

# Genetically Modified Organisms in Peasant Farming: Social Impact and Equity

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## INTRODUCTION

This paper's first objective is to discuss the potential social impact of the diffusion of genetically modified organisms (GMOs) into peasant sectors of less developed countries. While unwanted environmental impacts of the new technology can be partially assessed in controlled, experimental settings, assessment of social impacts requires experience and observation in particular farming systems. Owing to the absence of direct data or case studies on the spread of GMOs in peasant sectors, this paper reviews the well-studied social impacts of the Green Revolution as an exercise in what to expect from GMOs.

The paper then addresses equity issues relating to the use of genetically modified crops in developing countries. A critical issue is the flow of genetic resources from poor countries to industrial countries, where they are used and manipulated to create intellectual property. I confine myself to the social and ethical impacts of GMOs in agriculture. Agricultural GMOs are far less numerous and less profitable than GMOs in pharmaceutical and chemical industries, but they have received disproportionate attention in the international debate over transgenic products. The conflating of genetic resources and agricultural and pharmaceutical products is problematic but common. Likewise, conflating ecological and social impacts of recombinant DNA technology is problematic. The potentially negative ecological impacts of GMOs have received extensive attention, while social impacts are relatively understudied.<sup>1</sup>

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1. See Miguel A. Altieri, *The Ecological Impacts of Transgenic Crops on Agroecosystem Health*, 6 ECOSYSTEM HEALTH 13 (2000); Lawrence Busch, *The Social Impact of Biotechnology on Farming and Food Production*, in AGRIC. BIOTECH.: FOOD SAFETY AND NUTRITIONAL QUALITY FOR THE CONSUMER 191 (June F. MacDonald ed. 1990).

Genetically modified organisms are condemned because of the ecological, health, and social damage that may result from their use. Crop scientists are challenged over using genetic modification in ways that contradict their fundamental premises.<sup>2</sup> Unlike previous scientific breakthroughs in agriculture, GMOs have been met with opposition that has effectively stalled their diffusion and threatened further development.<sup>3</sup> Other than in the United States, where GMOs are widely deployed, the future of GMOs is gloomy in the near term and uncertain in the long term. Apart from affecting a few companies, their absence will not be of great consequence in wealthy, industrial nations where overproduction of food is a problem. The issue addressed here, however, is whether it is appropriate to deny poor nations access to technology that might alleviate hunger, until that technology is unequivocally found to be unacceptable.

Currently, there is simply inadequate data to make this determination. The benefits created by agricultural science in the past century counsel us to keep an open mind in considering whether GMOs should be further developed and utilized. The possible negative impacts of GMOs in developing countries must be assessed not only in light of a blemished record of GMO use in industrial countries, but also in light of the specter of denying the possible benefit of modern crop science to poor countries with rapidly growing and inadequately nourished populations. The harm of barring GMOs must be weighed against the harm their use might cause.

## I. BACKGROUND: THE GROWTH OF GMOS

### A. *Agricultural Development and Technology*

Agricultural development is a broadly shared goal in less developed countries, and the history of agricultural evolution demonstrates unambiguously that technological change is a necessary component of development.<sup>4</sup> Since the early twentieth century, the application of genetics

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2. See, e.g., LAWRENCE BUSCH ET AL., *PLANTS, POWER, AND PROFIT: SOCIAL, ECONOMIC, AND ETHICAL CONSEQUENCES OF THE NEW BIOTECHNOLOGIES* 201 (1991).

3. E.g., Fred Buttel, *Agricultural Biotechnology: Its Recent Evolution and Implications for Agrofood Political Economy*, 4 SOC. RES. ONLINE, Sept. 1999, at <http://www.socresonline.org.uk/4/3/buttel.html>.

4. See, e.g., B.H. SLICHER VAN BATH, *THE AGRARIAN HISTORY OF WESTERN EUROPE: A.D. 500-1850*, at 7-18 (Olive Ordish, trans.) (1963); LLOYD T. EVANS, *FEEDING THE TEN BILLION: PLANTS AND POPULATION GROWTH* (1998).

has been an essential and highly successful component of agricultural development. All countries with adequate financial resources undertake organized programs to apply genetics to crop breeding, whether through public or private means. It is virtually inconceivable that agriculture could feed over six billion humans without crop breeding and the diffusion of modern crop varieties. The history of crop breeding involves the use of genetic material on an ever-widening geographic and biological scale. Progressing from selection within local populations to crosses among populations, crosses of crop lines from distant regions, and wide crosses across species within a crop's lineage, crop geneticists have continually extended the range of diversity and complexity of the pedigrees of the crops.<sup>5</sup> Arguably, the modern human population would be either more malnourished or smaller in size without the crop varieties furnished by organized crop breeding.

The current unease surrounding the use of GMOs in agriculture is somewhat bewildering to many agricultural scientists who have been engaged in generating new crops to assist agricultural development in poor and less developed countries. The premise of most of these scientists is that history has largely justified the science of crop breeding, including the use of both broad crosses and hybridization with wild species. Genetic modification appears to be part of the normal and well-established trajectory of gaining control over and manipulating biological processes to achieve greater productivity. Moreover, it is also a logical extension of expanding the pool of genetic resources that are used to create a superior crop variety. This expansion has been especially marked since 1950, when world collections of crop germplasm became available to crop breeders.<sup>6</sup>

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5. See John M. Poehlman, *How Crop Improvement Developed*, in THE LITERATURE OF CROP SCIENCE 1 (Wallace C. Olsen ed., 1995).

6. Broad crosses, including crosses between wild and domesticated species, have been used in numerous crop breeding programs. See Hugh H. Iltis, *Discovery of No. 832: An Essay in Defense of the National Science Foundation*, 3 DESERT PLANTS 175 (1982) (offering a discussion of tomato); see, e.g., D.R. Knott & J. Dvořák, *Alien Germ Plasm as a Source of Resistance*, 14 ANN. REV. OF PHYTOPATHOLOGY 211 (1974); Roger T. Chetelat et al., *A Male-Fertile Lycopersicon Esculentum x Solanum Lycopersicoides Hybrid Enables Direct Backcrossing to Tomato at the Diploid Level*, 95 EUPHYTICA 99 (1997); Robert M Goodman et al., *Gene Transfer in Crop Improvement*, 236 SCI. 211 (1987); Milinda Smale, *The Green Revolution and Wheat Genetic Diversity: Some Unfounded Assumptions*, 25 WORLD DEV. 1257 (1997) (discussing increased pedigree complexity in wheat breeding).

This expanded pool of germplasm allowed crop breeders to develop a new generation of crops with higher yields than hitherto available.

Faith in science and other “modern” changes in agriculture, such as commoditization and the purchase of inputs from the industrial sector, is justified by the work’s long- and short-term ability to feed a population that has quadrupled since the first application of Mendelian genetics to crop breeding.<sup>7</sup> Despite hyperbolic population growth during the twentieth century, a smaller proportion of the human population is malnourished today than ever before.<sup>8</sup> Indeed, absent the roles of science and industrial capital in agricultural development, it is likely that many more people would be hungry today than the current levels, which are themselves viewed as unacceptable. It is precisely those areas where crop science and industrial capital are lacking in which hunger is most severe. Between 1975 and 1986, a time when crop breeding programs were active in most developing countries, population of these countries increased by 26% while the supply of food per capita increased 14%.<sup>9</sup> During this same period, yields of the world’s most important food sources, rice and wheat, increased by 32% and 51% respectively.<sup>10</sup> It is all but impossible to imagine an industrial society, with its attendant wealth and well-being, without applied crop genetics. The inescapable question this history presents is: “what can crop science do to maintain the food supply in order to feed the estimated eleven billion people who will inhabit the planet by the end of this century?” To many crop scientists, the obvious answer is that crop science should support the application of the newest technology available, including transgenic transformation of the crop plants we depend on.<sup>11</sup>

The inevitably increasing human population faces a future in which agricultural technology is likely to become more important than other sources of production gains. An increase in arable land is unlikely, as the wave of agricultural expansion has clearly slowed since 1970.<sup>12</sup> In particular, there seems to be relatively little new land available in Asia,

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7. See EVANS, *supra* note 4, at xi.

8. See *id.*

9. *Id.* at 151.

10. *Id.*

11. See *id.*

12. LEONARDO A. PAULINO, FOOD IN THE THIRD WORLD: PAST TRENDS AND PROJECTIONS TO 2000 53 (1995); see also JOEL E. COHEN, HOW MANY PEOPLE CAN THE EARTH SUPPORT? (1995).

where population numbers are expected to rise most sharply. Between 1975 and 1986, arable land in Asia increased by merely 0.5%.<sup>13</sup> Expansion generally is limited by the growth of urban settlements and political pressure to protect forests and other undisturbed areas.<sup>14</sup> In addition, the water necessary for irrigation is equally unavailable.<sup>15</sup>

Increasing the yield potential of crops, cropping more intensively, improving disease and pest resistance, and eliminating post harvest losses could greatly benefit food availability. Access to new genetic resources, identification of useful genes, and breeding those genes into crops will play an important role in achieving these goals. To crop breeders, genetic modification is a logical and necessary element in their tool kit of crop improvement techniques.<sup>16</sup> Recombinant DNA technology is more precise and rapid than conventional breeding, and precision avoids the transfer of unwanted or potentially dangerous germplasm.<sup>17</sup> Transgenic technology in crop breeding has yielded a handful of GMOs, and two of these—Bt and herbicide resistance—are dominant both in terms of acreage and the number of farms using GMOs.<sup>18</sup> Nevertheless, numerous other crop traits, such as higher protein or improved digestibility, are in the advanced stages of development.<sup>19</sup> Genetic modification has also been focused specifically on traits that will be more useful to the populations of developing countries, such as breeding a Beta-carotene trait into rice to address the vitamin A deficiency that blinds 250,000 to 500,000 pre-school children yearly, most of whom die within months of going blind.<sup>20</sup> Because of their ability to draw on a much wider pool of genes than conventional breeding, transgenic methods have greater potential to add such valuable traits as salt tolerance

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13. EVANS, *supra* note 4, at 151.

14. See Paul E. Waggoner, *How Much Land Can Ten Billion People Spare for Nature? Does Technology Make a Difference?*, 1 TECH. SCI. 17 (1995).

15. See Kenneth G. Cassman & Richard R. Harwood, *The Nature of Agricultural Systems: Food Security and Environmental Balance*, 20 FOOD POL'Y 439 (1995);

16. See GABRIELLE J. PERSLEY ET AL., COUNCIL FOR AGRIC. SCI. & TECH., APPLICATIONS OF BIOTECHNOLOGY TO CROPS: BENEFITS AND RISKS 2-3 (December 1999), available at [http://www.cast-science.org/pdf/biotc\\_ip.pdf](http://www.cast-science.org/pdf/biotc_ip.pdf).

17. *Id.* at 2.

18. See Clive James, *Transgenic Crops Worldwide: Current Situation and Future Outlook*, in AGRICULTURAL BIOTECHNOLOGY IN DEVELOPING COUNTRIES: TOWARDS OPTIMIZING THE BENEFITS FOR THE POOR 11, 16 (Matim Quaim et al. eds., 2000).

19. Buttel, *supra* note 3.

20. Howarth E. Bouis, *The Role of Biotechnology for Food Consumers in Developing Countries*, in AGRICULTURAL BIOTECHNOLOGY IN DEVELOPING COUNTRIES: TOWARDS OPTIMIZING THE BENEFITS FOR THE POOR, *supra* note 18, at 189, 191.

or disease resistance to crops. In sum, GMOs have the potential to meet the need for greater production and to solve health problems relating to nutrition, and this potential is not confined to wealthy countries.

*B. Opposition to GMOs*

Opposition to GMOs is as significant as their potential. Critics of transgenic technology have focused on four unintended consequences of GMO use: food safety, animal well-being, environmental impact, and social consequences.<sup>21</sup> No matter how powerful the case in favor of food biotechnology, including the use of transgenic plants and animals, that case has been poorly made.<sup>22</sup> One pitfall has been the modernist fallacy that GMOs must be acceptable because they are the product of “progress.” Another is the naturalist fallacy that GMOs are equivalent to the natural or historic alterations in plants that derive from nature or crop breeding and therefore pose no new threat. Opposition to GMOs rejects the logic of both the modernist and the naturalist arguments.

It is plausible that GMOs’ negative consequences will be more serious in developing than in developed countries because of the former’s environmental and social conditions. The presence of wild ancestors of crop plants and the abundance of biological diversity in some developing regions may elevate both the chances of “escape” of the transgenic trait into wild plants and the impact of such an escape on diverse plant communities. Lack of information or illiteracy may deprive citizens of developing countries of the ability to make informed decisions about food safety. Poor countries are apt to have insufficient regulatory infrastructure and personnel to develop and enforce bio-safety protocols for GMOs. The large number of people in poverty means that a negative social impact of GMOs that hurts small farms and poor people will be felt disproportionately in developing countries.

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21. See generally PAUL B. THOMPSON, FOOD BIOTECH. IN ETHICAL PERSPECTIVE (1997).

22. See *id.*; PERSLEY ET AL., *supra* note 16.

## II. THE SOCIAL IMPACT OF GMOs IN PEASANT AGRICULTURE

Technological change in agriculture has not escaped social criticism.<sup>23</sup> Since Marx, we have known that technological change is associated with alienation and the loss of control over means of production. Recent criticism of agricultural technology has centered on its direct and indirect negative social consequences. Direct consequences include harm done to a specific group or class of farmers, such as causing unemployment among farm laborers. Indirect consequences include negative changes in the relative position of a specific group or class of farmers—especially the social and economic losses of small farms relative to large farms. Between these, indirect consequences have received far more attention, both in developing theory and in case studies.<sup>24</sup>

### A. *Structural Change in Agricultural Development*

The history of agricultural development is characterized not only by capital substitution of land and labor but also by the restructuring of agriculture resulting from the decline of the number of farms and the growth of large ones. It is easy to surmise that technology is part of a process that leads to increasing farm size. Perhaps the most well developed theory of this process is Cochrane's "technological treadmill", applied to American agriculture.<sup>25</sup> The treadmill is characterized by continuous cycles of technology adoption, competition in markets with unfavorable prices, elimination of farms with older technology, and consolidation into large farms.<sup>26</sup>

A common tendency in the face of farm restructuring is to see technology as biased, either directly or indirectly, in favor of large farms. Cochrane emphasized the role of technology in propelling farm structure toward fewer and larger farms.<sup>27</sup> Increases in farm size observed in

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23. *E.g.*, WENDELL BERRY, *THE UNSETTLING OF AMERICA: CULTURE & AGRIC.* (1996); JIM HIGHTOWER, *HARD TOMATOES, HARD TIMES: (REPORT OF) AGRIBUSINESS ACCOUNTABILITY PROJECT, TASK FORCE ON THE LAND GRANT C. COMPLEX* (1978).

24. *See, e.g.*, KEITH GRIFFIN, *THE POL. ECON. OF AGRARIAN CHANGE* (1979); AMERICAN RURAL COMMUNITIES (A.E. Luloff & Louis E. Swanson eds. 1990).

25. *See* WILLARD W. COCHRANE, *THE DEVELOPMENT OF AMERICAN AGRICULTURE: A HISTORICAL ANALYSIS* 387-95 (1979).

26. *See id.* at 427-35.

27. *See id.*

industrialized countries might be traced to biases or distortions in capital substitution that favor large farms. Another explanation of increasing farm size looks to the decreasing proportion of food expenditures in an expanding economy, described by Engel's Law.<sup>28</sup> The price inelasticity of food in an expanding economy results in competition among farms for a decreasing slice of the total economic pie. The superiority of urban wages over rural ones and the tendency of food budgets to decline proportionately with income increases pull people out of agriculture and offer explanations for increasing farm size equally plausible as biased technology.

Whether technology or the shrinking proportion of social budgets in food production drives the trend toward fewer and larger farms, it is important to understand farm restructuring as part of a larger social transformation that has produced greater welfare for a larger number and proportion of a society's population.<sup>29</sup> The demographic shift from primarily rural to primarily urban society is a widely recognized and replicated phenomenon in economic development.<sup>30</sup> Urbanization is definitively associated with increased income and with the substitution of capital for land and labor in agriculture.<sup>31</sup> Regardless of the causes of increasing farm size in industrial countries, urbanization is another reason for emphasizing farm productivity—to permit a smaller share of the population to feed an increasingly large majority. In developing countries, this transformation is not only eagerly anticipated but also mandated by rapid population growth.<sup>32</sup>

The first problem that one confronts in determining whether GMOs will have negative social impacts in the peasant sectors of less developed countries is a lack of information. Industrial countries, in particular the United States, have dominated the production of GMOs, and only one less developed country, Argentina, has appreciable crop area in GMOs, accounting for 94% of the total GMO hectares in developing countries in

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28. See Josef Zweimüller, *Schumpeterian Entrepreneurs Meet Engel's Law: The Impact of Inequality on Innovation-Driven Growth*, 5 J. ECON. GROWTH 185 (2000), available at <http://www.iew.unizh.ch/wp/iewwp009.pdf>.

29. See AMERICAN RURAL COMMUNITIES, *supra* note 24.

30. See DAVID B. GRIGG, *THE AGRICULTURAL SYSTEMS OF THE WORLD: AN EVOLUTIONARY APPROACH* (1974).

31. See *generally* YUJIRO HAYAMI & VERNON W. RUTTAN, *AGRICULTURAL DEVELOPMENT: AN INTERNATIONAL PERSPECTIVE* (rev. & expanded ed. 1985).

32. See EVANS, *supra* note 4.

1999.<sup>33</sup> But the utility of Argentina as a case study for judging the impact of GMOs in the peasant sector is dubious. Argentina is a middle-income country and is distinguished in Latin America by the absence of significant peasant or indigenous sectors.<sup>34</sup> Moreover, the GMOs that are produced in Argentina are industrial crops—soybean and maize—rather than subsistence crops for small farm households.<sup>35</sup>

### B. *The Green Revolution as a Test Case*

Absent wide-scale or long-term adoption of GMOs in the peasant sector of developing countries, we must use a theoretical and comparative approach in assessing possible negative social impacts. The history of agricultural development is replete with case studies of the social impacts of new technologies, in both developed and developing countries. Perhaps the most exhaustive and relevant case history of technology diffusion and social impact is the “Green Revolution”—the diffusion of semi-dwarf varieties of wheat derived from Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) breeding programs and rice developed by the International Rice Research Institute (IRRI). This diffusion began around 1966 and was immediately noticed by both champions and critics. The Green Revolution earned Norman Borlaug (CIMMYT) the Nobel Prize for Peace in 1970. At the same time, it was disparaged by social scientists such as Frankel and Griffin.<sup>36</sup> Indeed, the high profile of the Green Revolution is such that it continues to provoke attacks a quarter century later.<sup>37</sup>

The Green Revolution is especially useful in weighing the potential impact of GMOs in poor, agrarian societies because it, too, deployed the results from biotechnology research—in this case conventional plant breeding. Comparison to the Green Revolution might warrant a distinction

33. James, *supra* note 18, at 12.

34. Argentina has the demographic profile of a developed country; 90% of its population is urban. Population Reference Bureau, *2001 World Population Data Sheet*, [http://www.prb.org/Content/NavigationMenu/Other\\_reports/2000-2002/sheet4.html](http://www.prb.org/Content/NavigationMenu/Other_reports/2000-2002/sheet4.html) (last visited Nov. 27, 2001); *see also* PETER R. ODELL & DAVID A. PRESTON, *ECONOMIES AND SOCIETIES IN LATIN AMERICA: A GEOGRAPHICAL INTERPRETATION* (2d ed. 1978).

35. CLIVE JAMES, INT’L SERV. FOR ACQUISITION OF AGRI-BIOTECH APPLICATIONS, BRIEF NO. 21, *GLOBAL STATUS OF COMMERCIALIZED TRANSGENIC CROPS: 2000* (2000), [http://www.isaaa.org/publications/briefs/Brief\\_21.htm](http://www.isaaa.org/publications/briefs/Brief_21.htm).

36. FRANCINE R. FRANKEL, *INDIA’S GREEN REVOLUTION: ECONOMIC GAINS AND POLITICAL COSTS* (1971); *see also* GRIFFIN, *supra* note 24.

37. *See, e.g.*, VANDANA SHIVA, *THE VIOLENCE OF THE GREEN REVOLUTION* (1991).

between the biotechnology used to breed semi-dwarf varieties and the transgenic technology used to create GMOs, but I would suggest that this distinction does not invalidate the analogy. In both cases, the technology at hand is generated by scientists rather than farmers, by “high technology” and capital intensive institutions, and with international transfers of genetic resources. The results of both are touted as offering benefits for poor and developing countries. Perhaps the most critical difference is that the Green Revolution crops were produced by public agencies and without intellectual property, while many GMO crops are produced by private companies using intellectual property.<sup>38</sup>

Both the theory and history of agrarian change and development—measured by higher incomes, lower population growth, longer lives, and lower infant mortality—confirm that two premises should frame any evaluation of a given agricultural technology: increased production and productivity in developing countries is necessary; increasing wealth will be accomplished through the replacement of land and labor by capital.<sup>39</sup>

These two premises frame this retrospective of the Green Revolution. The extent of world hunger, estimated to affect nearly one in six persons,<sup>40</sup> the high rate of human population growth in poor countries,<sup>41</sup> and the collapse or re-orientation of socialist economies<sup>42</sup> underscore the primacy of productivity enhancement as an economic development strategy.<sup>43</sup> While redistribution of productive resources and income would arguably relieve the hunger presently experienced in developing countries, increased productivity is essential to feed the billions of new people expected within a few decades. For instance, redistribution of food alone is clearly inadequate in Asia, where very large numbers of people subsist near the hunger level, and in Africa, where *per capita* food production has

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38. THOMPSON, *supra* note 21.

39. See Alain de Janvry & E. Phillip LeVeen, *Historical Forces that have Shaped World Agriculture: A Structural Perspective*, in *NEW DIRECTIONS FOR AGRICULTURE AND AGRICULTURAL RESEARCH* 83-104 (Kenneth A. Dahlberg ed., 1986).

40. FOOD & AGRIC. ORG. OF THE U.N. (2000). [\[Author: Please provide more information so that we can locate the source you are citing.\]](#)

41. COHEN, *supra* note 12, at 147-52.

42. *EASTERN EUROPE: OPPORTUNITIES AND NEEDS FOR FOOD AND AGRICULTURE* (F.A. Miller ed., 1993). [ILL]

43. See FOOD & AGRIC. ORG. OF THE U.N., *THE STATE OF FOOD INSECURITY IN THE WORLD* (2000), available at <http://www.fao.org/docrep/x8200e/x8200e00.htm>; COHEN, *supra* note 12.

declined.<sup>44</sup> Moreover, the political and economic history of the last century is rife with evidence of the immense difficulty of redistribution and the perils of neglecting productivity.

GMOs in agriculture, like the semi-dwarf varieties of wheat and rice of the Green Revolution, are clear and unambiguous examples of capital goods that replace land and labor to make agriculture more productive and wealth more attainable. Their abilities to resist pests or to reduce the labor involved in herbicide application are traits that most farmers find advantageous. Hence the wide acceptance of GMOs where governments allow unrestricted access.<sup>45</sup> GMOs are to the late twentieth and early twenty-first centuries what hybrid maize, synthetic fertilizer, and chemical pesticides were to the mid-twentieth century, and mechanization to the mid-nineteenth and early twentieth centuries. On this ground alone, they must be reckoned with as a technology that is likely to be promoted and widely adopted, despite near-term concerns. Although there have been very recent usage reductions in some countries and crops, the expansion of GMOs since their initial deployment appears to follow a classic diffusion path. Arguably, we are witnessing the initial stages of the normal diffusion of GMOs, when “early adopters” presage a take-off of much wider adoption.<sup>46</sup>

While other agricultural technologies have met with resistance, the opposition to further diffusion of GMOs is unprecedented in organization, scope and effectiveness. The weight of the history of agricultural development suggests that long-term forces favoring the substitution of capital for other agricultural inputs will prevail and succeed in establishing GMOs as one more capital asset that is available to farmers everywhere. Nevertheless, as Thompson reminds us, historical momentum is no reason for failing to evaluate technologies on a case-by-case basis. Knowledge of the possible negative social impact on poor farmers might well tip the balance in this confrontation.<sup>47</sup>

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44. E.g., Jonathon M. Harris, *World Agricultural Futures: Regional Sustainability & Ecological Limits*, 17 *ECOLOGICAL ECON.* 95 (1996); Steve Wiggins, *Interpreting Changes from the 1970s to the 1990s in African Agriculture Through Village Studies*, 28 *WORLD DEV.* 631 (2000).

45. James, *supra* note 18.

46. See EVERETT M. ROGERS, *DIFFUSION OF INNOVATIONS* 163-209 (3d ed. 1983) (outlining the classic diffusion path).

47. See THOMPSON, *supra* note 21, at 156-62.

*C. The Case Against GMOs: The Green Revolution Redux*

Thompson summarizes three general arguments against deployment of GMOs in developing countries:

1. Biotechnology will be harmful in provoking an agrarian transition to larger farms.
2. Biotechnology will be harmful in widening the gap between rich and poor because of its links to global trade.
3. Biotechnology will be harmful because of intellectual property.<sup>48</sup>

As noted above, because of the lack of wide diffusion of GMOs in developing countries, these are prospective rather than existing problems created by this technology. The Green Revolution in Asia provides a valuable analogy by which the likelihood of the negative consequences cited in the first two issues—scale bias and trade-induced inequities—might be weighed. The third issue—intellectual property—will be discussed in the next section.

The Green Revolution has been championed and vilified as comprising a bundle of technologies that were, on these respective views, either largely beneficial or largely harmful to peasants.<sup>49</sup> The bundle is made up of high-yielding crop varieties and other inputs, notably fertilizer and irrigation.<sup>50</sup> Its key is semi-dwarf varieties that have several favorable characteristics—a higher index of grain relative to the plant, shorter and stiffer stalks that resist lodging when the grain head is increased, and an ability better to utilize increased applications of fertilizer and irrigation. While the elements of this kit are separable, the greatest benefit of the shorter varieties was realized when seeds, fertilizer, and irrigation were adopted as a package.<sup>51</sup>

The criticism of the Green Revolution began soon after the first harvests of “miracle” rice and wheat. By far the most influential critics

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48. *Id.* at 163.

49. *E.g.*, PETER B.R. HAZELL & C. RAMASAMY, THE GREEN REVOLUTION RECONSIDERED: THE IMPACT OF HIGH-YIELDING RICE VARIETIES IN SOUTH INDIA (1991); YUJIRO HAYAMI & MASAO KIKUCHI, A RICE VILLAGE SAGA: THREE DECADES OF GREEN REVOLUTION IN THE PHILIPPINES (2000); SHIVA, *supra* note 37.

50. *Id.*

51. GRIFFIN, *supra* note 24, at 10, 35; HAYAMI, & KIKUCHI, *supra* note 49, at 115-28.

were the economists Francine Frankel and Keith Griffin.<sup>52</sup> Working on the Indian case, Frankel drew upon data gathered as part of the Intensive Agricultural Program. Frankel argued that increased rural violence after the Green Revolution was evidence of the disproportionately small share of benefits received by small-scale farmers.<sup>53</sup> However, Frankel virtually ignored the long-term tension in the Punjab between different religious and secular groups; nor did she reflect on the catastrophic violence that erupted in the region during the partition of India and Pakistan, 20 years before Green Revolution. This is equivalent to attributing the outbreak of lynching in the American South during the 1930s to the diffusion of hybrid maize, without acknowledging the racial conflicts and their interplay with the economic conditions of the Depression.

Griffin developed a theoretical model of technology's bias in favor of landlords over peasants, and drew upon data from various regions around the world. Using both farm-level and aggregate data from different countries to support his argument, he asserts that "with few exceptions, aggregate agricultural supplies have not increased spectacularly, but with almost no exception, the relative position of the peasantry seems to have deteriorated."<sup>54</sup>

Frankel and Griffin's criticisms concerned the fact that there appeared to be a scale bias in the diffusion of improved varieties—large-scale farmers benefited disproportionately while small-scale farmers obtained disproportionately meager benefits. Since Frankel and Griffin's analyses, scale bias has been the crux of criticism of the Green Revolution.<sup>55</sup> The concerns raised in the early 1970s have been picked up and amplified by many others in India and elsewhere. Scott's extended ethnography of Malaysian rice farmers is widely recognized as a definitive text on the issue.<sup>56</sup>

Three types of negative impacts are seen to flow from the key idea that the technology is inherently prejudiced against small-scale farms. First, small-scale farms suffer a variety of economic and social woes as a result of the Green Revolution—e.g., lower wages, displacement from the land, loss

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52. FRANKEL, *supra* note 36; GRIFFIN, *supra* note 24.

53. See FRANKEL, *supra* note 36, at 12-46.

54. GRIFFIN, *supra* note 24, at 62.

55. E.g., SHIVA, *supra* note 37, at 171-92.

56. See JAMES C. SCOTT, WEAPONS OF THE WEAK: EVERYDAY FORMS OF PEASANT RESISTANCE (1985).

of employment, and higher rents.<sup>57</sup> Second, small-scale farmers are victims of unfavorable changes in the agricultural system: increased instability in crop yields because of genetic vulnerability, increased use of pesticides, or dependence on usurious moneylenders for fertilizer purchase.<sup>58</sup> Third, small-scale farmers receive a disproportionately small share of the benefits from the new technology.<sup>59</sup> This third cost has generally been the most important.

Social impact is dauntingly difficult to understand under any circumstances, and its difficulties are multiplied by several orders of magnitude in developing countries where data is unavailable, unreliable, or difficult to obtain, and where change is a widely accepted social goal. In fact, the number of causal factors that should be considered creates nearly impossible demands on data.<sup>60</sup> One common problem is untangling the impact of agricultural technology *per se* from other factors and changes that might otherwise be part of agricultural development, such as greater reliance on off-farm inputs, labor migration, urbanization, or commercialization. Arguably, the decreasing share of rural income derived from production gains has many possible causes. Lack of education, subdivision of farms under rapid population growth, and the inelasticity of food prices relative to increasing urban income provide explanations other than scale bias for the relatively meager benefits of new technology that flow to the poor. It is inappropriate to assume that changes in the proportion of wealth enjoyed by different sectors within an agricultural economy would not occur in the absence of high-yielding seeds. The history of agriculture was filled with these and other changes before the advent of crop breeding or the Green Revolution.<sup>61</sup>

As a result of the complexity of measuring social impact, some critics of the Green Revolution have relied on ethnographic and qualitative approaches rather than quantitative research to test causality.<sup>62</sup> The

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57. GRIFFIN, *supra* note 24, at 46-94.

58. SHIVA, *supra* note 37, at 72-100.

59. GRIFFIN, *supra* note 24, at 51-54; see JIM HIGHTOWER, *HARD TOMATOES, HARD TIMES*, REPORT OF THE AGRIBUSINESS ACCOUNTABILITY PROJECT ON THE FAILURE OF AMERICA'S LAND GRANT COLLEGE COMPLEX 21 (1978) (discussing the U.S. case); COCHRANE *supra* note 25, at 200 (also discussing the U.S. case).

60. Errol Meidinger & Allan Schnaiberg, *Social Impact Assessment as Evaluation Research*, 4 EVALUATION REV. 507, 512-15 (1980).

61. See e.g., WALTER GOLDSCHMIDT, *AS YOU SOW* 186-202 (2d ed. 1978).

62. SCOTT, *supra* note 56.

qualitative results emphasize the perceptions of people who have experienced technological change, and these perceptions frequently rest on perceived differences between different groups. Scott observes that “there is no way in which the participants’ interpretation of the impact of the green revolution ... can be deduced from the crude economic facts.”<sup>63</sup> Thus, we may be confronted with situations where positive impacts, such as improved nutrition or income, are discounted because of the importance attributed to relative status.

The research institutes that generated Green Revolution technology were quick to respond to the criticisms. Economists at IRRI were particularly active in undertaking systematic research on the issue of adopting Green Revolution rice and measuring its impact on different rural groups.<sup>64</sup> This research built on a larger effort to understand the patterns and processes of technology adoption in developing countries.<sup>65</sup> Herdt’s and Hazell’s retrospective analyses of the Green Revolution in the Philippines and India are especially pertinent,<sup>66</sup> because their findings are strongly at odds with Frankel and Griffin’s conclusions, which were based on research that took place a decade earlier. While Griffin asserted that production gains were insignificant in the Philippines, Herdt finds that Philippine rice production grew annually by 4.5% between 1965 and 1983, from 4.04 million metric tons to 7.99 million metric tons.<sup>67</sup> In both India and the Philippines, farm size proved to be no obstacle to the adoption of High Yielding Variety (HYV) rice, but larger farms adopted sooner than small farms. In direct contradiction to the argument of Frankel, Griffin, and Scott, Herdt reports that landlords were the relative losers because of land reform that occurred at the same time as the Green Revolution in the Philippines.<sup>68</sup> Hired labor earned more and retained a higher share of the output after the spread of HYV rice. Likewise, in India, retrospective

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63. *Id.* at 180.

64. Per Pinstrip-Anderson & Peter B.R. Hazell, *The Impact of the Green Revolution and Prospects for the Future*, 1 FOOD REVIEWS INT’L 1 (1985); HAZELL & RAMASAMY, *supra* note 49, at 17.

65. See e.g., Gershon Feder et al., *Adoption of Agricultural Innovations in Developing Countries: A Survey*, 33 ECON. DEV. & CULTURAL CHANGE 255-98 (1985).

66. Robert W. Herdt, *A Retrospective View of Technological Change and Other Changes in Philippine Rice Farming, 1965-1982*, 35 ECON. DEV. & CULTURAL CHANGE 329, 345-48; HAZELL & RAMASAMY, *supra* note 49, at 1.

67. Herdt, *supra* note 66, at 330

68. *Id.* at 347; FRANKEL, *supra* note 36, at 128-30; SCOTT, *supra* note 56; GRIFFIN, *supra* note 24, at 62.

analysis shows that small farms and the poorest areas, not larger farms and richer areas are favored by the Green Revolution.<sup>69</sup>

Ethnographic research is not at all uniform in confirming Scott's negative assessment of induced technological change in Asian agriculture.<sup>70</sup> Two qualitative studies had the advantage of observing the same locality before and after the Green Revolution, and neither found a negative social impact to have followed implementation of Green Revolution technology.<sup>71</sup> Based on fieldwork in India's Punjab, Leaf observes that the "trickle down" theory is distasteful but not necessarily inappropriate for the village context: "what has happened in the village is not so much a trickle down as a 'swirl-around,' with ever widening circles of involvement, and at the same time an increase in the total range of possibilities for virtually everybody."<sup>72</sup>

Blyn finds generally shared positive attitudes toward HYV wheat and other changes associated with the Green Revolution.<sup>73</sup> The benefits are not enjoyed by everybody, but there is no discernable pattern of disproportionate benefit flows.

Herdt observes that the real "winners" of the Philippine Green Revolution were neither large nor small farms but urban consumers and rural workers who enjoyed lower prices for their staples as a result of the increased productivity of farmers.<sup>74</sup> This observation suggests that the Green Revolution is essentially the same as technological changes in other agricultural systems that create a treadmill of technology adoption and competition among farmers, resulting in relative declines in commodity prices.<sup>75</sup> Poor and small-scale farmers everywhere are potentially disadvantaged because of the likelihood that they will adopt new technology later than larger farmers. The time of adoption, however, is dictated not by scale bias in the technology but by the social and economic contexts of education, credit, and access to information. The goal of increased productivity, the inescapable need for new technology, and the decline of the share of food budgets in wealthier societies create a choice

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69. HAZELL & RAMASAMY, *supra* note 49, at 55-56.

70. SCOTT, *supra* note 55.

71. MURRAY J. LEAF, SONG OF HOPE: THE GREEN REVOLUTION IN A PUNJAB VILLAGE 105-09 (1984).

72. *Id.* at 109.

73. George Blyn, *The Green Revolution Revisited*, 31 ECON. DEV. & CULTURAL CHANGE 705-25 (1983).

74. Herdt, *supra* note 66, at 347-48.

75. COCHRANE, *supra* note 25, at 387-96 (outlining the theory of the treadmill).

that would satisfy Hobbs: either (1) maintain the level and relative distribution of wealth in underdeveloped societies or (2) increase the level of wealth but allow distribution that is unfavorable to the poor. Nevertheless, the long-term negative impact on small-scale farmers is mitigated by another long-term impact of technological change—higher living standards associated with off-farm employment.<sup>76</sup> The ubiquity of urban migration and increased trade (and subsequent increased wealth and welfare) associated with economic development and technological change confounds the simple conclusion that changes in the fortunes of different groups of farmers are inevitably offensive.

Investigation into the social impact of the Green Revolution reveals a confusing and virtually indecipherable set of contradictions between qualitative and quantitative studies done in different countries or regions or at different times. It is patently inappropriate to conclude that the Green Revolution has been shown to have strong negative impacts that would not have occurred absent the diffusion of HYV wheat and rice. There are simply too many other complicating factors that contributed to the negative outcomes attributed to the Green Revolution: increasing relative poverty of the lowest class, declining incomes relative to other groups, and political and social marginalization. It is impossible to separate new technology from the plethora of other factors that are known to affect the status of the rural poor—population increase, inelastic food prices relative to urban incomes, unfair or inappropriate policies such as commodity price controls, credit availability, and infrastructure investment.

In sum, no criticism of the Green Revolution, whether focusing on direct or indirect social effects, agricultural instability or scale bias, has gone unchallenged. Judged by such metrics as the proportion of the population that is malnourished, infant mortality and life expectancy, four decades of extending Green Revolution-type technology has been beneficial to the vast majority of the world's population. Moreover, these positive changes in food availability and life expectancy occurred during a time when the world's population more than doubled.

The large majority of agricultural scientists view the Green Revolution as a logical extension of long-term trends toward increasing the technological control of farmers over the physical and biotic components of

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76. See *id.* (discussing the U.S. case); HAYAMI & KIKUCHI, *supra* note 49, at 14-15, 38-44 (discussing the Philippine case).

agriculture and replacing land and labor with capital. The quiet and ubiquitous diffusion of Green Revolution crop varieties and similar modern technologies suggests that most farmers have determined that the new technology has merit.<sup>77</sup> There is neither compelling logic nor evidence, in the case of the Green Revolution, to indict GMOs as a technology that should be stopped because of negative social consequences that it will unleash. Indeed, it is equally possible that failure to deploy the new technology will have negative consequences such as increasing the disparity between industrialized and less-developed agriculture or depriving farmers of non-chemical means to control pests.<sup>78</sup>

### III. GMOs AND EQUITY ISSUES IN DEVELOPING COUNTRIES

As with forecasting potential social impacts of GMO technology in developing countries, assessing equity issues is likewise hampered by a lack of case studies or other information. Again, we must rely on analogy rather than direct example. One equity issue is the likelihood that GMOs will exacerbate inequities between industrial countries and poor countries. Another equity issue is the shift of agricultural research away from the historic pattern of public research and public goods.<sup>79</sup> Whether agricultural research occurs in developing or industrialized countries, research to create GMOs is likely to rely on privatization of research and intellectual property. While public research and public goods represent benefit-sharing mechanisms that manage biological resources as common heritage,<sup>80</sup> privatization redefines the benefit-sharing nexus between research and farmer.

These considerations take place against the backdrop of a long-standing debate on how to balance equities between countries that provide genetic

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77. See Derek Byerlee, *Modern Varieties, Productivity, and Sustainability: Recent Experience and Emerging Challenges*, 24 *WORLD DEV.* 697 (1996).

78. GARY L. COMSTOCK, *VEXING NATURE?: ON THE ETHICAL CASE AGAINST AGRICULTURAL BIOTECHNOLOGY* 175-82 (2000).

79. See INGE KAUL ET AL., *GLOBAL PUBLIC GOODS: INTERNATIONAL COOPERATION IN THE 21ST CENTURY* (1994) (discussing international development assistance and public goods); RAVI KANBUR ET AL., *THE FUTURE OF DEVELOPMENT ASSISTANCE: COMMON POOLS AND INTERNATIONAL PUBLIC GOODS*, POLICY ESSAY NO. 25 (1999). [ILLs]

80. Stephen B. Brush, *Bioprospecting the Public Domain*, 14 *CULTURAL ANTHROPOLOGY* 535, 539-42 (1999).

resources and countries that use them in biotechnology.<sup>81</sup> Four factors—the value of genetic resources, loss of genetic resources, intellectual property for plants and genes, and imbalance between industrial and non-industrial countries in using genetic resources—were linked in an argument to compensate “gene rich” but economically poor countries for their genetic resources.<sup>82</sup> This concept is articulated most clearly in the 1992 Convention on Biological Diversity (CBD), but it is implied in a long debate within the Food and Agriculture Organization (FAO) of the United Nations (UN) on recognizing “Farmers’ Rights” and in numerous private and public programs for “bio-prospecting.”<sup>83</sup>

The use of intellectual property in the commercialization of GMOs is a logical extension of extending intellectual property rights with respect to plants and other life forms. Beginning with the Plant Patent Act of 1930, the United States has permitted some form of intellectual property protection to crop breeders.<sup>84</sup> Since 1930, intellectual property over plants and other living organisms has both increased in scope and become stronger. The United States and other industrialized countries have limited exemptions to farmers and researchers that were included in early plant variety protection, and now accept the use of utility patents over living organisms.<sup>85</sup>

The fact that intellectual property rights to plants in industrialized countries often involve germplasm collected in less developed countries has been particularly troublesome, because such germplasm was customarily freely provided by farmers.<sup>86</sup> This transfer of biological resources between geographic regions and countries has gone on from time immemorial under

81. See John H. Barton & Eric Chrisensen, *Diversity Compensation Systems: Ways to Compensate Developing Nations for Providing Genetic Materials*, in SEEDS AND SOVEREIGNTY: USE AND CONTROL OF PLANT GENETIC RESOURCES 338 (Jack R. Kloppenburg, Jr. ed., 1988).

82. Stephen B. Brush, *Valuing Crop Genetic Resources*, 5 J. ENV'T & DEV. 416 (1996).

83. *Summary of the Sixth Extraordinary Session of the Commission of Genetic Resources for Food and Agriculture: 24 June – 1 July 2001*, 9 EARTH NEGOTIATIONS BULLETIN 197, available at <http://www.iisd.ca/biodiv/ExCGRFA-6/> (2001); see also Stephen B. Brush, *Farmers’ Rights and Genetic Conservation in Traditional Farming Systems*, 20 WORLD DEV. 1617-30 (1992); CARY FOWLER & PAT MOONEY, SHATTERING: FOOD, POLITICS, AND THE LOSS OF GENETIC DIVERSITY 174-76 (1990).

84. INTELLECTUAL PROPERTY RIGHTS ASSOCIATED WITH PLANTS (B.E. Caldwell & J. A. Schillinger eds., 1989). [ILL]

85. *Id.*; [ILL] Huib Ghijsen, *Plant Variety Protection in a Developing and Demanding World*, BIOTECH & DEV. MONITOR, Sept./Dec. 1998, at 2 (1998), available at <http://www.biotech-monitor.nl/3602.htm>.

86. PAT ROY MOONEY, SEEDS OF THE EARTH: A PRIVATE OR PUBLIC RESOURCE? 3-9 (1980); FOWLER & MOONEY, *supra* note 83.

the rubric of common heritage, which holds that genetic resources of farmers' crop varieties (landraces) and wild plants are part of nature.<sup>87</sup> As such, they were considered public goods without local or national boundaries. In contemporary terminology, genetic resources were understood to be part of the public domain.<sup>88</sup> This rubric fell victim to the politics of the North/South divide, as well as to the rhetoric of theft. The collection of crop germplasm and other biological material that ends up in a patented plant variety in the West has been termed "bio-piracy"—the uncompensated and unidirectional flow of an economic resource from less developed to industrialized countries.<sup>89</sup>

*A. The Assault on Common Heritage*

The successful assault on the foundations of common heritage stressed four factors:

1. A relative abundance of genetic resources in poor countries and a corresponding dearth in industrial countries.
2. Increasing economic importance of genetic resources in industrialized countries.
3. Decreasing amounts of genetic resources because of environmental destruction in developing countries.
4. The availability of intellectual property protection for living organisms in industrialized countries and the lack thereof in developing countries.<sup>90</sup>

The assault had two major consequences. First, it led to the 1992 Convention on Biological Diversity, which asserted that genetic resources belong to nation states as an element of national sovereignty.<sup>91</sup> Second, it

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87. See Stephen B. Brush, *Is Common Heritage Outmoded?*, in VALUING LOCAL KNOWLEDGE: INDIGENOUS PEOPLE AND INTELLECTUAL PROPERTY RIGHTS 143 (Stephen B. Brush & Doreen Stabinsky eds., 1996).

88. See Brush, *supra* note 80.

89. James O. Odek, *Bio-piracy: Creating Proprietary Rights in Plant Genetic Resources*, 2 J. INTELL. PROP. L. 141, 145 (1994).

90. See Jack R. Kloppenburg, Jr. & Daniel Lee Kleinman, *The Plant Germplasm Controversy: Analyzing Empirically the Distribution of the World's Plant Genetic Resources*, 37 BIOSCI. 190, 196-97 (1987); FOWLER & MOONEY, *supra* note 83.

91. See KRISTIN G. ROSENDAL, THE CONVENTION ON BIOLOGICAL DIVERSITY AND DEVELOPING COUNTRIES (2000).

led to efforts to control the collection and movement of genetic resources through contracts (“bio-prospecting”) involving short- and long-term benefit sharing and material transfer agreements.<sup>92</sup> These efforts are intended to curtail “bio-piracy”—a term laden with hidden assumptions about the nature of genetic resources and the previous system of common heritage.<sup>93</sup>

Genetic modification is more likely than conventional crop improvement and other technologies directed toward peasant producers in less developed countries to involve intellectual property rights. Reasons for this include the increase of private over public breeding, the additional investment required to create GMOs, and the centralized and more industrial processes involved in generating GMOs, as well as the expansion of intellectual property with the completion of the General Agreement on Tariffs and Trade (GATT), the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs), and the organization of trade organizations that emphasize intellectual property (the World Trade Organization (WTO) and the World Intellectual Property Organization (WIPO)). The intellectual property aspect of GMOs is frequently cited as one source of the inequities visited upon peasants who have resources but no recognized property rights.<sup>94</sup>

#### *B. Negative Consequences of Intellectual Property Protection*

Thompson identifies the two primary negative consequences associated with intellectual property protection for GMOs:

1. Farmers will be deprived of rightful compensation for property they already own.
2. Farmers will be deprived of important future economic opportunities.<sup>95</sup>

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92. WALTER V. REID ET AL., BIODIVERSITY PROSPECTING: USING GENETIC RESOURCES FOR SUSTAINABLE DEVELOPMENT 32-34 (1993).

93. Brush, *supra* note 87.

94. See, e.g., Hope Shand, *There is a Conflict Between Intellectual Property Rights and the Rights of Farmers in Developing Countries*, 4 J. AGRIC. & ENVTL. ETHICS 131 (1992).

95. THOMPSON, *supra* note 21, at 166-67.

The first of these consequences ensues if farmers have pre-existing but unrecognized ownership rights over indigenous knowledge and biological resources in their fields and forests. This consequence has the same underlying logic as the “bio-piracy” epithet or the aphorism “property is theft.”<sup>96</sup> Of the many different forms of property, intellectual property provides one of the clearer examples of property as a social construction rather than a natural right. It has historical roots that directly refer to social utility, it is limited in scope and time, it is unambiguously arbitrary, and it is confined to only a few societies.<sup>97</sup>

While it is possible that farmers or indigenous people have some form of autochthonous intellectual property rights covering their folk knowledge and biological resources, anthropologists have provided no evidence of this.<sup>98</sup> Rather, there is compelling evidence that biological resources and related folk knowledge are implicitly recognized as public goods and part of the public domain.<sup>99</sup> Perhaps most important is the evidence that both knowledge and resources are shared without restrictions that might be interpreted as implying intellectual property rights. Local crop populations in centers of crop origins and diversity, which contain significant genetic resources,<sup>100</sup> are often managed as open systems.<sup>101</sup> Seed moves frequently and rapidly among households, villages and regions. Local knowledge is embedded in variety nomenclature, but this nomenclature rapidly loses its precision with geographic distance.<sup>102</sup> Nomenclature is fluid and difficult to analogize to the constraints on knowledge that are customarily part of intellectual property regimes (e.g., novelty or non-obviousness, and stability and uniformity for plant varieties).<sup>103</sup> Genetic resources retain their

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96. VANDANA SHIVA, *BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE* 10 (1997).

97. See Fritz Machlup & Edith Penrose, *The Patent Controversy in the Nineteenth Century*, 10 J. ECON. HIST. 1, 11-17 (1950); JOAN ROBINSON, *THE ACCUMULATION OF CAPITAL* (3d ed. 1956).

98. See Michael F. Brown, *Can Culture be Copyrighted?*, 39 CURRENT ANTHROPOLOGY 193 (1998).

99. Brush, *supra* note 80, at 545-49.

100. Otto H. Frankel et al., *The Conservation of Plant Biodiversity* (1995).

101. See Dominique Louette, *Traditional Management of Seed and Genetic Diversity: What is a Landrace?*, in *GENES IN THE FIELD: ON-FARM CONSERVATION OF CROP DIVERSITY* 109 (Stephen B. Brush, Ph.D., ed., 1999); A.C. Zeven, *The Traditional Inexplicable Replacement of Seed and Seed Ware of Landraces and Cultivars: Review*, 110 EUPHYTICA 181 (1999) available at [http://147.46.94.112/e\\_journals/pdf\\_full/journal\\_e/e17\\_99110305.pdf](http://147.46.94.112/e_journals/pdf_full/journal_e/e17_99110305.pdf); KARL S. ZIMMERER, *CHANGING FORTUNES: BIODIVERSITY AND PEASANT LIVELIHOOD IN THE PERUVIAN ANDES* (1996).

102. C.F. Quiros et al., *Biochemical and Folk Assessment of Variability of Andean Cultivated Potatoes*, 44 ECON. BOTANY 254-56 (1990).

103. See Brush, *supra* note 80.

viability partly because they are shared so widely, and traditional farmers everywhere rely on access to seed that is free from the constraints of intellectual property protection.<sup>104</sup> Seed can be multiplied and given or sold to other farmers without invoking charges of piracy or theft. The openness of traditional seed systems accounts for the wide diffusion of crops and crop varieties away from their places of origin.<sup>105</sup> Indeed, the rapid diffusion of semi-dwarf varieties of wheat and rice occurred because of the prominence of the public domain in traditional seed systems.<sup>106</sup> These varieties were freely available and distributed without intellectual property limits affecting their multiplication and further distribution.

Even if farmers do not have an indigenous intellectual property system, the case might be made that the knowledge and genetic resources that are shared under common heritage should not thereafter end up as part of the intellectual property of an industrial firm. One argument supporting such a policy is that living organisms of any type are products of nature and should not be subject to private ownership.<sup>107</sup> While a political process might substantiate this argument and remove living organisms from the realm of intellectual property protection, the strong tendency over the last seventy years has been to extend and strengthen the intellectual property rights afforded in connection with living organisms.<sup>108</sup> Another argument is that seeds are vital to human welfare, and thus should not be the basis of private gain.<sup>109</sup> According to this argument, other vital goods, such as pharmaceuticals, should likewise be unfettered by intellectual property protection.<sup>110</sup> The primary counter-argument to this old debate points to the

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104. See generally CONNY ALMEKINDERS & WALTER DE BOEF, ENCOURAGING DIVERSITY: THE CONSERVATION AND DEVELOPMENT OF PLANT GENETIC RESOURCES (2000) [ILL]; ROBERT TRIPP, SEED PROVISION & AGRICULTURAL DEVELOPMENT: THE INSTITUTIONS OF AGRICULTURAL CHANGE (2001). [ILL/signal?]

105. JACK R. HARLAN, CROPS AND MAN (2d ed. 1992).

106. See Byerlee, *supra* note 77; Robert E. Evenson & Douglas Gollin, *Genetic Resources, International Organizations, and Improvement in Rice Varieties*, 45 ECON. DEV. & CULTURAL CHANGE 471 (1997) (offering a case study of rice).

107. MOONEY, *supra* note 86.

108. INTELLECTUAL PROPERTY RIGHTS ASSOCIATED WITH PLANTS, *supra* note 84 [ILL]; Ghijsen, *supra* note 85.

109. Martin Khor, *Third World—The Worldwide Fight Against Biopiracy*, 37 RACE & CLASS, Jan.-Mar. 1996, at 73, 76-77.

110. See Ellen 't Hoen, *Globalisation and Equitable Access to Essential Drugs* (2001), at <http://www.twinside.org.sg/title/twr120c.htm>.

increased availability of vital goods that has resulted from the private gains made possible by intellectual property regimes.<sup>111</sup>

As stated above, the current political trend strongly favors expansion of intellectual property protection. The expansion of intellectual property rights in all countries that become GATT signatories and WTO members insures that these rights will not be confined to industrial countries. Indeed, the TRIPs provision allowing countries to design a novel, *sui generis*, system of intellectual property protection for plants might permit protection of farmer knowledge and crop varieties.<sup>112</sup> There is, however, a tendency to opt for more conventional approaches and to leave farmer knowledge and crop varieties in the public domain, where they have always resided. The few countries that have attempted to fashion *sui generis* systems (e.g., the Andean Pact) have not extended intellectual property protection to farmer knowledge or landraces.<sup>113</sup>

The second intellectual property issue noted above is that farmers may be deprived of future benefit when a seed company creates and patents a novel organism using these farmers' resources. While unique and valuable traits have been found in specific crop populations, there is reason to argue that GMOs represent such a radically different breeding strategy as to vitiate this particular issue. Valuable traits in farmers' crops do not require genetic transformation simply because they are available through conventional crop breeding that may or may not involve private seed companies and intellectual property. Indeed, GMOs are unique precisely because they focus on traits that are not otherwise available through conventional breeding. The addition of exotic genes to a crop does not deprive farmers of future economic opportunities, because the patented genes and processes are not derived from farmers' varieties. Moreover, the

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111. Machlup & Penrose, *supra* note 97.

112. See Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization [hereinafter WTO Agreement], Annex 1C, art. 27(1) LEGAL INSTRUMENTS—RESULTS OF THE URUGUAY ROUND vol. 31, 33 I.L.M. 81 (1994) [hereinafter TRIPS Agreement], available at [http://www.wto.org/english/docs\\_e/legal\\_e/27-trips.pdf](http://www.wto.org/english/docs_e/legal_e/27-trips.pdf); see also Dan Leskien & Michael Flitner, *Intellectual Property Rights and Plant Genetic Resources: Options for a Sui Generis System*, ISSUES IN GENETIC RESOURCES, June 1997, available at <http://www.ipgri.cgiar.org/publications/pdf/497.pdf>.

113. Andean Community Decision 391: Common Regime on Access to Genetic Resources (1996), at <http://216.15.202.3/docs/andeancommunity-decision391-1996-en.pdf>; Andean Community Decision 345: Common Provisions on the Protection of the Rights of Breeders of New Plant Varieties (1993), at <http://216.15.203.3/docs/andeancommunity-pvdecision345-1993-en.pdf>.

argument of lost future benefits is rather easily turned on its head: farmers will benefit from GMOs because they will obtain access to traits that are otherwise unavailable to them.

### *C. Distortions in Agricultural Research*

The final and most compelling concern about GMOs is that they fundamentally reorient agricultural research in ways that are unfavorable to the poor and marginal farmer in less developed countries—arguably, the farmer who could benefit most from the science. Public sector agricultural science has generally proven itself to be a powerful ally of the peasant farmer in less developed countries, providing new technologies and inputs that are easily incorporated into peasant production. The trend toward fewer and larger farms, which appears to disprove this case, is in fact a product of a more general social transformation that would take place even without the technology generated from scientific laboratories and experiment stations.<sup>114</sup> Historically, organized research has contributed to farm welfare through public expenditures to ministries of agriculture and to universities.<sup>115</sup> In a few instances, scientific progress was quickly privatized, as in the discovery and deployment of hybrid maize in the American Corn Belt.<sup>116</sup> Until recently, however, the general pattern in developing countries has been that agricultural research is a public sector prerogative. The Green Revolution was a public sector partnership between international research programs and national research and extension programs in developing countries. The success of the Green Revolution rests on the skill and labor of scientists at both levels.<sup>117</sup> Nevertheless, public sector agricultural research has been besieged by two forces. First, the accumulation of debt in developing countries and the implementation of the neoliberal “Washington Consensus” since 1980 led to a sustained

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114. See discussion *supra* § II.A.

115. See ROBERT E. EVENSON & YOAV KISLEV, *AGRICULTURAL RESEARCH AND PRODUCTIVITY* (1975); Vernon Ruttan & Yujiro Hyami, *Induced Innovation Theory and Agricultural Development: A Personal Account*, in *INDUCED INNOVATION THEORY AND INTERNATIONAL AGRICULTURAL DEVELOPMENT* 22-36 (Bruce Koppel ed., 1994).

116. DEBORAH FITZGERALD, *THE BUSINESS OF BREEDING: HYBRID CORN IN ILLINOIS, 1890-1940* (1990). [ILL]

117. See HAZELL & RAMASAMY, *supra* note 49; HAYAMI & KIKUCHI, *supra* note 49; Byerlee, *supra* note 77.

assault on public expenditure.<sup>118</sup> International funding for agricultural research slowed markedly after 1980.<sup>119</sup> Ministries of agriculture in developing countries with predominantly agricultural economies were primary and easy targets of governmental reductions. For instance, total research expenditures of national agricultural research systems showed a decline in Africa and Latin America after 1981.<sup>120</sup> Second, public programs for agricultural research and extension were assailed as inefficient and biased against the poor.<sup>121</sup>

The solution to these problems was to devolve the functions of organized research and extension to the private sector, including non-governmental organizations (NGOs).<sup>122</sup> In many countries, NGOs have come to rival public sector organizations. With respect to agricultural research in developing countries, non-governmental organizations may be effective in outreach and extension but seldom have the interest or capacity to undertake agricultural research that results in technology similar to the semi-dwarf varieties of the Green Revolution. This type of research relies on long-term development and evaluation, access to the international germplasm system, and a permanent scientific staff. Ideally, the efforts of NGOs complement public sector research, with labor divided between the development of new technology and its diffusion. Unfortunately, the reduction of support for public sector research has placed undue responsibility on NGOs, which usually lack the facilities and personnel to carry out long-term development and evaluation of new technology. Theoretically, private sector research—for instance, by multinational seed companies—might replace public sector research programs. But it is doubtful that private research will address the needs of farm regions and

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118. John Williamson, *The Washington Consensus Revisited*, in *ECONOMIC AND SOCIAL DEVELOPMENT INTO THE XXI CENTURY* 48-59 (Louis Emmerij ed., 1997).

119. See Jock R. Anderson, *Selected Policy Issues in International Agricultural Research*, 26 *WORLD DEV.* 1149, 1151 (1998); PETER UVIN, *THE INTERNATIONAL ORGANIZATION OF HUNGER* (1994).

120. See Mywish K. Maredia et al., *Impacts of Food Crop Improvement Research: Evidence from Sub-Saharan Africa*, 24 *FOOD POL'Y* 531 (2000); K. Adebayo & I. A. Idowu, *The Aftermath of the Withdrawal of the World Bank Counterpart Funding for the Ogun State Agricultural Development Programme (ADP) in Nigeria*, 17 *J. SUSTAINABLE AGRIC.* 79 (2000); see also Julian M. Alston et al., *Financing Agricultural Research: International Investment Patterns and Policy Perspectives*, 26 *WORLD DEV.* 1057-71 (1998) (offering an analysis of Latin America).

121. ROBERT CHAMBERS, *RURAL DEVELOPMENT: PUTTING THE LAST FIRST* 1-25 (1983).

122. See Carl E. Pray & Dina Umali-Deininger, *The Private Sector in Agricultural Research Systems*, 26 *WORLD DEV.* 1127 (1998); W.F. Fisher, *Doing Good? The Politics and Antipolitics of NGO Practices*, 26 *ANN. REV. OF ANTHROPOLOGY* 439 (1997).

other populations, including small scale farms, marginal environments, and ethnic minority farmers, as they were previously addressed by public sector programs.<sup>123</sup>

Clearly, GMOs have arrived on the scene at a time when organized, public sector research capacity is extremely low. Consequently, the heavy investment in human and scientific capital necessary to develop GMOs is not available in the public sector of developing countries. It should be no surprise that private sector companies which have invested in GMOs would show little interest in addressing the needs of the poorest farmers. Besides lacking the financial resources to purchase new and private technology, poor farmers in developing countries often live in agriculturally marginal and heterogeneous locations that are much more costly to reach with research and extension than the optimal and homogeneous locations dominated by large, commercial farms. In addition, the lack of seed companies, weak or non-existent intellectual property law, and inadequate law enforcement in poor countries deter private companies.

The cost, scientific attractiveness, and intellectual property aspects of GMOs are apt to draw scarce resources away from public research organizations whose mandate is to create technology for the poor. This likelihood is exacerbated by the vulnerability of public sector and international funding to political attacks by the anti-GMO movement. The unfortunate consequence is that the poor farmers of less developed countries have an ever-shrinking scientific establishment to serve them. If technology is a driving force behind farm restructuring, GMOs seem to be devilishly suited to help large farms, indirectly hurting small farms by depriving them of new technology. An ironic solution to this is actively to promote the public sector research and development of GMOs for poor farms.

#### CONCLUSION

This paper has argued that the case against developing or deploying agricultural GMOs in less developed countries, based on negative social consequences, is not sustainable. Neither disparities between large and small farms nor the inequities of intellectual property are definitive. Based

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123. *Id.* at 455-59.

on the nature and recent history of the Green Revolution, GMOs seem unlikely to have a detectable, negative social impact in developing countries. The “precautionary principle” invoked against GMOs can equally be invoked in their favor to confront the negative social consequences of population increase and environmental change.<sup>124</sup> Equity is, however, problematic because of an increased likelihood that agricultural research will neglect disadvantaged agricultural sectors. The solution to this inequity may be not less but more GMO research by public research institutions that are now neglected, despite their substantial success in the recent past.

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124. COMSTOCK, *supra* note 78; THOMPSON, *supra* note 21.