Genetic Erosion of Agrobiodiversity in India and Intellectual Property Rights: Interplay and some Key Issues

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Abstract

Agrobiodiversity is the backbone of a nation's food security and the basis of economic development as a whole. Over the years this diversity in India is under pressure due to the massive commercialisation of agriculture leading to the almost extinction of traditional farming systems. The top-down system of agricultural research, where farmers are seen merely as recipients of research rather than as participants in it, has contributed to an increased dependence on a relatively few plant varieties. This trend and the increasing industrialization of agriculture are key factors in what can only be called "genetic erosion". The term refers to both the loss of species and the reduction of variety. Behind this commercialization there lies the interest of the breeders for obtaining intellectual property rights. It has a very complicated relationship with this diversity. The paper highlights this relationship and provides some suggestions in order to rectify the current negative phenomenon.

India's agrobiodiversity is most significant one in the world. This diversity is the result of thousand of years of farmer's selection, experimentation (even cross breeding) and propagation of desirable traits of desirable species in innumerable ways for their subsistence and cultural purposes. Over the years this unparallel diversity of various crops of India has been eroded. Replacement of landraces (a crop cultivar that evolved with and has been genetically improved by traditional agriculturists, but has not been influenced by modern breeding practices) or TVs (traditional varieties) by MVs (modern varieties) or HYVs (High Yielding Varieties) is one of the most important reasons. Breeders from many international agricultural research oraganisations and multinational companies accessed pure parental lines seeds of many traditional varieties and bred with other in order to achieve MVs. Most of the MVs are protected by various forms of Intellectual Property (IP) Rights (IPR-Intellectual property deals with the creations of the human intellect. Intellectual property rights are the rights awarded by society to individuals or organizations principally over creative works: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. They give the creator the right to prevent others from making unauthorized use of their property for a limited period) like Patents (a patent is an exclusive right awarded to an inventor to prevent others from making, selling, distributing, importing or using their, without license or authorization, for a fixed period of time) and Plant Breeder's Rights (PBR- plant breeder's rights are granted to breeders of new, distinct, uniform and stable plant varieties and it is a form of IPR) etc. Genetically uniform MVs that are being cultivated from *Kashmir* to *Kanyakumari*(north to south of India) and *Assam* to *Gujrat*(east to west of India)have not only eroded TVs but also damaged irrepairably the diversified cultures, cultural expressions and promoted regional disparity. Promotion of genetic uniformity in the name of agricultural development (so called "green revolution") cannot lead to the sustainable agriculture and it has devastating effect on food security of future generations.

Agrobiodiversity of India

India is classified among the 12 mega-diversity centres of the world, in relation to crops. As many as 167 species of crops, 320 species of wild crop relatives, and several species of domesticated animals, have originated here. The genetic diversity within these species is astounding. Some examples: Rice-50, 000 varieties, Mango-1000 varieties, Sorghum-5000 varieties, Cattle-27 breeds, Goats-22 varieties, Sheep-40 breeds, Poultry-18 breeds, buffalo-8 breeds (the world's total diversity)(based on information from National Bureau of Plant Genetic Resources, National Bureau of Animal Genetic resources, Central Rice research Institute of India). India is the region of diversity of many major cultivated plants like rice, wheat, maize, cotton, kodo millet, aubergine, mango, black pepper, sugarcane, brassica, groundnut, garlic/onion, cassava, cowpea etc [source: The State of the World's Plant Genetic Resources for Food and Agriculture, Food and Agricultural Organisation (FAO) of the United Nations, Rome, 1997].

The Indian rice variety originated from *Chhattisgarh* (an Indian state), which is home to some rare rice varieties in the country. It has varieties with varying harvesting periods, from 60 days to 150 days from the time seeds are sown; the largest rice variety (*dokra-dokri*); varieties that can grow under 10 feet (three metres) of water (*Naatrgoidi*); several varieties that are high in protein and have medicinal properties; one of the largest collections of scented rice varieties; and the longest and the shortest varieties. These varieties did not come from the laboratories but were produced after years of hard work with ingenuity by generations of farmers of Chhattisgarh. The southern regions of *Orissa* (an Indian state) have been considered as a secondary centre of origin of cultivated rice. Studies conducted by a project of MSSRF (M.S. Swaminathan Research Foundation in *Cuttack,* Orissa) have shown that the landraces (traditionally cultivated varieties) from this area could be the primary centre of origin for the *Aus* group of rice. The landraces of a primary centre of origin are assumed to contain many valuable genes particularly for resistance/ tolerance to various biotic and abiotic stresses and hence hold promise for their utilisation in future plant-breeding programmes.

Genetic Erosion of Agrobiodiversity in India

Genetic erosion is the loss of genetic diversity, including the loss of individual genes, and the loss of particular combinations of genes (i.e. of gene-complexes) such as those manifested in locally adapted landraces. The term "genetic erosion" is sometimes used in a narrow sense, i.e. the loss of genes or alleles, as well as more broadly, referring to the loss of varieties.

There are a number of different ways to represent the problems of genetic erosion. One of the most useful indicators is the narrowness of the food base. At another level, evidence regarding genetic erosion can be presented in terms of the replacement of landraces and traditional varieties (TVs) by MVs. There are many evidences of genetic erosion in India. Some of them have given below:

MVs (HYV) that have been developed under the programme of "Green Revolution" (in 1966-1967) in India heralded the so-called genetic erosion. MVs have wide adaptability in various environments and these seeds are genetically uniform.

A single (green revolution) wheat variety, *Sonalika* covering half the wheat growing area in North India replaced TVs.

The adoption of `green revolution' rice in Andhra Pradesh (an Indian state), India, led to the loss of 95% of TVs without their collection and/or documentation (Kothari, 1994).

In India a large number of genetically rich rice varieties in *Jeypore* tract of Orissa state, rice varieties with medicinal properties, popularly called *'Njavara'* in *Kerala* state and a wide range of millet species like Little millet (*Panicum sumatrense*), Italian millet (*Setaria italica*), Kodo millet (*Paspalum scrobiculatum*), Common millet (*Panicum miliaceum*), Barnyard millet (*Echinochloa colona*), and Finger millet (*Eleusine coracana*) in Tamil Nadu have faded out of cultivation in their native habitats.

Five decades ago, each region in the State of Chhattisgarh (then part of Madhya Pradesh) cultivated 19000 rice varieties those were suitable to the soil, climate and other variations. But in the 1960s, almost all the local varieties were replaced by high-yielding varieties of rice, which were insensitive to the local conditions. The HYVs depended on heavy use of fertilizers and pesticides for increased productivity. Over time, the soil quality depleted because of the indiscriminate use of fertilizers and pesticides, and productivity began to fall.

After the Green Revolution of the 1960s in India, farmers in the hilly region of *Tehri Garhwal* district of *Uttaranchal* state of North India also started using high input-intensive techniques of farming to increase productivity. New 'improved' seeds of high yielding varieties were introduced here, along with a range of pesticides, fertilizers and other external inputs. In the race for modernization, the farmers began to rapidly lose their traditional systems of sustainable agriculture. Several indigenous practices and seeds (rice, kidney beans) had already been 'lost' in this area.

The Biodiversity Strategy and Action Plans (BSAP) for *West Bengal* (an Indian state), based on a survey conducted in all the 18 districts of the State, states that in the post-Independence phase, it is the production of `minor' crops, which are not considered `economically' important, that has gone down. The BSAP mentions that the progenitor of cultivated maize, which existed in Sikkim and Darjeeling hills along with the Assam hills, has been lost. Of the five minor millets such as *ragi, cheena, kaon, gundli* and *sawan,* only two, that is, *ragi* and *kaon*, have survived.

Causes of Genetic Erosion and interplay of Intellectual Property Rights

India is an agriculture-based country where more than 70% people are living in villages and their main source of subsistence is agriculture. Majority of Indian farmers are very poor and they live on subsistence farming. Traditionally Indian agriculture has been characterized by the use of extremely diverse crops and cropping patterns/methods. They are the original curators of agrobiodiversity. More specifically farmer women had the greatest contribution towards maintaining this diversity. A traditional rice field provided not just rice, but also fish, crabs, frogs and other important elements of the rural diet. Traditional farming also provided for the fuel, fodder, and other ritual, cultural needs of the community, and was intimately connected to social relations, festivals, and other aspects of rural life.

After the independence of India (1947) and subsequent recurring famine and war with the neighbouring countries lowered agricultural production drastically. Total food grain production was marginally increased from 51 million tonnes in 1950-51 to 82 million tonnes in 1960-61(source: Economic Survey 1995-1996 of Government of India). To feed the increasing population India was to increase its agricultural production. Since the mid-1960's, the traditional agricultural practices are being gradually replaced by modern technology and farm practices in India and a veritable revolution is taking place in the country. Initially, the new technology was tried in 1960-61as a pilot project in seven districts and was called Intensive Agricultural District Programme (IADP). Later, the HYVs Programme (HYVP) was also added and the strategy was extended to cover the entire country. This strategy has been called as "Green Revolution". The main target of the green revolution was to increase the yield by providing cheaper foods through the using of genetically uniform MVs, chemical fertilizer and pesticides input and farm mechanization. The dramatic increase of food grain production since after green revolution in the subsequent decades is directly traceable to these crop improvement programmes. This green revolution is also the beginning of genetic erosion in India.

According to a study conducted by FAO (source: The State of the World's Plant Genetic Resources for Food and Agriculture, FAO, the United Nations, Rome, 1997), the main cause of genetic erosion in crops, as reported by almost all countries (81 countries), is the replacement of local varieties by improved or exotic varieties and species. The other causes of genetic erosion are population pressure, environmental degradation, legislation/policy, pests/weeds/diseases, changing agricultural systems and overexploitation of species etc. MVs require to use chemical fertilizers, pesticides, other chemicals like hormones, antibiotics etc. A vicious cycle exists among the breeders of MVs and multinational companies producing agrochemicals, fertilizers, farming implements in order to obtain IPR. With the introduction of HYVs in 1960's the fertilizer (N-nitrogenous+P-pohosphatic +K-potassic) consumption in the country increased from 65,600 tonnes in 1950-51 to 2,92,100 tonnes in 1960-61 and 11,000600 tonnes in 1966-67 and 19,306500 tonnes in 2000-01whereas net area sown (total geographical area 328.73 million hectares) increased marginally from 41.8% (118.75million hectares) in 1950-51to 46.6%(142.60 million hectares) in 1998-99. The number of tractors used in 1998-99 in India is 1,520000.76 million hectares out of net sown area are cultivating HYVs in 1997-98. Pesticides consumption also increased drastically from negligible amount in 1950's to 43.58 thousand tonnes in 2000-2001 (source: Department of Agriculture & Cooperation, New Delhi.). There are currently estimated 20 companies in India with proprietary hybrids and multinational companies tend to work only with the firms that have access to proprietary germplasm. However, the result of the homogenisation of agriculture (monoculture), that is market-oriented cultivation, over the past few decades present a not-so-pleasant picture in many parts of the country. While the overall fertility of soil has gone down in some cases, in some others the promotion of rice and wheat has led to the decline of crops such as groundnut and millets.

When farmers look to increase their sale they often sow different and more commercially viable seeds. Sometimes various government schemes force them to adapt specific seeds or new plant varieties. Thus commercial agriculture tends to increase genetic uniformity and this, in turn leads to genetic erosion. IP system encourages commercial agriculture that accelerates genetic erosion. Biotechnology research focuses on commercial agriculture and leads to demand for IP protection with the same potentially negative consequences for genetic diversity.

The criteria for awarding PVP (Plant Variety Protection) certificate to the breeders (PBR) involve lower thresholds than the standards required for patents. There are requirements for novelty and distinctness, but there is no equivalent of non-obviousness (inventive step) or industrial application or utility. Thus PVP laws allows breeders to protect the varieties with very similar characteristics, which means the system tends to be driven by commercial considerations of product differentiation and planned obsolescence, rather than genuine improvements in agronomic traits.

Similarly, the requirements for uniformity (and stability) in UPOV (Union Internationale Pour la Protection Des Obtentions Vegetales or International Union for the Protection of New Varieties of Plants was established in 1961 in Geneva for coordinating the intercountry implementation of PBR) type systems exclude the local varieties developed by farmers that are more heterogeneous genetically, and less stable. But these characteristics are those that make them more adaptable and suited to the agro-ecological environments in which the majority of poor farmers live. Another concern is the criteria for uniformity. While proponents argue that PVP, by stimulating the production of new varieties, actually increases biodiversity but in reality requirement for uniformity, and the certification of essentially similar varieties of crops, will add to uniformity of crops and loss of biodiversity. Moreover similar concerns have arisen in respect of greater uniformity arising from the success of Green Revolution Varieties, leading to greater susceptibility to disease and loss of on-field biodiversity. In addition, the privatization of genetic resources that have been engineered and patented accelerates the trend toward monocultural cropping.

Furthermore an engineered organism may produce unanticipated harmful impacts on other species in its new environment that may cause further erosion and ecological degradation.

Indian public sector institutions are doing transgenic (the plants obtained through genetic engineering contain a gene or genes normally from an unrelated organism in order to obtain a desirable trait or traits in the plants, such genes are called transgenes, and the plants containing transgenes are known as transgenic plants) researches in rice, tobacco, mustard, potato, tomato, brinjal, cauliflower and cabbage. Bose Institute, Calcutta; Tamilnadu Agricultural University, Coimbatore; Delhi University, Delhi and Indian Agricultural Research Institute (IARI), New Delhi and some other universities and research laboratories are conducting transgenic research.

Bt cotton (*Bacillus thuringiensis*) was released for commercial cultivation in March 2002 in India. In 2003, transgenic crops were cultivated in India 0.1million hectares (source: Clive James, 2003). Transgenic mustard hybrids are also in advanced field trials and if found suitable, may be released for general cultivation. The gene of the soil bacterium, *Bacillus thuringiensis* (Bt) has been patented by a number of companies in the USA and Europe.

Improved seeds require more fertilizer and pesticide consumption, which has tremendous contribution towards biodiversity loss, and have direct impact on floral, faunal and microbial population. Moreover substantial royalties payment to the developed countries and multinational seed companies will greatly increase the debt burden that could further intensify the environmental and social disruption if we consider the debt repayment such as the export of natural products.

Some key issues:

There are some key issues that need to be addressed immediately in order to revert this negative phenomenon. Promotion of monoculture accompanied by replacement of TVs by MVs across the length and breath of India created serious problems. *Firstly*, cultivation of MVs calls for substantial investment, thus in case of crop failure there remains no variety to bank upon and the condition of marginal farmers deteriorates. After the cultivation of Bt cotton, crop failure even led to mass sucide of farmers in Andhra Pradesh. Again, very recently sunflower cultivation was promoted in *Midnapore* district of West Bengal by governmental agencies with many hybrid varieties that turned to be a great crop failure. Characteristically this area is not suitable for this cultivation but suitable for groundnuts and cashew but the farmers being lured by institutional assurances had to counter heavy loss. *Secondly,* from time immemorial traditional multiple cropping systems fulfill the multicoloured social and cultural needs and aspirations of the community. As for example, there were number of rice varieties in west Bengal. Some of them were specifically used as staple food, some for *muri* (fried or parched rice), some for *chira* (flattened rice), some for *Khoi* (popped rice) and some for festivals like *Nabanna* "Naba Anna" or New Rice-a harvesting festival in West Bengal, Poush Sankranti –a popular festival in West Bengal of making rice cakes in the month of December/January etc. But cultures of HYVs denied their socio-cultural rights, as most TVs are no more exists and rests are on their way to obsolescence. *Thirdly*, indiscriminate administration of pesticides, chemical fertilizers and other agrochemicals put the fields to surpass its carrying capacity and eroded its fertility. For hundreds of years farmers and their ancestors had returned organic matter to the soil via cow manure and dead leaves. Promoted by generous government subsidies, chemical fertilizers appeared to remove the need for cattle, which were sold. Combined with the HYVs, which produce less leaf to be ploughed back into the ground as mulch, the result was a steady fall in the soil's level of humus year after year. The soil's microbial activity consequently decreased, along with its fertility and water retention capacity. Farmers who took up green revolution technologies did so largely because of technical advice and assurances of financial gain given to them by government agriculture extension workers. Many financial institutions provided loans to adopt this technology discouraging traditional farming practice. Green revolution has institutionalized the process of discouragement and strangulation of traditional farming system in the name of feeding growing population and to develop their livelihood. Traditional farming is not only capable of better sustainability but also of better efficiency too. Better sustainability has been proved by the Tehri-Garhwal Himalayas farmers who have adopted the unique and highly evolved Baranaja ("12 crops") system. In the same area, the efforts of the *Beej Bachao Andolan* (Save the Seeds Movement) have helped conserve and promote agricultural diversity. They revived this multi-cropping system against countrywide market oriented monocultural farming. As for instance of better efficiency, A study conducted in 1992-93 by *Navdanya* of traditional varieties of rice (as reported in the Draft National Biodiversity Strategy and Action Plan) grown in the Garhwal area of the Himalayas showed "a combined output of rice and straw equal to 17,600 kg a hectare (7,200 kg of grain and 10,400 kg of straw) in case of some varieties (such as *Jhumkya*) while the highest-yielding varieties such as *Saket* showed yields of only 13,200 kg (6,200 kg of grain and 6,400 kg of straw)". *Fourthly*, when developing countries are heading towards organic farming system, developing country like India still cannot escape from the menace of green revolution. *Fifthly*, though India has become self-reliant in food grain production but still many MVs are imported from other countries. If any difficulty crop up regarding seed supply, diseases etc. there will be no traditional varieties to bank upon as TVs and traditional farming has almost been rooted out. Due to 1960's intensification of providing cheap food policy to feed the growing population, most of the farmers gave up their traditional farming practice in order to response to the call of the market. Some of them gave up their cultivation of their marginal lands to work on the irrigated fields of the richer farmers. That was the beginning of current genetic erosion. Thus high productivity/efficiency of HYVs is a myth propagated and institutionlised so that manufactures of these seeds, fertilizers, pesticides and other related agro-chemicals can prosper. Rather, a concerted effort highlighting positive sides of traditional farming is needed to sustain self-sufficiency in food-grains.

Farmer's have different management strategy for maintaining the agrobiodiversity from that of formal management strategy. *First*, traditional producers/communities use a different set of selection and evaluation criteria for germplasm management than modern breeding or commercial seed programmes. *Second*, their methods of experimentation and testing are fundamentally different, although there are some points of common interest. *Third*, the strategies that preserve biodiversity are often embedded in community action, which channels and encourages individual households to act in such way as to foster biodiversity. The basic difference between the formal and informal cultivar selection is that breeders tend to narrow the genetic alternatives in search of yield and diseases or climatic resistance while marginal, subsistence farmers tend to broaden their choices by seeking more diverse varieties to fit their overall needs. The social locus of biodiversity management within households resides mainly with women specially postproduction activities (storage, seeds selection, processing and cooking). Women, who are often in charge of these non-field activities, handle materials in such as way to increase this diversity further.

Future ahead

Despite an emphasis on the value of traditional farming system, the prevailing belief among most agricultural scientists is that improved agricultural systems should replace those traditional systems that are not capable of producing sufficient food and income. Though the Protection of Plant Varieties and Farmer's' Rights Act, 2001 (Act 53 Of 2001) of India talked much about to protect the farmers' right but it has a distinct inclination towards breeders' right. Traditional farming community of India know how to preserve biodiversity, have been doing it for centuries, and do not need a great deal of outside direct assistance to get the job done. However they cannot continue to preserve the essential agrobiodiversity solely for the sake of conservation if there is no compensation for their labours or access and control over their ancestral resources. There are many factors like intellectual property rights for the farmers, community rights, true encouragement for traditional farming systems through various institutional means from governmental front, proper local *in-situ* management and conservation of plant genetic resources, current public distribution system of the government that are need to be restructured and reexamined on a war footing. Agrobiodiversity of India cannot be preserved *in –situ* unless local communities see it in their best interest to do so. Marginality and poverty are the greatest impediments towards the conservation of agrobiodiversity in India. Intellectual property rights and its various forms like patents, trademarks, geographical indications and trade secrets will benefit local communities if government allows income from these legal arrangements to reach local populations. These are the factors, which need to be restructured in order to see a better and sustainable tomorrow.

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