GLOBALIZATION, NEW AGRICULTURAL TECHNOLOGIES AND IPRS: IMPLICATIONS OF MODERN BIOTECHNOLOGY AND GENETIC ENGINEERING FOR CAPABILITIES, EXCLUSION AND LIVELIHOODS IN DEVELOPING COUNTRIES

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Abstract

The paper seeks to develop a broad framework for analysing the implications of changes in intellectual property rights regimes deriving from both new international legal mechanisms and conventions, and from new agricultural technologies based on modern biotechnology and genetic engineering. The framework can function as a model for analysis and further research on the impact of these changes on the commons and related issues such as biodiversity, and on indigenous knowledge. These impacts could be in terms of social exclusion, loss of skills and knowledge for specific groups and categories of people resulting in a loss of capabilities and entitlements, and a consequent reduction in livelihood choices and strategies. It is also stated that these technologies have the capacity to perpetuate inequalities among groups within a community and between nations and economies. This occurs through excluding people from access to forms of knowledge, skills, techniques, and markets, which are important for subsistence, survival and for competing in a globalized economy.

The paper is based on and uses the influential capabilities and entitlements approach developed by Amartya Sen, to analyse the effects of legal and technological changes on the survival and subsistence abilities and livelihood choices of farm households in developing countries. The capabilities and entitlements approaches are applied to study these effects in terms of changing 'rights regimes', and impacts on poor people's functioning arising from changes in livelihood options or 'capabilities set'. A trend away from pluralistic approaches to law, from a diverse technology and livelihoods basket, and towards greater uniformity and reduction in biodiversity is seen to contribute to the exclusion and marginalization of the rural poor from the development process. Shifts in technology and IPR regimes resulting from the process of globalization transform the social organization of knowledge systems and their application - with a concomitant decay in indigenous knowledge systems. More importantly these have significant impacts on particular social groups such as women, small and marginal farmers, pastoral communities, agricultural labour, groups more dependent on commons etc. A significant aspect of the new changes is that they are brought about by a specific combination of international legal mechanisms and technological / scientific techniques that recast social and economic relations between social groups, communities and nation-states. To capture the nature and consequences of these changes, the paper develops an “impact map for the commons” that will serve as a model for analysis. The “impact map” is then integrated with Sen’s ‘entitlement mapping’ so as to enable the clear delineation of impacts of livelihood changes on poverty and exclusion. In doing so it draws upon selected case studies of farm household, village, and community level impacts of technological and rights regime changes in the access to and use of common property resources in south Asia. A second strand of analysis derives from established scientific evidence on products of modern biotechnology and genetic engineering, and infers logical conclusions regarding possible impacts on the rural poor in developing countries, in terms of their livelihood choices as reflected in shifts in entitlements and capabilities.

Globalization, new agricultural technologies and IPRs: implications of modern biotechnology and genetic engineering for capabilities, exclusion and livelihoods in developing countries

The implications of newly emerging technologies for law and legal changes has not been paid as much attention by scholars as it should be, compared to activists who have often stressed on these linkages in terms of their impacts on peoples' abilities to meet their needs and sustain their livelihoods. On the one hand, new agricultural technologies deriving from biotechnology and genetic engineering are often proprietary technologies which cannot by reproduced by users (farmers) without paying for their use again and again. On the other hand technologies are being evolved which make in impossible for farmers to reproduce seeds even if they wish to. Both these have impacts on the farming community in terms of reducing their abilities to innovate, experiment, and adapt to ecological and economic changes. This directly reduces their capabilites and impacts on their welfare. Also through spread of these technologies, there is the possibility of genetic contamination, and biodiversity degradation which reduces peoples' abilities to cope and eke out a livelihood in various ways. But the development of technologies also points to a radical new rupture as far as rights issues are concerned. The meaning of legal rights in relation to peoples' capacity to improve their welfare undergoes in transformation along with changes in technological options. In the case of traditional technological regimes functioning under customary and locally negotiated norms, technologies are regulated on the basis of a right to livelihood and sustenance from natural resources. On the other hand, new technologies have led to the creation of a new rights regime wherein the use and exploitation of a technology for making profits is given primacy over all other considerations. This basic epistemological difference between IPRs over natural resource technologies, and customary or traditional rights over natural resource use constitutes a basis in this paper for making certain observations regarding the exclusion of entire groups of people from using and innovating upon technological options to participate in economic growth processes. In particular, it is argued that possibilities are inherent in new international legal regimes as well as emerging technological regimes, with reference to further eroding the capabilities of communities in managing and using natural resources for their sustenance.

Lakshman Yapa (1993: 270) in analyzing the "genetic transformation of seed into a non-reproducing commodity" refers to the way in which promoters of these technologies have failed to perceive the social relations of production embedded in all technologies, what he calls "seed as nexus of relations". In critiquing the whole epistemology of development that are endorsed by the supporters of new agricultural seed based technologies, he points to relations of dependence and types of 'scarcities' that emerge as a result of adoption of such technologies.

An analysis of studies of agricultural technologies based on modern biotechnology and genetic engineering reveals some basic differences in the way in which these are critiqued by scholars and activists in the developed and developing countries. Ethical – as differentiated from moral – reasons and environmental and health effects are most often cited by western opponents of these technologies for imposing restrictions on them. On the other hand, activists in developing countries, particularly in India have cited the direct effects on poverty, and indirect effects, in terms of the impacts of environmental degradation on livelihoods, as reasons for opposing these technologies. In particular effects for specific groups such as women, agricultural labourers, and

those who are more dependent on natural resources, common property, and diversified farming and livelihood systems are projected as those most likely to be affected. However while activists have quoted selected studies and anecdotal evidence in support of their positions, rigorous studies, similar to those in the west are absent for most developing countries. This is partly due to the methodological complexity of assessing actual and potential long term environmental impacts on peoples livelihoods.

One way in which these methodological complexities could be addressed is to study the impacts (actual and potential) in terms of their consequences for peoples sources of livelihoods, the mechanisms by which rural people are able to meet their subsistence needs. We also need to study the capabilities and entitlements that people have or lose as a result of a particular configuration of natural resource management, availability, and technology use. Technologies, through an adverse impact on biodiversity or on commons, may not only reduce livelihood options but also take away the opportunity to use one's capabilities for productive purposes, or take away certain entitlements, for instance the entitlement to exchange one's labour for a set of commodities.

This paper attempts to use the influential capabilities and entitlements framework developed by Amartya Sen, to analyse the effects of legal changes in intellectual property rights and technological changes for rural people's welfare and development . Sen's concepts of capabilities and entitlements are applied to study these effects in terms of changing 'rights regimes', and impacts on poor people's functioning arising from changes in livelihood options or a 'capabilities set'. A trend away from pluralistic approaches to law, and towards greater uniformity, it is suggested, contributes to the exclusion and marginalization of the rural poor from the development process.

I. Entitlements and Capabilities

While Sen's work on capabilities and entitlements are now well accepted in famine analysis, and analysis of food security, few attempts have been made to widen the scope for applying these concepts in the broad areas of development economics, and poverty analysis. Changes in property rights regimes for instance, and shifts in natural resource use due to economic, social, political, technological and environmental reasons offer ample scope for studying their impacts on peoples' welfare. The opportunities for clarity in understanding dynamic processes are all the more since Sen specifically focuses on legal and rights issues in his presentation of the entitlements approach.

Sen's theory of entitlements based as it is on a set of rights of 'ownership, transfer and rectification' (Sen, 1984: 311), brings in law as an important mediating agency in a very significant way. In this framework, 'endowment vectors' are related to sets of alternative commodity entitlements through what is called an 'entitlement exchange mapping'. The entitlement approach centres on an individual's entitlements to commodity bundles that may also include food. Exchange can be of two types: trade - which involves exchange with others, and production - which involves exchange with nature. Entitlement then depends not only on the endowment vector that an individual starts with, but is also related to exchange relations. These relations in the form of entitlement exchange mapping (or 'E-mapping' as Sen refers to them)

depend on the *legal*, political, economic, and social characteristics of the society in question. Entitlements therefore refer to "the set of all the alternative bundles of commodities that he can acquire in exchange for what he owns" which is the "'exchange entitlement' of what he owns" (1999: 3). Sen further states that "'production opportunities, trade possibilities, legal rights to the produce, and social conventions" all affect the e-mapping. While endowments can decline (eg. Through land alienation, discussed later in this paper), entitlements can also fail if for instance food entitlement declines because one has produced less food (direct entitlement failure), or one cannot obtain adequate food through trade (trade entitlement failure). Poverty and starvation therefore result from both a "fall in the endowment bundle and unfavourable shifts in exchange mapping". Analysis of legal and technological shifts with reference to natural resources ownership and control precisely enable us to understand how for instance, the decline in access to, and the degradation of common property and biological resources can result in change in ownership bundles, and consequent entitlement failures

An understanding of entitlements would not be complete without the complementary concept of capabilities. For Sen, a capability is a feature of a person in relation to goods. In that sense it is much more than simply 'endowments'. Capability is the ability to function and "reflects what a person can do" In Sen's words, "capabilities are … directly valuable in a way that the possession of primary goods[1] cannot be, since they evidently are means to some more human ends" (1984:323). A capability set refers to the alternatives sets of functioning that an individual has access to based on endowments but also on political, legal, social, and economic structures, and includes such features as freedom, health and education. Sen thus displays explicit awareness of the role of laws and legality both in bestowing and transferring endowments, and in providing an individual with entitlements to meet her / his needs.

The concept of social exclusion which has become popular currently and is being used both in the south and the north, in this paper follows closely its elaboration by Sen, who links it to concepts of capabilities and entitlements. Analyzing the concept within a "framework of freedoms and capabilities", he suggests that focusing on social exclusion, "can substantially help in the causal as well as constitutive analyses of poverty and deprivation" (2000:47). He states that the "perspective of social exclusion reinforces … the understanding of poverty as capability deprivation". He also argues that "an analysis of entitlement failure … can be fitted into a reasoning in which the idea of exclusion can be given a useful part" (2000:12), especially in situations where endowments and assets are denied access for individuals and groups of people. In an age where technology is playing key roles in economic growth and social transformation, loss of capabilities to adapt and innovate can result whole or partial exclusion from full participation in society.

Over the last couple of decades, scholars and activists have brought out the implications of shifts in property regimes (common property resources, IPRs, patents, land alienation etc.) for peoples' livelihoods and well being. However the exact process by which livelihood sources and abilities to cope are compromised by these changes are not well understood. Moreover the implications of legal and technological changes which undermine pluralistic and diverse approaches and thereby the entitlements and capabilities of individuals, households and communities have not been adequately worked out. By focusing on the shifts in entitlements and capabilities arising from

[1] In the Rawlsian sense

legal and technological changes, this paper attempts to explain how people's abilities to cope, experiment, innovate, adapt, and manage natural resources as part of survival strategies have been deeply impaired.

II. IPRs and New agricultural technologies: implications for exclusion

Developments in biotechnology and genetic engineering have introduced new options in agriculture. Many of these have controversial effects, and are being opposed by environmental activists around the world. However while the opposition to these new technologies in agriculture have come from activists, scholarly studies charting the actual impacts for peoples' livelihoods have been few partly because of the low levels of adoption of these technologies. In this section we attempt to logically develop some of the consequences of these technologies for peoples' capabilities and entitlements, and secondly, to discuss the ramifications of these for intellectual property rights. It is argued that new IPR regimes threaten people's abilities to cope, adjust and innovate in order to adapt to changes. Environmental consequences of these new options such as loss of biodiversity also significantly impair community resilience in the face of stresses and shocks, and environmental, demographic and economic changes.

The specific focus of this section is on a) unequal benefits deriving from these technologies, and b) their impact on social exclusion for specific groups and categories. The latter will be analyzed in terms of decline in capabilities and entitlements for people in areas where these technologies have been adopted.

It is attempted to demonstrate that these technologies, despite their benefits, perpetuate inequalities among groups within a community and between nations and economies. This occurs through excluding people from access to forms of knowledge, skills, techniques, and markets, which are important for subsistence, survival and for competing in a globalized economy.

Despite, or precisely because of large-scale adoption of new technologies, yields are rapidly declining in most parts of the world in agriculture, which is compounded by loss of soil fertility, and increased pest attacks. The impacts of these are most dramatically seen in the suicides of farmers in parts of India, over the past few years, attributed to indebtedness, loss of control over the production process, and the unsustainability of their livelihood patterns.

However the focus here, is specifically on the products of modern biotechnology and genetic engineering including GMO (genetically modified organisms). Several environmental consequences can occur as a result of using GMO seeds. For instance, the influence of a genetically engineered organism on the food chain may damage the local ecology. The new organism may compete successfully with wild relatives, causing unforeseen changes in the environment. Once genetically modified bacteria and viruses are released into the environment it is impossible to contain or recall them. Unlike chemical or nuclear contamination, negative effects are irreversible. Toxins introduced into plants to resist or kill pests may end up killing beneficial species such as butterflies, bees and beetles as well. Such crops have the capability to accelerate evolution of resistance in pests and the evolution of 'super pests'. Once pests become resistant to pesticides, it may lead to higher use of pesticides and higher rates of crop failure. This will not only result in more debts and more suicides but will wipe out both biodiversity and

farmers' livelihoods. Some scientists however state that plants genetically engineered to be herbicide-resistant will greatly decrease the amount of herbicide use. However, farmers, knowing that their crops can tolerate the herbicides may use them more liberally, leading to extermination of beneficial plants and organisms. By increasing production costs through increased use of purchased GMO seeds and inputs, these technologies thus may have deleterious effects on the livelihoods of farmers in developing countries. They also increase dependence on external agents such as seed and pesticide dealers.

Insects, birds, and wind can carry genetically altered seeds into neighboring fields and beyond. Pollen from transgenic plants can cross-pollinate with genetically natural crops and wild relatives. All crops, organic and non-organic, are vulnerable to contamination from cross-pollination. In the case of genetically engineered seeds, all the seeds have identical genetic structure. As a result, if they are planted over a wide area, and if a fungus, a virus, or a pest develops which can attack this particular crop, there could be widespread crop failure. Not only do these problems raise the issue of genetic pollution, but also as we shall see, fundamental issues relating to protection of indigenous knowledge and products vis a vis intellectual property rights of scientists and corporations arise. The existing means of resolution of such conflicts are invariably biased towards MNCs.

Apart from the scientific / technical differences which have consequences for the environment, plant behaviour and human metabolism, other differences emerge when the principles of modern biotechnology are put into practice. It is interesting to note that differences in social and economic impacts noted by scientists in third world situations due to modern technologies, are not even mentioned by those in the first world. The implications for developing countries include those for biodiversity, problems related to technology transfer, knowledge and skills retention for women, and the role of privatization in influencing the choice of research area in terms of commercial versus social considerations. Arguments for 'substantial equivalence' (of new technologies with older ones) then, are derived from a narrow, laboratory based, reductionist view of the science of genetic engineering. Laws and regulations relating to the testing, use, production and patents of these technologies then do not even consider the social and economic consequences of these technologies, and are only concerned with certain kinds of private property rights. Thus assessments of costs and benefits of these technologies do not touch upon many social, economic, and cultural issues of communities which are affected by the new technologies.

While environmental consequences of technologies inevitably have impacts for communities dependent on them, the situation is starker in developing economies where there is a greater degree of dependence on natural resources for survival and subsistence. For instance the loss of biodiversity has an impact in terms of increased abiotic stress. Farmers may have a reduced choice of mechanisms in terms of varieties and options for adapting to drought, low fertility soils etc. Under conditions where much of the crop originates from seed bought from companies, seed renewal is not adequate, since the quantum of saved seed is less, and hence there is a deterioration in the quality of seeds. Gradually farmers are forced to depend more and more on biotech companies for their seeds. In many parts of the world there are already reports that farmers plant GMO's regardless of market demand because there are not enough regular seed to go around.

Such large-scale homogenization resulting from increasing adoption of genetically engineered and transgenic crops are likely to worsen the ecological problems already associated with monoculture. Unquestioned expansion of this technology into developing countries may undermine the agricultural diversity of many of these countries, and extensive monoculture could inhibit or reduce this diversity, especially keeping in mind consequences in terms of serious social and environmental problems.

Monopoly capital in the agri-food business has a tendency to create broad international markets for single products, thereby simplifying cropping systems and creating genetic uniformity in rural areas. Large areas planted to a single crop variety become quite vulnerable to new matching strains of pathogens or insect pests. Moreover, widespread use of homogeneous transgenic varieties will inevitably lead to "genetic erosion," and a sharp reduction in biodiversity.

Much of modern technology ostensibly at the service of the poor then, even if not by design, at least by ignorance, have reverted back to the much reviled and derided 'top down' approach of development. Small and marginal farmers typically plant several different varieties on their land, tailoring their choice to the characteristics of each plot, in terms of drainage, fertility, consumption needs etc. Planting many varieties is also a technique of risk minimization for small farmers (Setyawat, 1996). However, such options cannot be easily developed with current top down and highly centralized research and extension structures and methods. Formal research methods and research systems simply are not equipped to handle the complexity of physical and socio-economic conditions in much of third world agriculture. Thus numerous variables important to farmers have to be 'reduced' or ignored altogether in order to produce new technologies. In particular, studies have shown that small farms utilize “a broad array of resources … and their farming systems are diverse” focusing on preservation of biodiversity and ecosystems. (Rosset, 1999). By contrast, biotechnology and genetic engineering focus only on single traits: and ignore multiple livelihood systems. The technolgoies developed therefore may not provide the necessary inputs or resources, such as fodder, food, fuelwood, building material etc. necessary to support small farmers’ livelihoods.

Genetic engineering is the very antithesis of recent approaches such as agroecology, farming systems or participatory, farmer-led research. A purely technological approach ignores real alternatives. It ignores the mixed crop livestock systems, and the use of indigenous seeds and inputs. HYV and GE are approaches which are reductionist; and are decontextualized from the specific systems in which farmers eke out their livelihoods. At best improvements are at the cost of other components of a livelihood or farming system. At worse, it exacerbates existing problems. Diversity was and is a central feature of the old strategies whose function was to share scarce resources such as water, nitrogen, soil nutrients, light, and energy resources.

In the specific context of developing countries, not only do their economies become more and more dependent on the metropolitan economies, leading to further underdevelopment, but significant sections of society get marginalized and excluded from the production process which adversely affect their well being, and disempowers them by taking away their capabilities to function and earn a living for themselves.

Historically in order to survive under such conditions, farmers have attempted to adapt agricultural technologies to their highly variable but singular circumstances, in terms of

agroecological, socio-economic, and environmental factors including resource bases, access to institutions, and climatic conditions. Farmers have thus evolved complex sustainable livelihood systems which balance risks related to drought, market failure, pests, etc. with factors such as labor, investment, nutrition, weather patterns, etc. The agrarian systems that evolved were characterized by multiple annual and perennial crops, animals, fodder, and a variety of foraged wild products. Under such highly varied circumstances, uniform varieties, or precision techniques such as those introduced under the green revolution, and genetically engineered or 'transgenic' innovations, are unlikely to be useful for many such farmers. On the contrary further marginalization of the rural poor is likely. Studies carried out in arid Western Rajasthan, in India for instance confirmed that villages with low genetic diversity were unable to cope in conditions of drought, compared to village where farmers had saved seeds of traditional varieties of pearl millet better adapted to weather conditions. Low genetic diversity in the former villages had been brought on by high adoption of hybrid cultivars derived from sa limited gene pool, and an abandonment of traditional or local landraces.

The social and economic consequences of loss of biodiversity are quite severe. Farmers are unable to innovate and adapt to changing conditions, drastically bringing down their capability levels. The endowments that they do have begin to yield less, leading to both direct (production) and trade entitlement failures. Farmers are forced to be part of globalization since industrial agriculture, export orientation and commercialization lead to homogenization and a preference for standardized products. The increasing difficulties of transnational agribiotech firms in maximizing their profits compounded with huge amounts spent on research for which there are little returns, has meant that they develop varieties with wide adaptation. This also results in loss of biodiversity. Farmers are forced to be part of this process of reducing biodiversity through market mechanisms of a decline in prices for local varieties, and pressures to adopt new technologies for their potential gains.

Several of the innovations of biotechnology directly threaten the independence of farmers around the world. Vasavi (1999), commenting on cotton farmers suicides in southern India indicates that commercialization of agriculture and/or the introduction of technological innovations result in the 'separation of the economic dimension of local agriculture from its established cultural bases,' since the social implications in terms of 'disjunctions' and 'dissonances' within society", are not considered. In "privileging the economic impetus of taking to commercial agriculture, many had overlooked the importance of retaining social ties", she argues pointing to decrease in social capital within the village and increasing dependence on external commercial agents.

Since biotech companies have invested millions of dollars in research, they naturally wish to get back returns at the earliest. When farmers buy seed of genetically engineered varieties, they have to sign a contract that outlines the rules of use. For example, they are not allowed to save any of the seed from their crop to plant the next season. Saving seed is a common practice used for thousands of years, but companies like Monsanto forbid saving, reselling, or exchanging seed, requiring farmers to buy new seed from the company every year. Companies can legally patent biotech crops because the plants are basically creations of the company -- there is no way they could possibly exist naturally. They contain genes from bacteria or other organisms spliced together in laboratories. Monsanto for instance has taken several farmers to court over this issue and has accused farmers using saved seeds in Canada and the US of infringing on their intellectual property rights, but many of the farmers claim the wind blew the GMO technology

into their fields which is difficult to disprove. Thus the sustainable practice of saving seed and cultivating the land now has become an unsustainable form of livelihood due to the forced dependence on an external agent from whom inputs are to be purchased. Farmers then cease to have complete control over the production process, and also cease to have the ability and freedom to experiment, since that process can only be carried out by the owner of the technology.

Farmers and farmer organizations in India have also expressed fears about the enslavement of farmers to multinational and local corporations and a loss of freedom and choice in their cropping patterns and sources of livelihood. The family farms of the poorer nations depend on saved seed for survival. They are too poor to buy new seed every year. Biotech companies also patent technologies and products in the development of which they have no hand. American corporations have patented Basmati rice, neem, and quinoa, taking advantage of indigenous knowledge and centuries of selective breeding by small farmers without giving anything in return. Thus there are very real fears of farmers losing access to traditional knowledge and resources and becoming enslaved to MNC who patent varieties in which they have very little contribution. The loss of knowledge - which is a key community endowment and is used to prevent entitlement failures by providing the ability to adapt, is major outcome of modern technologies and laws (in the form of patents and IPRs) associated with them.

New international and national level laws and agreements are supplemented by technological tools to get greater control over agricultural production and prevent local level adaptations and innovations. Contracts are very difficult to enforce in developing countries and also involve costly litigation. Transnational biotech firms therefore have come up with new sets of technologies which make IPRs redundant. These are usually referred to as Genetic Use Restriction Technologies. This is most clearly reflected in the Terminator Technology, which causes crop seed to become sterile at harvest time. A terminator seed will grow, but the seeds it produces are sterile, thus effectively killing the process that let farmers save and sow their own seeds. This will entail disempowerment of farmers, increased dependence on corporations, loss of traditional skills and indigenous knowledge, and a decrease in the ability to experiment and innovate.

In addition to the above processes, changes have been brought about in most countries with reference to PBRs or Plant Breeders Rights. Farmers rights in most laws and conventions are fragile. Earlier in most of these act farmers rights and privileges in saving, storing and reusing seed were granted. These rights have gradually been eroded through many national and international treaties and acts. For instance farmers' rights in the Plant Variety Protection and Farmers' Rights Act in India has been diluted and they cannot now sell seed. This severely curtails farmers' abilities to experiment and innovate especially in conditions when new technologies fail and farmers have few other alternatives. Many studies have demonstrated the importance of local seed systems in sustaining agricultural systems in the absence of well developed public and private sector seed systems. Thus the consequences of the ban on farmer to farmer sale of seeds effectively means that even when appropriate technologies and options are available, households and communities will not be able to use their endowments to exchange them for appropriate commodity bundles, due to lack of access to these options such as seeds.

In addition to the Terminator Technology, there are a whole series of technologies that are labelled by critics as Traitor Technology. The thrust of these technologies is that for the plant to grow and yield up to it's potential, farmers have to apply various company supplied sprays in conjunction with various company herbicides/insecticides to turn on genetic 'switches' that control specific characteristics such as high yield or pest resistance. Most innovations in agricultural biotechnology are profit-driven rather than need-driven. This is best illustrated through a review of the major technologies on the market today such as herbicide resistant crops like Monsanto's "Roundup Ready"soybeans, which are tolerant to Monsanto's own herbicide Roundup, and Bt" crops which are engineered to produce their own insecticide. In the first case, the objective is to win a greater herbicide market-share for a proprietary product. In the second it is to boost seed sales at the cost of damaging the usefulness of a key pest management product - the *Bacillus thuringiensis* based microbial insecticide which is used by many farmers, including organic farmers, as a powerful alternative to insecticides. These technologies have been developed by biotechnology companies to intensify farmers' dependence upon seeds protected by intellectual property rights, which conflict with the traditional rights of farmers to reproduce, share /sell or store seeds. Thus corporations will force farmers to buy their brand of inputs and will forbid farmers from keeping or selling seed. By controlling germplasm from seed to sale, and by forcing farmers to pay inflated prices for seed-chemical packages, companies are determined to extract the most profit from their investment. Laws now become infructuous as technologies take over their function. A key threat to legal pluralism then emerges from modern technologies.

Another technique to control farming operations is by linking chemicals and seed development, and by developing technologies to protect seed and plant from their own chemicals, corporations seek to accelerate increases in expenditures per unit for seeds plus chemicals, delivering significantly lower returns to growers. Companies which are developing herbicide tolerant crops are trying to shift as much per unit cost as possible from the herbicide onto the seed via seed costs and/or technology charges. Increasingly price reductions for herbicides will be limited to growers purchasing technology packages. For multinationals it is infinitely more profitable to sell seeds programmed to commit suicide (or become sterile) at harvest. This will force farmers to pay the company in order to obtain the chemicals to have them re-activated for the next planting either through a seed conditioning process or through the purchase of a specialized chemical that brings saved seed back to life.

Such technologies also shift the cost of developing and producing seeds to the farmer. The seed companies will only have to sell seeds and not produce, transport, or stock them. Farmers will reproduce seeds, and either through royalty / license fee mechanism or through chemically induced germination, the seeds will be made 'fertile'. As these seed companies increase their control of the world market, there will be diminished interest in future plant breeding and research. Furthermore, farmers will not have any power over what to grow or plant and will be "in a position of absolute dependency" on multinational seed companies. In line with industrial workers in developing countries producing products for the global economy who have become part of the putting out system, farmers also will become putting out workers with little control over their skills, tools, etc. Such technologies thus directly reduce capabilities through a deskilling process whereby gradually, farmers - especially women who are mainly involved in seed selection and saving - lose the ability and freedom to innovate. Knowledge of germination

requirements, seed preparation, weather, soil, breeding of farm animals, knowledge of the feed value of fodder species, fuel of fire wood types all have vested with women traditionally. Enormous disempowerment and exclusion from the economy and decision making thus occur for women due to the introduction of certain kinds of new technologies.

Thus genetically engineered seeds seem to be designed for agribusiness farming, not for the capabilities of small family farms of the developing nations like India. How are they to buy and distribute the required chemical inputs? What will happen to their livelihoods if they are made dependent for all their inputs on multinational firms? How will farm households manage risk in conditions of uncertainty and loss of diversity - which is a major source of risk management?

Perhaps the most significant marginalization that can occur as a result of the flow of genetically engineered products is of rural women involved in agricultural operations. Agarwal has argued that "womens' access to land and livelihood ….. "is also important for improving productive efficiency" on farms. Loss of biodiversity, influx of new options accompanied by a decline in the overall choices available are most likely to affect women living and working on farms. Two broad impacts on women can be identified. At a first level, traditionally in most Asian countries, women have been the repositories of knowledge, skills and techniques in agriculture, especially those pertaining to saving and storing seed, but also, and more importantly, breeding for specific traits (Rice et al, 1998). The 'hybrid' revolution forcing farmers to buy seed has already severely impacted on these skills and knowledge base, which has been eroded. The complete appropriation and alienation of the capacity to innovate and experiment (en)gendered in genetic engineering and biotechnology will further exterminate these skills and forms of knowledge.

At another level women also will suffer from loss of biodiversity and an increase in monoculture, especially a shift away from mixed cropping and crop-livestock systems. This will accelerate ecological degradation thereby making it difficult to obtain water, fuelwood, and fodder - all activities carried out by women. This impacts on time-allocation patterns with consequences for larger development issues including health, employment, child-care, education and so on. The ability of women to better manage households under conditions of scarcity is also compromised as sources of income in cash and kind dry up. Traditional cropping systems catered to a variety of needs - food, fodder, and fuelwood, which is not the case with monoculture, and with varieties bred for specific traits which normally do not meet other needs. Large scale decline in the livestock economy in India, especially the absolute numbers of cattle, are directly related to decline in fodder availability resulting from shifts in cropping systems. It is to be noted that in traditional mixed crop - livestock systems, output and income deriving from livestock vested primarily with women.

Entire communities and nations are thus pushed to the margins of survival, because of reductionist perspectives which ignore the complex survival and livelihood systems of the poor in developing countries.

An example which clearly brings out the implications of loss of biodiversity for reduction in capabilities in a major way is the recent controversy over 'golden rice'. Iron, protein and vitamin A deficiencies are the chief causes of malnutrition in much of Africa and Asia. These result in anemia, impaired learning ability, increased susceptibility to infection and reduced capacity to work (owing to lack of energy). The consequences also include reduced life spans, and

disabilities such as blindness. Recent innovations in genetic engineering include rice varieties which are fortified with iron or vitamin A and which have been touted as significant achievements for modern biotechnology. One of these is 'golden rice' which is a genetically engineered rice variety fortified with Vitamin A.

Nutritionists argue that vitamin A deficiency warns us of broader dietary inadequacies associated with poverty, as well as with agricultural change toward monoculture. People's diets have been reduced to rice (or some other cereal) because of this and thus people suffer many dietary illnesses. It has been observed that Vitamin A deficiency is more widespread in those parts where rice or wheat forms an integral part of the diet compared to areas where the major staple is maize, millet or sorghum. These in fact provide considerable amounts of vitamin A and other nutrients including higher levels of protein. Unimaginative poverty reduction policies such as the Public Distribution System in India have aggravated this problem by replacing traditional cereals and providing the poor with rice or wheat at cheap prices. Thus growing poverty has resulted in the poor becoming more dependent on rice alone for their dietary requirements. The problem therefore isn't one of rice not containing a particular nutrient, but the absence of dietary diversity resulting from poverty and monoculture.

The issue that is highlighted here is that in areas where previous green revolutions have taken place, reduced dietary diversity is an outcome of reducing cropping diversity. Also in the green revolution areas, skewed use of chemical fertilizers especially focussing on yield enhancing fertilizers such as nitrogen, has meant a concomitant neglect of micronutrients. These have had their effects on food quality, diet and nutrition. Reduced capabilities in terms of health are therefore related to loss of biodiversity. While balanced nutrition is more and more becoming a problem in rural areas, loss of biodiversity also has reduced access to traditional plants which were used for medicinal purposes.

In the words of Vandana Shiva then, "diversity … is the matrix from which an alternative calculus of productivity and skills can be built", and provides a crucial reason for preserving biodiversity especially in areas of poverty. Acknowledgement of "women's work and knowledge is (not only) central to biodiversity conservation as she argues, but in terms of the framework outlined in this paper, loss of diversity and new technologies "displace women from decision making and custodianship rights to seed and (are transformed) into unskilled labour". The transition from skilled workers to unskilled labour marks a decline in capabilities and leads to entitlement failures that partly explain the 'feminization of poverty' that is being observed in rural areas of the developing world.

There are also other ways in which entitlements of individuals and families are destroyed through newly developing agricultural technologies. In particular there are significant implications for what Sen refers to as a decline in “trade independent security” A study in Andhra Pradesh in India has indicated a rapid increase in female child labour in areas where seed production of high technology cotton seeds are produced. Women and female children have been taken out of family farms producing food crops to participate in cotton seed production. Other scientists have also expressed concern that farmers may lose their independence and become agricultural workers on contract to multinational agribusiness corporations. Thus even though they may have access to incomes, in times of scarcity, distress or shortage, they have

entitlements deriving from direct productive activity. As Sen has mentioned landless labourers are most likely to face entitlement failures leading to starvation.

Another important issue that is well summarized by the political scientist Arun Agarwal is that decline and devaluation of traditional indigenous knowledge also leads to the devaluation of traditional authority and institutions with implications for conflict resolution. Power equations change as those with access to 'modern' knowledge have the ability to dictate terms. In a Foucauldian world where knowledge is closely enmeshed with power, loss of knowledge / power can mean significant reduction in entitlements in terms of production declines, bargaining capacities, and cooperative behaviour in the realm of production and exchange. Rice et all (1998) also speak of a 'social infrastructure' that 'shapes seed and information flows', which is likely to be destroyed when seed production is shifted away from farms to firms.

Thus while some scholars (Janvry et al, 1999) gloss over capabilities effects by stating that GMO technology "substitutes for human capital at the farm level", the actual effect is one of throwing existing skills into disuse, and reducing the capabilities to adapt, innovate and experiment. In conditions of high variability and risk, this loss cannot simply be substituted by technologies. Nor can such deskilling be compensated by processes such as bio-prospecting contracts. Given that authorship with reference to genetic resources rests in large collectivites, contracts as they are practised benefit only a small number of people excluding large numbers, provoking "egregious and dangerous inequitieswithin regions with genetic resources" as Brush (1998) argues. In fact he goes on to argue against IPRs as they are currently in place, by saying that lack of private ownership enhances adaptive capacities of farmers in coping with risks.

Fugure 2 summarizes the ways in which capabilities and entitlements decline as a result of introduction of new agricultural technologies in developing countries. One of the important effects of these technologies is that farm level adoption has impacts that go beyond the indivdual farm, impacts occur on local ecosystems, in neighbouring farms etc. In particular, through lack of ability to produce certain livelihood requirements (fodder, fuelwood), decline of ecosystem biodiversity, decline of genetic diversity in a species, increasing tolerance to pesticides among pests etc., it is likely that there is a comprehensive decline and deterioration in quantity and quality of common property resources. These also have substantial implications for social exclusion of people dependent on commons for their livelihoods especially in times of distress and scarcity.

These issues emerge with greater clarity in the following section on common property resources.

IV. Common property resources, biodiversity, and social exclusion

Loss of biodiversity can have several kinds of consequences on livelihoods, and the kind of endowments people can exchange to meet their needs. While the loss of biodiversity can affect farm households at the individual farm level, it also has significant effects on common property resources which can impact on basic capabilities and entitlements of individuals. Recent research in this area from around the world, but especially in South Asia have brought out the crucial significance of common property resources for subsistence of the rural poor. However the actual

processes involved in the livelihood strategies of the poor who are dependent on CPRs is still not well known. While direct impacts of decline and degradation of CPRs have been brought out in several studies, what is not so well analysed is the way in which decline of CPRs affect other kinds of entitlements - both direct and trade entitlements. Particularly the links between biodiversity loss and decline of common property resources have not been adequately researched. The implications for productivity decline, labour entitlement, and declining livelihood options are the focus here, as is an attempt to understand the different legal issues involved. It is important to remember that "there exists a level of complimentarity between common property resources and private property resources" (Babu, 1998: 2) and that decline of CPRs reduce entitlements and capabilities at an individual or household level. Jodha has pointed out that "performance of crop farming is better" (1995:558) with higher access to CPRs; Beck has exposed an important ambiguity in the difference between private property and common property by pointing to the "use of private resources in common" including those that are negotiated by the poor: access to fallen fruits, gleaning of grains from privately owned farm land etc. (Beck, 1984: 187). Sinha and Herring (1993: 1425) also mention the use of "private property for common good".

To begin with a brief statement on the decline of CPRs - it is estimated that twelve percent of the poor peoples income in India is derived from CPRs which include community pastures, forests, wasteland, ponds, rivers, rivulets, their banks and beds. Jodha, who has written extensively on the decline of CPRs is of the view that this decline not only represents the degradation of a community asset but also leads to an "erosion of survival options". He also states (Jodha, 1995 and 1986) as other studies have shown, that CPRs are a veritable source of employment, Jodha estimating that they offer more employment than targeted employment generation programmes. During lean seasons, CPRs are an important means of subsistence, keeping starvation at bay.

Most important of the products from CPRs are fuel and fodder. In a 'scoping' study, Babu shows that the landless labourers and marginal farmers benefit most through enhancement of access to CPRs since they need to purchase less of fuel and fodder. In the absence of a capacity to buy, and in a scenario of CPR degradation, the poor, especially women have to travel longer distances and spend more time in searching for fuelwood and fodder. Not only does this decrease the labour entitlement of women, but it also leads to a decline in the amount of time available and allocated for other activities which may be more welfare inducing including wage labour, education etc. Beck (1994) also demonstrates the way in which decline of CPRs or access to CPRs decreased the time available for gleaning on private farmland significantly reducing access to crucial resources for subsistence. Decline or degradation of CPRs thus takes away the right to ones own labour or reduces its entitlement. Pasha (1991), in studying the use of and access to fodder from common waste land, points out that "animal husbandry provides employment to surplus labour", especially old people and children whose labour would otherwise have gone 'waste. Stating that "animal husbandry is no longer neutral to economic status of individuals" as a result of degradation of village commons, pasture and grazing lands, Karanth (1992) also mentions the loss of time for other more productive activities due to increased amount of time spent on foraging for fodder and grazing livestock in distant grazing lands.

The multiple uses of CPRs and the issue of interrelated rights on CPRs is a constant theme in several studies on common property resources. Failure to consider these in new rules, laws and institutional arrangements is frequently cited as a factor adversely affecting those dependent on

CPRs for their livelihood. Jodha (1991), for instance points to the possibilities for diversification and flexibility due to enhanced availability and access to CPRs, while also drawing attention to the interlinkages among different production systems - crop, livestock, harvest from CPRs etc. Thus what emerges clearly is that degradation and / or loss of access to the commons does not just result in loss of those resources that people had access to, but also indirectly affects other livelihood systems. They also lead to the inability to use ones own labour and harvest CPR products for exchange and consumption.

What is also emerging in a fairly obvious manner from the studies is that common property is a highly nuanced term and includes resources which are conventionally and by law regarded as private property. For instance, in many parts of the country, farmers, labourers and cattle owners have grazing and animal penning rights on privately owned farmland. Kerr and Sanghi (1992) argue for a "need to relax laws restricting harvesting and transporting trees from private land", which was a traditional practice in the semi-arid villages they studied. Reference has already been made earlier to other kinds of common and negotiated access to private property such as gleaning of grains. In conditions of instability in agricultural output for the poor then, CPRs constitute a major source of livelihood. Attention has also been drawn in this paper to the fact that while privately owned resources are sometimes negotiated by the poor for common access, the health of CPRs also affects the efficiency of cropping systems through preventing soil erosion for instance, or by enabling farm households to go in for marketable options since certain needs are met from the commons. Thus healthy CPRs and access to them enable poor households to make use of their endowments and get fair entitlements by using their resources, and capabilities, including labour, skills, and knowledge in an optimal manner. This requires appropriate legal and institutional support which enjoys local support and legitimacy.

Coming to the relationship between biodiversity loss and common property resource degradation, scholars have pointed out that" events or conditions occurring at a particular position in environmental space lead to consequences elsewhere in environmental space" (Reiners and Dreise, 2001) As Nunes and Bergh argue,economic science provides only a very incomplete perspective on the unknown value of biodiversity changes. Changes in biodiversity affecting resources used commonly have not been well documented but are not unknown. Studies have shown that geentic diversity of crops plays a very important role in increasing yield stability (Deb et al, 2000). Consequences of adoption of new technologies for both ecological and economic systems have not been well investigated. Environmental impacts as well as negative impacts on societies and economies do not enter the calculus of assessments of these technologies. In fact most studies focus only on economic costs and benefits at the individual farm level, for those who are able to pay for the use of these technologies. (eg. Pardey et al, 2002, Pray et al, 2001)

Amartya Sen in fact in his work on Hunger and Entitlements: (p13): specifically draws attention to "diversification of production and of sources of income…., rather than concentrating exclusively on the expansion of food output", as a means of enhancing entitlements. Monoculture either by directly substituting variety in germplasm, or decline in biodiversity through intercrossing between species triggered by transgenic crops are likely to precisely result in reduction of diversified production systems in such a way to as to reduce entitlements for individuals and families deriving their livelihoods from the presence of diversity (ecological and economic).

Thus there are several ways in which the introduction of products derived from biotechnology and genetic engineering, and the imposition of international conventions on IPRs may impact on the livelihoods of poor and marginal farmers and workers in the rural areas of developing countries. First the crop varieties may be such as to take away the capacity to adapt and innovate, owing to the irreproducibility of the seeds, as outlined earlier. This outcome is also possible through a loss of biodiversity and dilution of the genetic material within a species. Secondly since most of these technologies focus on a single trait or characteristic (yield, pest resistance etc.), other traits of the crops may not be given importance, forcing farmers to further degrade the environment by overutilizing the commons. Third, through a decline in biodiversity, there may be a direct impact on loss of several species in common lands and common resources. This can happen through inter-crossing between species, by creating tolerance among pests to certain toxic material, by wiping out certain species of plants and animals, insects etc., or by creating some very strong species such as superweeds which suppress other plants from obtaining the necessary nutrition for growth. Finally, the poor are disabled from exchanging their labour for entitlements through either the decline in commons, where they can work (collection of forest products , grazing, fishing), or by eliminating certain tasks involved in cultivation (pest management, weeding etc.)

These impacts and their implications for reduction in the capabilities and entitlements of the poor are mapped in Figure 1and 2. It is hoped that more empirical studies will be carried out which will bear out the connections made in the framework presented in this paper in terms of identifying the actual impacts of new technologies and IPR conventions on the lives of the poor in developing countries. The debate on modern biotechnology and genetic engineering in agriculture needs to move beyond assessing impacts on the environment and map out the actual implications for the mechanisms that poor people use in adapting to their environments, manage risks, and eke out sustainable livelihoods in extreme social, economic and ecological conditions.

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Figure 1. Generalized Entitlement Exchange Mapping for an Agricultural Community

Ownership and Capabilities Set

Land	Labour (knowledge and skills)	Common Property Resources	Biodiversity	Diversified Cropping Pattern / Farming system
1. Production for self-consumption 2. Production for exchange (trade)	1. Labour for wages 2. Labour on own farm 3. Labour on commons for self-consumption and / or trade	1. Extraction of commodities for trade 2. Extraction of products for self-consumption (food, fodder, water) 3. Optimize conditions of various kinds of resource scarcity (all the above is done through use of labour)	1. Maintains health of commons 2. Reduces risk and increases system stability 3. Capacity to experiment and innovate 4. Enables use of other endowments (Labour, land, livestock)	1. Enables risk management through dversified production system 2. Enables use of products and by-products for a variety of purposes (food, trade, livestock, building material)

Entitlement
Commodity bundles
Food, Fodder, Fuelwood, Housing material, Cash, Commodities and goods for meeting other basic needs

↓

Maintenance of capability levels and availability of entitlement opportunities leads to increased security of livelihood, risk minimization, expansion of knowledge, increased system stability, and insures against future distress and scarcity.

Figure 2. Possible range of impacts due to expanded use of biotechnology and genetic engineering in agriculture

Impact on common property resources	Impact on biodiversity	Impacts on cropping pattern
1.Decline of commons: deterioration (quality) Decline (quantity) 2. Encroachment for products not available from farming system (from humans and livestock)	1. Loss of flora and fauna in the commonly owned land 2. In privately owned land, species and varietal loss	1. Lower quantum and less number of by-products from farming system 2. Decline of mixed cropping (leads to decline in certain products such as vegateble, and problems wth crop/pest management)

Outcomes

1. More cash required for purchase of products previously obtained from farming system and commons
2. Loss of diverse sources of livelihood, so more risk
3. Loss of certain forms of skills and knowledge
4. Inability to use labour on farm, and in the commons