now, time has come to make all efforts for sustainable management of biodiversity.

For sustainable management of plant genetic resources proper planning is needed for exploration, collection, evaluation and equitable utilization of priceless plant genetic resources to match with the demand of food. Efforts should be made for enrichment of crop gene pool by introducing them from each and every corner of the globe, and there is also the need to strengthen our plant exploration, for its sustainable use of indigenous genetic resources(Khoshoo,1988; Khoshoo,1996; Singh *et al.,* 2011). The purpose of this article is to assess the status of plant genetic resources in India and their needs for boosting crop production in the light of International treaties and change in climatic conditions. Emphasis has been given to generate awareness among the workers engaged in breeders /crop improvement works. These can be utilized by prospective crop improvement work to plan to meet out the national food security.

Bio diversity and plant genetic resources (PGR): Indian share : Biodiversity encompasses variety of life on earth and manifests itself at three levels: species diversity which refers to the number and kind of living organisms; genetic diversity which refers to genetic variation within species; and ecosystem diversity which denotes the variety of habitats, biological communities and ecological processes (Harlan, 1971; Singh *et al.,* 2004; Singh *et al.,* 2005). Knowledge of the number of species inhabiting the earth is still incomplete; estimates vary from 8 to 14 million. Till date, about 1.7 million species have been described while many more await discovery. India, with 2.4% of the total land area of the globe accounts for 7-8 percent of the recorded species of the world, spread over 45,500 species of plants and 91,000 species of animals (Arora *et al.,* 1975; Bhagmal *et al.,* 1970; Harlan, 1971). Nearly 6,500 native plants are being used in indigenous healthcare systems and nearly 140 native breeds of farm livestock; continue to thrive in its diversified farming systems. The country is recognized as one of the eighth VCODCP, having more than 300 wild ancestors and close relatives of cultivated plants (Chatterjee, 1939; Chandel, 1996; Paroda *et al.,* 1986). About 80,000 species of plants have been used to meet the routine needs of human beings. So far 30,000 species have been identified as edible and about 7,000 species have been cultivated and /or collected for food at one time or the other (Dabadghao *et al.,* 1972; Chopra *et al.,* 1981; Mehra *et al.,* 1986; Whyte, 1964). Man uses 3000 or more plant species for food and cultivates about 150 species. Currently, only 20 to 30 crops such as cereals (wheat, rice, maize, millets, and sorghum), root/tuber crops (potato, sweet potato, cassava), legumes (pea, bean, peanut, soybean), sugarcane, sugar beet, coconut and banana are mainly used to feed the world. Crops that produce at least 20 million metric tons include wheat, rice, corn, potato, barley, sweet potato, cassava, grape, soybean, oat, sorghum, sugarcane, millet, banana, tomato, sugar beet, rye, orange, coconut, cotton, apple, yam, peanut and watermelon. India is treasurer of agro-biodiversity, its proper management and utilization in sustainable manner, conservation with futuristic approach and equitable sharing are some basic rules to follow for its environmental friendly and sustainable evolution of plant genetic resources (Singh *et al.,* 2008; Mehra *et al.,* 1971; Mehra *et al.,* 1975).

Plant introduction, domestication and selection : Most of the crop species have a long history of domestication; however, many wild species are yet to be explored from natural habitats, particularly in tribal belts. Plant introduction scientists have to be on alert to know and locate, where the evolution of plant species of interest is actively in progress. Emphasis should be on the introduction of plant genetic resources with broader genetic bases. It also implies domestication of crop species in new areas beyond their habitat/form e.g. *Simmondesia chinensis* (Jojoba), in area outside USA and Mexico (Singh *et al.,* 1984; Singh *et al.,* 2005; Stalker, 1980). In India, it is in the process of establishing itself in arid areas of Rajasthan and Gujarat. There is close relationship between plant's behaviour pattern and response to environment and its physiology. The influence of individual environmental factors such as temperature, moisture, light etc. and their inter-relation in the whole ecosystem has been significant in shaping a variable form, which is evident from specific environment interactions. The first step in the development of cultivated plants is their domestication. It is the process of bringing a wild species under human management. It is still being done and is likely to continue for a long time in future because human needs are likely to change with time (Arora and Nayar, 1983; Stalker, 1980; Sundararaj, 1967; Swaminathan *et al.*, 1992). Consequently, the wild species of little importance in today's context may assume greater importance tomorrow. Prehistoric men domesticated most of the crops knowingly or unknowingly and must have selected the characteristics suited to them (Singh *et al.,* 1990; Arora and Nayar, 1983).Under domestication, the crop species have changed considerably as compared to wild species from which they originated. The change is often so vast that they are classified as distinctive species. The

Table 1 : Global agro biodiversity interdependence indicator

Region	Production (%) by non-native crops		
	Kloppenburg and Kleinman, 1987[#]	Cooper *et al.* (1994)	NBPGR (2004)*
Australia	100	100	100
North America	100	100	94.5
Mediterranean	98.2	99	100
Africa	87.7	88	91.4
Chino-Japan	62.8	62	85.6
Latin America	55.6	56	85.2
Hindustan	48.5	49	63.7
Indo-China	33.2	34	75.5
West Central Asia	30.8	31	63.7

Kloppenburg and Kleinman, 1987. Bio Science 37 (3): 190-198; *National Bureau of Plant Genetic Resource. New Delhi. *Annual Report*. 2004

great difference between cultivated plants and their wild relatives was brought about by selection by man as well as nature (Arora and Nayar, 1983; Chandel ,1996; Paroda *et al.,* 1986). Precise sequence of events in evolution of crop plants under domestication is not known. But it may be generalized that in the early stages a considerable variability existed in the domesticated species. New variability arose from hybridization followed by recombination and from mutation. The extent and manner of selection exerted by man on the domesticated species is not known. Selection may be described as the phenomenon of some genotypes from a population leaving behind more progeny than others (Reevs, 1950; Sharma *et al.,* 2003; Mc fadden, 1930). The genotypes that produce more progeny are selected for, and the other are selected against. In nature, there is continuous selection by natural forces e.g. temperature, soil, weather, pests, diseases etc. As a result, the genotypes more suited to a green environment leave behind more progeny than the less adapted ones. This process is called natural selection, thus it rarely stops a genotype from producing any progeny. Selection by man (artificial selection) on the other hand, often permits only the selected plants to reproduce; the progeny from the remaining plants are is generally discarded. Thus, natural selection retains considerable variability in the species, while artificial selection progressively reduces variability (Reevs, 1950; Singh *et al.,* 1990).

As per the study conducted by various workers on interdependence of PGR, crops dependence values for native crops and introduced crops estimated for 12 megacentres **(***1Chinese, 2 Indonesian, 3 Australian, 4 Indian, 5 Central Asian, 6 West Asian, 7 Mediterranean, 8 African, 9 Euro-Siberian, 10 Central American, 11 South American, 12 North American) are reported in Table1. This clearly indicates that no county is fully self-dependent in case of PGR. Countries like Australia and North America are almost totally dependent on other countries for their PGR requirement (Chandel,1996; Paroda *et al.,* 1986; Swaminathan *et al*., 1992; Brahmi *et al.,* 2005; Tyagi *et al.,* 2010).

Climate change and their role in Indian agro-biodivrsity *vis - a- vis* Indian agriculture : Climate is usually defined as the average weather, or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time, ranging from months to thousands or millions of years. The term climate change refers to a statistically significant variation in the mean stage of the climate or in its variability, persisting for an extended period, typically a decade or longer. Climate change may be due to natural internal processes or external forcing, or due to persistent anthropogenic changes in the composition of atmosphere or in land use. The fourth assessment report of the Intergovernmental Panel on Climate Change (Aggrawal, 2003; IPCC, 2000; IPCC, 2007) confirms that the global average temperature has increased by 0.74°C over the last 100 years; and the projected increase in temperature by 2100 is about 1.8 to 4.0°C. An increase of temperature by 1°C would be equivalent to 150 km Northward shift of isotherms (lines joining places with similar temperature) or about 150 m lower altitude (Aggrawal, 2008; IPCC, 2007). Global warming poses a potential threat to agricultural production and productivity throughout the world and this might affect crop yield, incidence of weeds, pests and plant diseases and the economic costs of agricultural production. Crop productivity is projected to decrease even by a small rise in temperature (1 to 2°C) at the lower latitudes, especially in the seasonal dry and tropical regions (IPCC, 2007; Verchot, 2007). There is a 5 % decrease in rice yield at each °C rise in temperature above 32 °C. The reduced length of growing seasons as a result of climatic change could cause detrimental effects on agriculture. In South Asia, crop yield could decrease by 50 % by 2050 if suitable measures are not been taken. The most significant impact of climatic change is expected with respect to the availability of water. Sinha and Swaminathan (1991) reported that the magnitude of yield gains and losses of crops at the selected sites under elevated atmospheric CO_2 and associated climate change; integrated impact of rise in temperature and CO_2 concentration on crops yield may be negative. It was estimated that a 2°C increase in air temperature could decrease rice yield by about 0.75 tons ha^{-1} in high yielding areas. Experimental results on CERES Sorghum simulation indicated a decrease in yield and biomass of rainy season sorghum at Hyderabad, and Akola under all climate change scenarios.

The positive effect of increased CO_2 if any, was masked by the adverse effects of predicted increase in temperature, resulting in shortened crop growing seasons. Gangadhar *et al.* (1995) and Aggarwal (2003) reported that in North India irrigated wheat yields decreased as temperature increased by 2°C resulting in 17 % decrease in grain yield and with further increase in temperature the decrease in yield will be very high. Atmospheric CO_2 concentration has to rise to 450 ppm (parts per million) to nullify the negative effect of rise in temperature. So the effect of climate change scenario of different periods can be positive or negative, depending upon the magnitude of change in atmospheric CO_2 and temperature. Kalra *et al.* (2008) reported decrease in chick pea grain yield per degree rise in the Rabi season temperature was observed in Haryana (3.0 1 q ha^{-1}), followed by Punjab (1.81 q ha^{-1}), Rajasthan (1.27 q ha-^{1}) and Uttar Pradesh (0.53 q ha^{-1}). It was further indicated that due to climate change, there may be reduction in crop yield by 10 to 40 % of the present yield level by the end of the century.

Plant genetic resources exchange in the light of international treaties : Mutual give and take of germplasm or PGR from all the available sources can be described as Germplasm Exchange, and PGR may be a seed, a plant or plant part that is useful in crop breeding, research or conservation because of its genetic attributes (Dhillon and Agrawal, 2004; Hamilton *et al*., 2005). The word "genetic resources" was used for the first time in 1967 in the 2nd Tech meeting on Plant Exploration and Conservation co-hosted by FAO and International Biological Programme to assess the danger of genetic loss in diversity of crop plants and to define a global strategy for conservation of PGR. PGR exchange offers enormous opportunity for better economic growth, potential stability, human health and sustainable environment. There is a continuous need of genetic resources for developing varieties resistant to various pests and diseases and to improve the quality and quantity traits. Genetic resources constitute undeniable interdependence between countries and continents. Even biodiversity rich regions depend for more than 30 % of their food production on crops originating from other countries (Cooper, 1994) and this interdependence plays a vital role in international collection and exchange of germplasm. Acquisition of diverse and superior germplasm and their conservation is an important concern (Chandel, 1996; Paroda *et al.,* 1986; Swaminathan *et al*., 1992; Singh *et al.,* 2003; Singh *et al.,* 2004; Singh *et al.,* 2008; Tyagi *et al*., 2008)

Due to the advent of IPR regime flow of plant genetic resources from everywhere to the developing world is slowing down. Secondly, we are not getting the trait specific materials as it was previously observed. It may be due to several reasons but reservation by most of the donor countries is one of them. Under this circumstance judicious evaluation of existing germplasm /genetic resources is to be conducted for crop improvement for our current and future requirements as well (Tyagi *et al*., 2008; Brahmi *et al.,* 2005). Achievement of the Indian agriculture in 60s and 70s with respect to staple crop production was one of the most remarkable successes in the history of technological development at the global level. In order to feed the burgeoning population there is urgent need to double the cereal crop production by the year 2050. Therefore, utmost need is to breed potentially high yielding varieties to bridge the huge gap between potential yield and average yield harvested by farmers. Before 1970 agriculture had been tremendously benefitted in the past through unrestricted exchange, utilization and marketing of germplasm. Farmers were the breeders and conservers, and breeders obtained seeds by buying or collecting or accepting from farmers as gift. They had full right to do anything with the seeds without restriction. Thus, every country gained more than what it contributed. It promised self-sufficiency in food, food security and improved economy. Green revolution was made possible under such international germplasm exchange. Earlier, biodiversity including PGR was regarded a common heritage of mankind, (everybody should have access to resources to meet their basic needs). Free availability of germplasm, especially from *ex-situ* collection of CGIAR centres helped most countries to strengthen crop improvement programmes. India has benefitted tremendously by importing germplasm, varieties and new crop species from other countries, which have improved agricultural productivity and led to diversification of crop species (Brahmi *et al.,* 2005; Tyagi *et al.,* 2008;Tyagi *et al.,* 2010). Due to Convention on Biological Diversity (CBD), a paradigm shift has been noticed in free flow of genetic resources to a restricted exchange. Developing countries began to argue that common heritage implied the existence of common responsibilities, an important point given concern over loss of diversity in farmer's fields and absence of any global system, or mechanism, for preventing genetic erosion. The concept behind was that profits accrued from developing commercial products such as new varieties or new compounds should be shared with the provider of the genetic material/ resources used to develop the product and thus various issues related to the access of germplasm came into the forefront.

Issues related to access to germplasm and intellectual property rights (IPR's) : IPRs refer to ideas or information which is used in new inventions or processes. It enables the holders to exclude imitators from marketing such inventions or processes for specified period of time in exchange; holder is required to disclose the formula/ idea behind the product/process.Effect is therefore, the monopoly overexploitation of idea/information for a specified period of time. IPR is therefore are an opportunity to stimulate invention by offering higher monetary returns. Apprehensions related to limited access to PGR has raised several question such as ownership issues and availability. Questions such as who owns biological resources/living things (Dua, *et al*., 2004; Evenson, 1999; Hamilton *et al*., 2005) and can these be shared or sold. Can we use it for breeding and research without any obligations for using them? The dilemma of doing only what we are allowed to do and also to ensure that others do what they are allowed to do. These issues were addressed to the policy makers and concerns were far beyond the scientific communities. Thus, understanding these issues and complying with them is a priority to meet the ever-changing needs of crop improvement programmes and sustainable agriculture. Plant Breeder Rights (PBR) in 1970's was implemented in many developed economies of the world which encouraged expansion of private sector breeding. Inclusion of IP rights in the Trade –Related Aspects of Intellectual Property Rights (TRIPS) section of General Agreement on Tariffs and Trade, now World Trade Organization (WTO), were widely discussed in the context of international trade, agriculture and development, The WTO TRIPS agreement required all signatories to implement IPR protection for a range of biologically based material that they had not previously been obliged to protect.

Many developing countries were required to address Intellectual Property issue for the first time. With stronger patent rights incorporated into TRIPS and biodiversity being regarded as a treasure under national sovereignty, apprehensions on free exchange of germplasm were raised. Issues were raised on the ownership of PGR and benefit sharing, as the vast collection of germplasm conserved in various gene banks in CG system were collected from gene rich/economically developing nations and stored away from the place of collection. Continued free exchange of germplasm was the main concern but more importantly the most critical issue is how the farmers who are the true discoverers, conservers, producers and breeders of these invaluable resources can benefit from these resources. For addressing these issues and concerns, several international agreements and conventions entered into force which directly or indirectly had implications on the conservation and access of genetic resources (Brahmi *et al.,* 2005; Tyagi *et al.,* 2008; Tyagi *et al.,* 2010). These international and national agreements and conventions which address the issues of access to biological resources are discussed hereunder briefly.

Trade related aspects of intellectual property rights (TRIPs) : The main objective of TRIPS is to recognize and protect monopolistic and private IPR's. Enjoins to grant patents for any inventions in all field of technology which covers biotechnology, Hence, biodiversity falls firmly under the legal regime. But article 27(2) and (3) in TRIPS provide important exceptions in favour of protecting environment and thereby the biodiversity. There are two preconditions to exclude inventions from patentability. Commercial exploitation of the invention should be disallowed, such prevention is necessary for the purpose of avoiding serious prejudice to the environment, exclusion should not merely because the exploitation is prohibited by domestic law. Interface between TRIPS and CBD has not been tested between them which hold legal priority, TRIPS being later in time should supersedes CBD in case of conflict, however CBD deals more specifically with protection of public and morality. TRIPS has a valid ground for protective measure and CBD provision should supersede those of TRIPS.

International undertaking on plant genetic resources (IUPGR) : Based on the universally made principle that PGR is heritage of mankind and consequently should be available to everyone without restriction. FAO in 1983 adopted a non-binding International Undertaking on Plant Genetic Resources (IUPGR) with the objective to ensure that PGR are of economic and / or social interest particularly for agriculture, will be explored, preserved, evaluated and made available for plant breeding and research purposes. FAO Commission on Genetic Resources for Food & Agriculture (CGRFA) monitored the implementation of IUPGR. However the principle gradually narrowed and 1989 amendment made it consistent with Plant Breeder's right favouring technology rich countries.

Convention on biological diversity (CBD) : Most widely adopted UN agreement ever aimed at conservation and sustainable use of the components of biodiversity with fair and equitable sharing of benefits arising from the utilization of genetic resources was adopted in the background of increased threat to genetic resources by the developments in biotechnology. Legally binding Convention on Biological Diversity (CBD) entered into force in 1993. Access is to be determined by national governments subject to Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT). Accordingly, patents on genetic material can only be consistent with the CBD if the resources are acquired legally (with national approval). Thus country of origin and proof of PIC together known as disclosure issues be indicated in patent applications. Though it was meant to encourage exchange of germplasm, it also raised the required level of negotiations (CBD, 1992).

International treaty on plant genetic resources for food and agriculture (ITPGRFA) : Legally binding ITPGRFA was thus negotiated as a direct response to CBD in 2001, came into force in 2004 to facilitate access to PGRFA in harmony with CBD, through an efficient mutually agreed Multilateral System (MS) of access and benefit sharing. Access is only for research, breeding and training and not for chemical, pharmaceutical nor non-food/feed industrial use. No Intellectual Property rights can be claimed on the form received from MS that limit the facilitated access to PGRFA/genetic parts or components. To ensure that the germplasm is used only legally, the Material Transfer Agreement (MTA) binds terms and conditions on the recipient to use it. MTA is signed for both inflow and outflow of germplasm. The treaty works through inter-governmental agreement as required by CBD. Two key components of the treaty being: each party should facilitate germplasm exchange for a list of crops covered in Annexure I (includes 35 food crops and 29 forages), which are important for food security and for which countries are interdependent; provides a system to enforce equitable share of benefits, through a central fund for obligatory payments to country of origin. Despite the position taken by CBD that IP issues must not conflict with the conservation and sustainable use of biodiversity and must be supportive, conflicts do arise. India enacted two laws to implement TRIPs and CBD first Protection of Plant Varieties and Farmers Right Act (PPV and FR Act) and second Biological Diversity Act (BDA).

Plant varieties and farmers right act (PPV and FRA) : The Indian PPV and FR Acts provide effective system for protection of plant varieties, and protect rights of farmers and breeders. The Act has recognized farmer as a conserver, provider of genetic resources, breeder and as a producer and consumer of seeds and is effective from January 2005 (www.plantauthority.in). Bramhi *et al.,* 2004.

Biological diversity act (BDA) : Under the provisions of the CBD, Government of India enacted legislation called Biological Diversity Act (BDA) in 2002 and also notified the Biological Diversity Rules in 2004. The objective was to provide access to biological resources of the country and equitable share in benefits arising out of the use of biological resource together with sustainable use and conservation of biological diversity. As per the Act (Section 3), no person from outside India or a body corporate, association, organization incorporated or registered in India having non -Indian participation in its share capital or management, can access any biological resources or knowledge associated, for research, commercial utilization, bio-prospecting or bio-utilization, without proper approval of National Biodiversity Authority (NBA). No person can apply for any IPR in or outside India for any invention based on any research or information on a biological resource obtained from India without obtaining approval from NBA. Collaborative research projects involving transfer or exchange of biological resources of information between Governments sponsored institutions of India, and such institutions in other countries, if they conform to the policy guidelines or approved by the Central Government are however exempted. The person who shall be required to take the approval of the National Biodiversity Authority [Section 3 (2)] are, namely (a) a person who is not a citizen of India; (b) a citizen of India, who is a non-resident as defined in clause (30) of section 2 of the Income tax Act, 1961; (c) a body corporate, association or organization- (i) not incorporated or registered in India; or (ii) incorporated or registered in India under any law for the time being in force which has any non-Indian participation in its share capital or management *(Dua* et al., *2004*; Tyagi *et al.,* 2010).

Transfer of plant genetic resources/germpalsm material from India to other countries : Any supply/exchange/transfer of genetic resources for food and agriculture/ germplasm/ genetic material/ genetic components for research export of germplasm out from India is done under Material Transfer Agreement (MTA), which specifies the conditions for exchange of germplasm between two parties and both the parties sign it or agree upon. These include the conditions of purpose of exchange, IPR clauses, and third party transfer etc. The conditions for transfer are as follows: Within India, not covering persons as described in Section 3 (2) of the Biological Diversity Act, 2002 (18 of 2003) (BDA); Within India, wholly or partly covering persons as described in Section 3 (2) of BDA; Outside India, with Members of the International Treaty for Food and Agriculture (ITPGRFA), wholly or partly covering persons as described in Section 3 (2) of BDA; Outside India, with non-members of ITPGRFA, and wholly or partly covering persons as described in Section 3 (2) of BDA. Standard Material Transfer Agreement (MTA) specifies the conditions for exchange of germplasm between signatories (parties) to International Treaty for Plant Genetic Resources for Food and Agriculture.

Plant introduction in india during pre-and post-cbd period– an analysis : Introduction of exotic germplasm has enriched the Indian agriculture since times immemorial. Introduction has resulted in establishment of large number of crops and development of high yielding varieties.Not only India, almost all countries are interdependent with respect to genetic resources required for their crop improvement programmes. Enforcement of CBD and provisions of TRIPs in 1990's led to the apprehension that exchange of germplasm would get restricted. Hence, an analysis was carried on introduction of germplasm from foreign sources including CG centres by Tyagi *et al.* (2008). In this analysis period undertaken was (1988-1992) for Pre-CBD and (1997-2001) Post-CBD (Fig. 1). Period 1993 to 1996 was excluded to avoid the effect of transit phase. Results showed that introduction/inflow of PGR from CG Centre decreased from 51 to 49 % whereas contribution from various National Gene Bank increased from 46 to 54 percent during study period. Therefore,

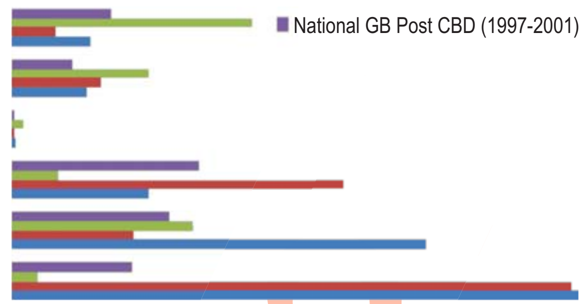

Fig. 1 : Plant Introductions in India during Pre-and Post-CBD Period

an overall decline of 6.6 percent was observed in introduction of accessions during post-CBD period. Number of accessions pre-CBD was decreased from 89,561 to 83,682. Despite overall decrease, there was an increase in import of accessions from CG centers. Number of accessions pre-CBD was increased from 42,911 to 44,057. The decline from CG Centre was confined to supplies from NGBs, which suggest of cautious approach adopted by different countries in sharing of germplasm. The analysis revealed that overall decline of 14.5 percent in the imported germplasm during post CBD period attributed to the restricted supply from National Gene Banks of various countries, indicating cautious approach adopted by different countries post CBD in sharing their germplasm. Also an interesting fact was observed that 81 % of germplasm introduced from NGB did not originate as these were not the centres of diversity for that particular biological resource. These reflect that these countries might have realized the importance of PGR much earlier and have vast collections of PGR.

Plant genetic resources (PGR)**exchange - present context :** Access to germplasm is now viewed as politicized and legally controlled, subject to international agreements as well as national legislations. In addition, the agriculture scenario is confronted by numerous other problems which call out for modalities for benefit sharing, for ensured continuity of germplasm exchange. Critical analysis of laws and policies that impact access and use of germplasm needs to be done. The future demands for mutual agreements to undertake research and accessing the germplasm and technologies without infringing IPRs. Therefore, if any new technology is developed it should also spell out the terms and conditions on which it may be made available. As one can foresee considerable dangers to food security if the technologies are not accessible to those who really need them and there is no alternative for them. It is, therefore, to be spelt clearly whether the current scenario is encouraging or restricting research and development. Certainly now the future of biodiversity is to be decided by utilization of genetic resources for obtaining IPR. Dua *et al.,* 2004; Evenson, 1999; Brahmi *et al.,* 2005 has discussed about the policy scenarios based on restricted resource exchange and evaluated using the International Model for Policy Analysis of Agricultural Commodities (IMPACT) by International Food Policy Research Institute (IFPRI) and in Scenario 1 discussed about the potential effects of stronger IPRs in developed countries combined with limited IPRs in developing countries. Whereas in scenario 2 he describes potential effects of a 10-20 year period of dispute resolution over farmers' right, limiting genetic resource stocks from which to develop improved varieties and concluded that the expansion of IPRs if properly managed actually lead to welfare improvement. However, the scenarios when explored have shown deleterious effects on the welfare of consumers in developing countries. Policy makers need to understand the importance of maintaining systems of genetic resource exchange. What one is supposed to do now is to learn more about the changing scenario of IP regime which is guiding the management of PGR and exchange of these resources following all if's and but's of the policy. To regulate access to the germplasm and to ensure that it is used legally the exchange is done under Material Transfer Agreement (MTA) in and out of country through single window system. The MTA defines the terms and conditions which are binding on the parties who are signatory to it. The terms and agreements specified speaks what can be done and what cannot be done with the acquired germplasm and thus ensures its compliance with all relevant national and international agreements and treaties. The MTA is signed for all germplasm designated in different groups viz. germplasm governed either by ITPGRFA, or by CBD and for germplasm not covered by either of them. The possible next steps are to prepare options for national implementation; looking at how national legislation conforms to international obligations; to continually study inter linkages with other organisations and provide support for participation in specific meetings/ organisations/ forums (Dhillon and Agarwal. 2004; FAO,2002; Singh *et al.*, 2005; Tyagi *et al.,* 2010).

Acquisition of more exotic germplasm as early as possible has become priority due to latest development under convention on Biological Diversity and other International treaties and laws, which makes flow of genetic resources bit more difficult than it was ever before enforcement of new laws. Germplasm of diverse crops were required for our National needs which were further distributed to various potential users (breeders/crop improvement workers) in the country for its evaluation and further utilization in their ongoing /ensuing crop improvement works for our food and nutritional security. Now we are facing multi-faced challenges posed to our agricultural production system. To sustain the current requirement and future needs we have to widen our genetic resources for crop genetic wealth to march ahead from food security to nutritional security (Dua *et al.,* 2004; Singh *et al.*, 2003; 2004; 2008; 2010; Tyagi *et al.,* 2008).Trait specific genetic materials are needed to sustain our long term needs. Now the stage is set to reorient pre breeding/breeding/ advanced breeding works by its utilization. If utilized in the right direction it will transformed Indian agricultural scenario in short span of time. This will boost Indian economy and will have synergistic effect on the mega national goal of second green revolution. The flow of plant genetic resources from everywhere to India is slowing down gradually in the era of strong intellectual property right (IPR). Secondly we are not getting the trait specific materials as it was previously seen. It may be due to several reasons but reservation by most of the donor country is one of them. Under this present circumstance we have to judiciously evaluate our existing germplasm / genetic resources to plan and conduct crop improvement programme for our current requirement and future use as well. The main thrust of this paper is to generate awareness among the workers engaged in crop improvement by its wide circulation. Let the entire worker should know what kind of genetic stock (germplasm) is already available in India, tagged with some prominent features expressed in particular agro climatic conditions and what exactly is needed for agricultural sustainability as a whole. The National Bureau of Plant Genetic Resources (NBPGR) is the nodal organization in India for all activities concerning exchange of crop genetic resources which will cater the Indian needs well in advance (Singh *et al.*, 2003; 2004; 2008; 2010; Tyagi *et al.,* 2010).

Need of germplasm : Every crop plant has some unique agronomic traits which influence the economy produce of the crop. The trait may vary from crop to crop to grate extent and some extent by the agro-climatic situation and micro climate. In this paper emphasis are given on plant stature, duration of crop, tilling / branching behaviour's, flowering and maturity, required for Indian agriculture.

Realization of the potential of economic yielding capacity depends on numerous factors. Economic yields, being a polygenic character, are also influenced by biotic stresses. Insects, pests and disease causing elements are commonly known as biotic stress causing agent. In modern agriculture, the genetic base is narrowing due to use of fewer genes to produce new cultivars / improved varieties, which is a potential threat under adverse condition for crops and favourable conditions for biotic agent. Biotic stress has the potential to vanish total crops as it was seen in past like Irish potato famine and Bengal rice blast etc. There is urgent need to broaden the base of genetic makeup of the varieties of crops to counter effect on this trait. Hence, in this citation we are mentioning the crop and their most important biotic trait to be introduced from abroad, which can be utilized by crop improvement man in their programme against the particular pest.

Abiotic stresses are one of the major cause of hindrances for crop production. These stresses are highly influenced by adaphic, topographic, climatic and geographical conditions. Drought, flood/submergences, heat, cold, salinity and alkalinity, acidic and physiological stress are common and frequent in nature. Information pertaining to introduction on this aspect is covered in this presentation for specific crops.

Quality of produce is one of the important parameter which is going to attract more prices. The data recorded by researcher in this accept is present here. The need for most promising introduction in respect to quality traits were categorized into different sets and mentioned for each crops on priority basis.

Crop group based priorities for specific trait are to be identified to cater the nations requirement. Accordingly, comprehensive enlisting is to be carried out for procurement of particular germplasm to be introduced from specific country.

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