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Protecting Traditional Agricultural Knowledge

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Protecting Traditional Agricultural Knowledge

Stephen B. Brush*

Conservationists have advanced various proposals to protect farmer knowledge and engender the farmer participation necessary for continued crop evolution that generates plant genetic resources for food and agriculture. These proposals include increasing the demand for traditional crops by farmers and consumers,¹ enhancing the supply of those crops,² and negotiating a monetary value for crop resources.³ While achieving *in situ* conservation is possible without changing farmers' customary management of crops as common pool resources, an alternative approach is to negotiate a contract with providers of the resource that involves direct payment and royalties. This bioprospecting mechanism implies a change in the customary treatment of crop genetic resources as common pool goods and is in line with national ownership mandated by the Convention on Biological Diversity (CBD).⁴ Until the end of the last century, crop genetic resources were managed as public domain goods according to a set of practices loosely labeled as "common heritage." The rise of intellectual property for plants, the commercialization of seed, the increasing use of genetic resources in crop breeding, and the

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1. Valeria Negri & Nicola Tosti, *Phaseolus Genetic Diversity Maintained On-Farm in Central Italy*, 49 GENETIC RESOURCES & CROP EVOLUTION 511, 518-19 (2002); Margaret E. Smith et al., *Participatory Plant Breeding with Maize in Mexico and Honduras*, 122 EUPHYTICA 551, 552 (2001).

2. MAURICIO R. BELLON, DEMAND AND SUPPLY OF CROP INFRASPECIFIC DIVERSITY ON FARMS 1-2 (Economics Program of the International Maize and Wheat Improvement Center (CIMMYT), Mexico, D.F., Working Paper No. 01-01, 2001).

3. Paul J. Ferraro & Agnes Kiss, *Direct Payments to Conserve Biodiversity*, 298 SCIENCE 1718, 1719 (2002).

4. CBD (1992), available at <http://www.biodiv.org/convention>.

declining availability of crop genetic resources have contributed to extensive revisions to the common heritage regime. Changes include specifying national ownership over genetic resources and use of contracts in the movement of resources between countries.

This article explores the impact of these changes in cradle areas of crop domestication, evolution and diversity (Vavilov Centers) where farmers continue to grow diverse populations of crops that serve as stores of genetic resources and sources for new resources. The question posed here is whether protection of traditional knowledge is best accomplished through a form of bioprospecting that replaces common pool management by private ownership. The article addresses two issues relating to the demise of the common heritage regime:

1. What role does common heritage play in the management of crop genetic resources?
2. What steps are available to protect crop genetic resources in the public domain and to recognize the stewardship of farmers who maintain those resources?

The article discusses these issues in reference to the flow of genetic resources between traditional farming systems of Vavilov Centers and the commercial and public crop breeding sectors in developed countries.

I. VAVILOV CENTERS AND THEIR CROP RESOURCES

The uneven distribution of crop diversity among geographic regions was one clue used by nineteenth-century naturalists such as Alphonse DeCandolle and Charles Darwin to identify centers of domestication for different crops.⁵ The contrasts between centers of origin and other regions where crops are cultivated are still impressive. A single province in the Peruvian Andes has more potato diversity than all of North America.⁶ Likewise, the cassava diversity found in a single Amerindian village in Guyana has been found to be greater than the diversity in core collection of the international gene

5. STEPHEN B. BRUSH, *FARMERS' BOUNTY* 24 (2004).

6. C.F. Quiros et al., *Biochemical and Folk Assessment of Variability of Andean Cultivated Potatoes*, 44 *ECON. BOTANY* 254, 264-65 (1990).

bank of the crop.⁷ Early in the twentieth century, Nikolai Vavilov added a second clue, the presence of wild relatives, to solve the problem of locating centers of crops' origins.⁸ Vavilov's accomplishment is recognized among crop scientists by the concept of a Vavilov Center to designate the geographic regions where a particular crop was domesticated and initially evolved under cultivation.⁹ Although the idea of "center" has been debated¹⁰ and crop centers are redefined according to new data,¹¹ the current consensus among crop scientists is that cradle areas of crop domestication are identifiable and reasonably well known.¹² While genetic resources are found in all farming systems, they are particularly valuable and abundant in Vavilov Centers. Concern for conservation and protection of traditional knowledge associated with them is appropriately focused on these centers. Vavilov Centers are critical locations for genetic resources of the world's crops because of their on-going processes of crop evolution, such as gene flow between wild relatives and cultivated types and decentralized selection by farmers.

Just as uneven distribution reveals origin, it also is evidence of diffusion and the fact that farmers and consumers elsewhere are beneficiaries of the resources derived from Vavilov Centers. Thus, maize and cassava farmers in Africa and Asia rely on crop genetic resources that originated in MesoAmerica (maize) and the Amazon Basin (cassava); and New World farmers who grow rice, an Asian domesticate, or sorghum, from Africa, draw on resources from the Old World. The flows of genetic resources in public breeding programs, diffusion of improved crops, and commercial seed also evidence a contemporary dependence on genetic resources from

7. M. Elias et al., *Assessment of Genetic Variability in a Traditional Cassava (Manihot esculenta Crantz) Farming System, Using AFLP Markers*, 85 HEREDITY 219, 226 (2000).

8. N.I. Vavilov, *The Origin, Variation, Immunity, and Breeding of Cultivated Plants*, 13 CHRONICA BOTANICA 1, 45 (1949/1950).

9. JOHN GREGORY HAWKES, *THE DIVERSITY OF CROP PLANTS* 65 (1983).

10. See JACK R. HARLAN, *CROPS AND MAN* 51 (2d ed. 1992).

11. See David L. Lentz et al., *Prehistoric Sunflower (Helianthus annuus L.) Domestication in Mexico*, 55 ECON. BOTANY 370, 374 (2001).

12. HAWKES, *supra* note 9, at 52.

Vavilov Centers that is perhaps greater than in times when crop diffusion was informal.¹³

The flow of crop genetic resources has occurred in different spatial and organizational frameworks since the beginning of agriculture. Indeed, some crop scientists speculate that domestication occurred because the wild ancestors of crops were moved beyond their original habitats.¹⁴ The diffusion of crops beyond their original cradle areas starts with the exchange of seed among farmers and is a dominant pattern of crop evolution.¹⁵ This diffusion was accomplished through the incessant movement of human populations and the constant quest for new crops and crop varieties to meet the obstacles of crop production and to satisfy the urgings of human curiosity and palate. Long before the "Columbian Exchange"¹⁶ connected the Old and New Worlds and before European imperial ambitions moved crops here and there,¹⁷ the patterns of long-distance and trans-continental crop diffusion existed. In the prehistoric New World, maize, beans, avocados, and chili pepper, among other crops, migrated from MesoAmerica in the Northern Hemisphere to South America, and cassava, tomatoes, and tobacco moved in the opposite direction. In the prehistoric Old World, wheat, cabbage crops (*Brassica oleracea*) among others moved eastward from the Fertile Crescent and the Mediterranean to the far reaches of Asia, while rice and stone fruits (e.g., peaches, apricots) moved westward to the Atlantic.¹⁸ Similar patterns are evident in Africa and Oceania, for

13. See generally Robert E. Evenson & Douglas Gollin, *Genetic Resources, International Organizations, and Improvement in Rice Varieties*, 45 ECON. DEV. & CULTURAL CHANGE 471 (1997) (evaluating the effect of international organizations and programs on improvements in rice varieties); Cary Fowler et al., *Unequal Exchange? Recent Transfers of Agricultural Resources and Their Implications for Developing Countries*, 19 DEV. POL'Y REV. 181 (2001) (examining current patterns of gene flows and finding that developing countries are major net recipients of germplasm samples); MELINDA SMALE ET AL., THE DEMAND FOR CROP GENETIC RESOURCES (International Food Policy Research Institute, Environment and Production Technology Division (EPDT) Discussion Paper No. 82, 2001) (recognizing that germplasm samples distributed by the U.S. National Germplasm System favor developing countries).

14. HAWKES, *supra* note 9, at 30.

15. LLOYD T. EVANS, CROP EVOLUTION, ADAPTATION AND YIELD 113 (1993).

16. ALFRED W. CROSBY, JR., THE COLUMBIAN EXCHANGE: BIOLOGICAL AND CULTURAL CONSEQUENCES OF 1492, at 64 (1972).

17. LUCILE H. BROCKWAY, SCIENCE AND COLONIAL EXPANSION: THE ROLE OF THE BRITISH ROYAL BOTANIC GARDENS 6, 37 (1979).

18. JONATHAN D. SAUER, HISTORICAL GEOGRAPHY OF CROP PLANTS 27, 116, 207, 218

instance in the diffusion of sorghum south of the Sahara and taro across the Pacific.¹⁹ More formal mechanisms for diffusing crop resources appear to have complemented informal methods since antiquity. The biogeography of rice was recognized in China at least 2000 years ago,²⁰ and expeditions that included the collection of new crops and crop varieties are reported for the Sumerians in 2500 BC.²¹

Beginning in the fifteenth century, the colonial expansion and global migration of Europeans changed the scale and nature of crop diffusion in two ways. First, the amount and rapidity of diffusion were greatly augmented by the Iberian linkage between Europe, Africa, and the New World.²² This connection changed the agricultural landscape on all continents. Second, crop exploration and diffusion were formalized and eventually institutionalized.²³ Naturalists and plant explorers accompanied expeditions that had colonial or imperial intentions, and the collection and diffusion of medicinal, industrial, and food crops played a visible role in the European expansion between the sixteenth and twentieth centuries.²⁴ Indeed, plant collection and exchange was seen as a normal part of diplomatic and economic intercourse among nations,²⁵ an idea that was immortalized in Thomas Jefferson's aphorism, "[t]he greatest service which can be rendered any country is, to add a useful plant to its culture".²⁶

By the early twentieth century, plant collection, conservation and introduction had become a formalized government activity in the United States, Russia, and Australia.²⁷ Responding to the discovery

(1993); DANIEL ZOHARY & MARIA HOPF, DOMESTICATION OF PLANTS IN THE OLD WORLD 15, 84, 172, 181 (2d ed. 1993).

19. SAUER, *supra* note 18, at 84; EVANS, *supra* note 15, at 73.

20. F. Bray, *Agriculture, Vol. VI Pt. 2*, in J. NEEDHAM, SCIENCE AND CIVILIZATION IN CHINA 487 (1984).

21. C. LEONARD WOOLLEY, THE SUMERIANS 79 (1928).

22. CROSBY, *supra* note 16, at 73.

23. JOHN GASCOIGNE, SCIENCE IN THE SERVICE OF EMPIRE: JOSEPH BANKS, THE BRITISH STATE AND THE USES OF SCIENCE IN THE AGE OF REVOLUTION 130 (1998).

24. BROCKWAY, *supra* note 17.

25. Knowles A. Ryerson, *History and Significance of the Foreign Plant Introduction Work of the United States Department of Agriculture*, 7 AGRICULTURAL HISTORY 110 (1933).

26. *Services of Jefferson (1800)*, in IX THE WORKS OF THOMAS JEFFERSON 65 (Paul Leicester Ford ed., 1905).

27. Ryerson, *supra* note 25, at 121.

of the principles of inheritance in genetics,²⁸ national crop breeding programs grew out of the foundations of informal plant exploration and introduction. The young science of genetics changed crop resources from a possible source of new production to a probable source. Vavilov was one of the first crop scientists to recognize and promote this idea.²⁹ International programs for collection, conservation, evaluation, and use of genetic resources further changed the scope and nature of the movement of crop genetic resources among human communities and across great distances. Establishing effective crop breeding programs for international development followed the path blazed by Vavilov and others in assembling, evaluating, and utilizing large national collections of genetic resources from many places but principally from cradle areas of crop domestication.³⁰

II. THE COMMON HERITAGE REGIME

“Common heritage” has historically been the implicit system for managing the diffusion of crop genetic resources, from the informal movement of crops in prehistoric times to the formal national and international framework of crop exploration and conservation agencies. Common heritage refers to the treatment of genetic resources as belonging to the public domain and not owned or otherwise monopolized by a single group or interest. Defining common heritage is similar to belated and sometimes last-ditch efforts to demarcate the public domain after the expansion of private property.³¹ Just as the public domain is most easily defined when its constituent parts are appropriated and privatized,³² common heritage

28. John M. Poehelman, *How Crop Improvement Developed*, in *THE LITERATURE OF CROP SCIENCE* 1, 9 (Wallace C. Olsen ed., 1995).

29. Vavilov, *supra* note 8, at 15.

30. DONALD L. PLUCKNETT ET AL., *GENE BANKS AND THE WORLD'S FOOD* 7-8 (1987); Ryerson, *supra* note 25, at 123 (discussing U.S. expeditions to Europe, Asia, and North Africa in the early twentieth century to bring myriad genetic resources from those countries to the United States).

31. See generally Jessica Litman, *The Public Domain*, 39 *EMORY L.J.* 965 (1990) (examining the public domain and copyright law).

32. See generally ROSEMARY J. COOMBE, *THE CULTURAL LIFE OF INTELLECTUAL PROPERTIES* (1998) (analyzing the constitutive role intellectual property plays in law and society).

is made visible when exchange and use of biological resources are restricted and privatized. An obstacle to understanding and appreciating common heritage is its inherently implicit nature, but roots of the concept are visible in the free exchange of seed among farmers, the long history of diffusion through informal and formal mechanisms, established scientific practices, and the application of the term to other resources in the international arena. Moreover, the robust debate about common property³³ was likely to have triggered the use of the term by crop scientists. Reference to crop genetic resources as a common heritage appeared in the 1980s in association with the establishment of the Commission on Plant Genetic Resources at the Food and Agricultural Organization of the United Nations (FAO) and the launching of the International Undertaking of Plant Genetic Resources.³⁴ The 1983 conference establishing the FAO Commission and International Undertaking affirmed a resolution stating that "plant genetic resources are a heritage of mankind and consequently should be available without restriction".³⁵

Common heritage for plant resources implies open access to seeds and plants from farmers' fields, with due recognition of prior informed consent and the importance of farmers' need for seed and undisturbed fields. Common heritage reflects common property regimes described by anthropologists and other social scientists.³⁶

33. See Garret Hardin, *The Tragedy of the Commons*, 162 *SCIENCE* 1243 (1968); Duncan Kennedy & Frank Michelman, *Are Property and Contract Efficient?*, 8 *HOFSTRA L. REV.* 711 (1980).

34. Resolution 8/83 of the Twenty-second Session of the FAO conference recognized that "plant genetic resources are a heritage of mankind . . ." Food and Agriculture Organization of the United Nations (FAO) Res. 8/83, *International Undertaking on Plant Genetic Resources for Food and Agriculture*, U.N. FAO Commission on Genetic Resources for Food and Agriculture (CGRFA), 22d Sess. [hereinafter Res. 8/83] pt. (a), at 1 (1983). Resolution 5/89 of the Twenty-fifth Session of the FAO conference recognized that "plant genetic resources are a common heritage of mankind . . ." FAO Res. 5/89, *Farmers' Rights*, U.N. FAO, 25th Sess., pt. (a), at 1 (1989); see also CARY FOWLER, *UNNATURAL SELECTION* 189 (1994); ROBIN PISTORIUS & JEROEN VAN WIJK, *THE EXPLOITATION OF PLANT GENETIC INFORMATION* 10-15 (1999).

35. Res. 8/83, *supra* note 34, Annex, at 2 (1983).

36. Bonnie J. McCay & James M. Acheson, *Human Ecology of the Commons*, in *THE QUESTION OF THE COMMONS* 1 (Bonnie J. McCay & James M. Acheson eds., 1987); see also Fikret Berkes, *Common-Property Resource Management and Cree Indian Fisheries in Subarctic Canada*, in McCay & Acheson, *supra*; Arun Agrawal, *Common Property Institutions and Sustainable Governance of Resources*, 29 *WORLD DEV.* 1649 (2001) (examining common property-based resource management).

Like these common property regimes, common heritage implies open access; but whereas common property regimes often imply "club goods"³⁷ that are openly accessible only to members, common heritage for genetic resources tends to involve fuzzy and permeable boundaries and lack of concern about access. This contrasts with the clear boundaries and control of access that are usual for more tangible and finite common property assets such as pastures, irrigation systems, and wood lots.³⁸ The universal processes of diffusion and dispersal and the historical practice of reciprocity, which are all in the nature of crop genetic resources, provide the logical foundation for common heritage, but not for drawing sharp boundaries that define ownership. Crop genetic resources derive originally from the natural and amorphous processes of crop evolution: mutation, natural selection, exchange, and decentralized selection. Because no person or group controls crop evolution, it is inappropriate for anyone to claim authorship or ownership. Likewise, the tangled history of diffusion and dispersal not only obscures points of origin but suggests that all farmers benefit from fluid movement of seed. Farmers who openly provide seed expect to receive it in the same manner, and the same is true for crop breeders.

Neither common heritage nor common property imply a lack of rules governing the use and management of common assets,³⁹ a fact that has been often misunderstood.⁴⁰ Rather, community management involves regulated access to common resources and reciprocity among users. One implicit principle in common heritage of genetic resources is the principle of reciprocity: those taking seeds are expected to provide similar access to crop resources. Open access is balanced by generalized reciprocity among farmers and plant breeders across economic sectors and national borders. Reciprocity by plant collectors and breeders becomes evident in three ways. First,

37. RICHARD CORNES & TODD SANDLER, *THE THEORY OF EXTERNALITIES, PUBLIC GOODS, AND CLUB GOODS* 33 (2d ed. 1996).

38. ELINOR OSTROM, *GOVERNING THE COMMONS* 90 (1990).

39. 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); see also OSTROM, *supra* note 38, at 92; CORNES & SANDLER, *supra* note 37.

40. McCay & Acheson, *supra* note 36, at 8; Hardin, *supra* note 33.

plant collectors who gather material that is freely exchanged within farming communities continue this free exchange with crop breeders everywhere.⁴¹ Second, collectors and crop breeders have historically worked under the ethos of public sector research in which the free dissemination of improved crops and the availability of genetic resources from gene banks represents reciprocity to farmers and countries that provide genetic resources. The wide diffusion of modern crop varieties from international breeding programs is one indication of the extent of reciprocity under common heritage.⁴² Third, plant variety protection, the most widely used form of Breeders' Rights, includes farmers' and researcher's exemptions which allow farmers to replant and researchers to reuse certified seed without paying royalties to the certificate holder.⁴³ Illustrating the reciprocity principle in practice, Shands and Stoner enumerate the multiple ways that the U.S. National Germplasm System honors its obligations in the global flow of crop resources. These include donor support to foreign and international conservation and crop improvement programs, cooperative breeding programs, access to USDA collections, repatriation of germplasm, training, and scientific exchange.⁴⁴

The exchange of seed among farmers and the lack of explicit proprietary rules governing specific crop types, traits, or germplasm appear to be common to agriculture before the twentieth century. It remains the dominant approach to seed management for the large majority of farmers around the world. The occasional prohibitions on the export of seed or plant cuttings, such as the nineteenth-century embargo by Peru and Bolivia on the export of *Chinchona* seedlings⁴⁵

41. Henry L. Shands & Allan K. Stoner, *Agricultural Germplasm and Global Contributions*, in GLOBAL GENETIC RESOURCES 97, 97-98 (K. Elaine Hoagland & Amy Y. Rossman eds., 1997).

42. Derek Byerlee, *Modern Varieties, Productivity, and Sustainability*, 24 WORLD DEV. 697, 697 (1996).

43. David J. Houser, *Exemptions Under Patents and Certificates Covering Plants and Comments on Material Transfer Agreements*, in INTELLECTUAL PROPERTY RIGHTS: PROTECTION OF PLANT MATERIALS 107, 108 (P. Stephen Baenziger et al. eds., 1993).

44. Shands & Stoner, *supra* note 41, at 101.

45. BROCKWAY, *supra* note 17, at 115-16; TOBY MUSGRAVE & WILL MUSGRAVE, AN EMPIRE OF PLANTS 154 (2000).

or Ethiopia's more recent embargo on coffee,⁴⁶ cannot be interpreted as negating the custom of treating genetic resources as public goods. The age-old and continuing diffusion of crops through informal and formal mechanisms, without restrictions on the use of progeny, also supports the argument that genetic resources historically have been defined as part of the public domain.

The crop scientists who articulated the idea of common heritage for crop resources were acculturated in science as a social system without proprietary relations over its basic resources: theories, algorithms, or methodologies.⁴⁷ The sociology of science in this context was described by Merton as the Communism of science in which concern for authorship did not imply exclusive rights.⁴⁸ Accordingly, most crop scientists who helped establish the international framework for plant genetic resources worked in public breeding programs that released their products as public goods.

Crop scientists also adopted the concept of common heritage from the international discourse about caring for the global environment.⁴⁹ The search for ways to confront degradation in extra-territorial regions such as the open seas led to the concept of common heritage⁵⁰ and to international legal frameworks such as the Antarctic Treaty (1959) and the U.N. Convention on the Law of the Sea (1982). Five elements of common heritage emerged from these negotiations:⁵¹

1. Areas defined as common heritage would not be subject to appropriation by private or public interests;
2. All people would share in the management of common territory;

46. CARY FOWLER & PAT MOONEY, *SHATTERING: FOOD, POLITICS, AND THE LOSS OF GENETIC DIVERSITY* (1990).

47. ROBERT K. MERTON, *THE SOCIOLOGY OF SCIENCE* 293 (Norman W. Storer ed., 1973).

48. *Id.* at 274.

49. Francis X. Cunningham, *The Common Heritage*, *FOREIGN SERV. J.*, July/Aug. 1981, at 13.

50. Christopher C. Joyner, *Legal Implications of the Concept of the Common Heritage of Mankind*, 35 *INT'L & COMP. L.Q.* 190 (1986).

51. *Id.*

3. Economic benefits from the exploitation of common territory would be shared internationally;
4. Common territory would only be used for peaceful purposes; and
5. Scientific research in common territory would be freely and openly accessible.

These principles were never explicitly applied to crop genetic resources, perhaps because of ambiguity about the exact definition of these resources. If resources are defined as wild relatives of crops or cultivated populations of farmers' varieties (landraces) that cannot be attributed to one farmer or specific point of origin, then these common heritage principles are appropriate. If resources are defined as all genetic material of crops, then the first three of these principles are violated by the plant patenting and plant variety protections (Breeders' Rights) that were in place in industrial countries before 1980. Some used common heritage to argue against the right of breeders to protect their products,⁵² while others saw common heritage and Breeders' Rights as co-existing.⁵³ The central vagueness in defining common agricultural heritage is whether it applies to all genetic material or just to material that is in nature and unclaimed as property. This ambiguity has had devastating consequences for the continued practice of relatively easy and open access to genetic resources.

Common heritage management of genetic material that is not claimed as intellectual property remains conspicuous at two extremes: in farming communities of Vavilov Centers and in the flow of germplasm through international gene banks. The exchange of crop material among farmers within and between communities appears to be ubiquitous and perhaps a necessary part of agriculture.⁵⁴ Seed exchange is necessitated and promoted by many factors. Seeds have finite viability because of the constantly changing natural

52. P.R. MOONEY, *THE LAW OF THE SEED* 45 (1983).

53. C. Mastenbroek, *Plant Breeders' Rights, An Equitable Legal System for New Plant Cultivars*, 24 *EXPERIMENTAL AGRIC.* 15, 22-24 (1988).

54. Stephen B. Brush, *Bioprospecting the Public Domain*, 14 *CULTURAL ANTHRO.* 535 (1999).

environment, especially pests and pathogens. Seed becomes infested with disease organisms, such as viruses. Human tastes are notoriously fickle, especially when reflected in markets. Households lose seed in bad years or to rot and vermin. These factors and many others lead to common folk admonitions to change seed often,⁵⁵ while other forces result in a constant commingling of individual farmers' material.⁵⁶ Commingling of genetic material within and among villages occurs on common threshing floors, in the exchange of gifts of seed, wage payment in kind to agricultural labor, and in regional trade of commodities and seed.⁵⁷ This commingling poses a high barrier to any other form of seed management than common heritage.

Case studies of rice turnover in Thailand⁵⁸ and maize seed flow in Mexico⁵⁹ illustrate the significance of farmer-to-farmer seed exchange. Dennis found that Thai rice farmers relied mostly on traditional varieties and grew an average of 1.7 varieties per farm, but variety turnover was high.⁶⁰ Variety lists from 1950 to 1961 indicate eighty-nine types of rice in the study region, and in 1982–83, only fifteen of these were still present among the total of 122 varieties. Dennis found that average projected turnover time for upland rice was thirty to forty-eight years, while the time for lowland, irrigated rice was thirteen years.⁶¹ Traditional and local varieties were subject to turnover as well as modern varieties. In sum, variety turnover is a regular part of traditional Thai rice agriculture, and traditional varieties are not necessarily local varieties.

55. A.C. Zeven, *The Traditional Inexplicable Replacement of Seed and Seed Ware of Landraces and Cultivars*, 110 EUPHYTICA 181, 181–82 (1999).

56. Stephen Brush et al., *Potato Diversity in the Andean Center of Crop Domestication*, 9 CONSERVATION BIOLOGY 1189 (1995) (examining diversity and population structure of potato landraces to better conserve genetic resources).

57. Stephen B. Brush et al., *Dynamics of Andean Potato Agriculture*, 35 ECON. BOTANY 10 (1981); Hugo Perales R. et al., *Dynamic Management of Maize Landraces in Central Mexico*, 57 ECON. BOTANY 21 (2003).

58. John Value Dennis, *Farmer Management of Rice Variety Diversity in Northern Thailand* 123 (1987) (unpublished Ph.D. dissertation, Cornell University) (on file at University Microfilms, Ann Arbor, MI).

59. D. Louette, *Traditional Management of Seed and Genetic Diversity: What is a Landrace?*, in GENES IN THE FIELD 109 (Stephen Brush ed., 1999).

60. Dennis, *supra* note 58, at 194.

61. *Id.* at 124.

Similarly in Mexico, a Vavilov Center like Thailand, the flow of maize germplasm also appears significant among farming communities. Louette found that farmers in Cuzalapa, Jalisco regularly change the seed lots of their maize landraces and acquire seed of existing varieties and new varieties from outside their community.⁶² She found that fifteen percent of the seed lots in the study period were from outside. Perales found a similar pattern in the Chalco and Cuautla Valleys of central Mexico, where farmers frequently purchase seed in urban market places and where seed of maize landraces moves between different states.⁶³ Both Louette and Perales describe the genetic base of maize landraces as an open system. This description has likewise been applied to potato landraces found in Quechua farmers' fields in the Cusco area.⁶⁴ With better information about farmer seed management in traditional farming systems, we now think of landraces as metapopulations or networks of individual populations that are linked through seed flow among farmers and communities.

Moving from farmers' fields in Vavilov Centers to the flow of crop germplasm through international gene banks and crop breeding programs, we also see an open system. Duvick argued that a distinguishing characteristic between traditional and modern farming systems was the locus of diversity in each.⁶⁵ According to this view, diversity in traditional farming systems was found on individual farms and in farming communities, while in modern systems diversity was shifted to a network of gene banks and breeding programs. We have modified our thinking about traditional farming to recognize the importance of metapopulations and seed systems, but we can accept Duvick's description of modern agriculture as an interdependent network of seed and germplasm sources.⁶⁶ Very few

62. Louette, *supra* note 59.

63. Hugo Rafael Perales Rivera, Conservation and Evolution of Maize in Amecameca and Cuatla Valleys of Mexico 230 (1998) (unpublished Ph.D. Dissertation, University of California Davis) (on file at University Microfilms, Ann Arbor, MI).

64. Karl S. Zimmerer, *The Ecogeography of Andean Potatoes*, 48 BIOSCIENCE 445, 452 (1998).

65. Donald N. Duvick, *Genetic Diversity in Major Farm Crops on the Farm and in Reserve*, 38 ECON. BOTANY 161 (1984).

66. *Id.*

countries or farming systems in the world today do not rely to some degree on the international system that moves crop germplasm, breeding lines, improved varieties, and commercial seed across international borders. Studies of breeding programs show that developing countries, including those within Vavilov Centers, are heavily dependent on international flows of germplasm and more dependent than developed countries.⁶⁷ Rejesus et al. examined wheat breeding and found that in West Asia, the Vavilov Center for wheat, wheat breeders' use of their own landraces and advanced lines accounted for 34.2% of the breeding material in their programs compared to 37.9% from international sources.⁶⁸ For rice, Evenson and Gollin document the flow of germplasm in Asia and the dependence of Asian countries on germplasm obtained from the International Rice Research Institute (IRRI).⁶⁹ Vavilov Center countries (e.g., India, Burma, Bangladesh, Nepal, Vietnam) depended on IRRI for between 65.0% (India) and 98.1% (Vietnam) for the rice material in their breeding programs. This compared to 13.6% in U.S. rice breeding. Fowler et al. estimate that 89.8% of the rice samples distributed from IRRI go to developing countries.⁷⁰ The international exchange of crop germplasm is similar to exchange among farmers in being an open system.⁷¹

Both farmer seed exchange and international crop germplasm flows evolved originally as common heritage regimes. Common heritage is logical within farming communities where land and other natural resources are communally owned, seed is exchanged or shared, invention is collective, provenance is ambiguous, and natural and artificial selection are intertwined. Because of the transaction costs of proprietary management of seed, common heritage arguably is the best way to satisfy the frequent necessity to change or acquire seed in non-market economies. Privatization of land and the development of a market for labor do not necessitate the privatization

67. SMALE ET AL., *supra* note 13.

68. R.M. Rejesus et al., *Wheat Breeders' Perspectives on Genetic Diversity and Germplasm Use*, 9 PLANT VARIETIES & SEEDS 129, 132 (1996). The origin of the remainder of parent material in wheat breeders' crossing blocks was not clearly identified. *Id.*

69. Evenson & Gollin, *supra* note 13, at 481.

70. Fowler et al., *supra* note 13, at 192.

71. *Id.* at 190.

of genetic resources. Intellectual property for plants was a rather recent change⁷² that lagged far behind the development of markets for land and labor. Plant patenting and other forms of intellectual property in plants has been willingly embraced in some countries but resisted in many others.⁷³

Likewise, a common heritage approach for international exchange is sensible because it lowers transaction costs that are inherent in defining and defending property over genetic resources.⁷⁴ These costs include negotiation, pre-distribution tracking, and post-distribution tracking⁷⁵ as well as the conventional transaction costs (e.g., exclusion, information, and communication), identified by economists.⁷⁶ An example of information costs associated with crop genetic resources is how to ascertain the true "source" of collections. Germplasm collecting existed for many decades before it was more formally organized in the 1970s with the creation of world collections and the International Board for Plant Genetic Resources to facilitate collection and exchange. The United States received germplasm from many sources, including missionaries, diplomats, and plant explorers. The original collections that established the U.S. national gene bank (National Seed Storage Laboratory) included material that had only the country of origin.⁷⁷ These U.S. collections were duplicated and distributed to other national and international gene banks, such as the Italian National Gene Bank at Bari and the International Center for Agricultural Research in the Dry Areas (ICARDA), thus multiplying the material without detailed provenience in gene banks around the world.⁷⁸ A 1984 review of the status and use of gene banks by Peeters and Williams reports that passport data was wholly lacking for sixty-

72. FOWLER, *supra* note 34, at 73.

73. Martin Khor, *Third World*, 37 RACE & CLASS 73, 74 (1996).

74. BERT VISSER ET AL., GLOBAL FORUM ON AGRICULTURAL RESEARCH (GFAR), DOC. NO. GFAR/00/17-04-04, TRANSACTION COSTS OF GERmplasm EXCHANGE UNDER BILATERAL AGREEMENTS 2-3 (2000), available at http://www.egfar.org/documents/02_-_meetings/conferences/gfar_2000/session_2/gf170404.pdf.

75. *Id.* at 3.

76. Ronald H. Coase, *Notes on the Problem of Social Cost*, in THE FIRM, THE MARKET, AND THE LAW 157-86 (1988).

77. Conversation with Ardeshir B. Damania, Genetic Resources Conservation Program, University of California, Davis (Jan. 15, 2003).

78. *Id.*

five percent of the samples in the active international network of gene banks.⁷⁹ This percentage has probably decreased as more systematic collection has added to inventories, but the FAO reports that only thirty-seven percent of the material in national collections has passport data.⁸⁰

Plant explorers often cover large territories and reduce collection times by collecting in markets and other central places such as schools. Even if collections come directly from farmers, the seed may be a recent acquisition from another farmer or village. Assigning a territorial designation may also be problematic because of the frequency of migration and the transitory nature of political boundaries. Assuring that source information adheres to collections also incurs cost. Imposing transaction costs associated with privatization onto the international exchange crop germplasm is defensible if the benefits of privatization, such as improved access and conservation are realized, but whether these benefits will indeed result is yet to be demonstrated.

In contemporary parlance, common heritage means that genetic resources are an international public good⁸¹ used by crop scientists to produce other public goods. Common heritage is a rational system of managing crop genetic resources in the international system that was principally organized as a way to facilitate public breeding programs. The public good nature of this system is embodied in the practice of open exchange of crop germplasm among crop breeders and in the research exemption of plant variety protection systems.⁸² The period of common heritage management provided an international benefit of immeasurable proportions. The availability of crop resources outside of their original hearths provided food sources that altered human

79. J.P. Peeters & J.T. Williams, *Towards Better Use of Genebanks with Special Reference to Information*, 60 PLANT GENETIC RESOURCES NEWSL. 22, 24 (1984).

80. UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION, THE STATE OF THE WORLD'S PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE (1997) [hereinafter STATE OF THE WORLD], available at <http://www.fao.org/waicent/faoinfo/agricult/agp/agps/pgrfa/pdf/swrfull.pdf>.

81. RAVI KANBUR ET AL., THE FUTURE OF DEVELOPMENT ASSISTANCE: COMMON POOLS AND INTERNATIONAL PUBLIC GOODS (1999); Inge Kaul et al., *Defining Global Public Goods*, in GLOBAL PUBLIC GOODS 2, 13 (Inge Kaul et al. eds., 1999).

82. Houser, *supra* note 43, at 108.

history. The “Columbian Exchange”⁸³ not only benefited Europeans but it also made new staples, such as maize, beans, sweet potatoes, and potatoes, available to Africa and Asia. More recently, the collection of genetic resources under common heritage led directly to increasing food availability around the world through breeding high yielding varieties whose pedigrees include germplasm from numerous countries.⁸⁴

III. CLOSING THE GENETIC COMMONS

Following the successful initiatives of the 1970s to organize an international framework for conserving crop genetic resources, the common heritage approach for managing access came under increasing, erosive pressure. Factors that combined to threaten the common heritage approach include the increasing value of genetic resources, the expansion of Breeders’ Rights in industrial countries, the liberal policy formulation for agricultural development, the North/South political discourse, and the rise of the environmental movement. These strands converged in the early 1990s to produce the CBD, and when taken together with the Global Agreement on Trade and Tariffs, they point to the demise of common heritage. By the beginning of the twenty-first century, however, common heritage had regained status as the underlying principle of a new international framework for managing access to crop genetic resources.

Genetic resources gained value throughout the twentieth century by virtue of increasing demand and decreasing supply. The discovery of the principles of inheritance provided impetus for the creation of systematic crop breeding, an endeavor that required a supply of genetic material.⁸⁵ Public and private crop breeding expanded its role throughout the twentieth century, first in the rapidly industrializing countries of Europe and North America,⁸⁶ and then internationally

83. CROSBY, *supra* note 16, at 185–88 (describing the importance of New World crops to Africa).

84. Byerlee, *supra* note 42, at 697; Melinda Smale, *The Green Revolution and Wheat Genetic Diversity: Some Unfounded Assumptions*, 25 *WORLD DEV.* 1257, 1257 (1997).

85. Ryerson, *supra* note 25, at 123–24.

86. DEBORAH FITZGERALD, *THE BUSINESS OF BREEDING: HYBRID CORN IN ILLINOIS, 1890–1940* (1990). Fitzgerald chronicles the rise of private corn breeding on the foundations of

into the developing countries.⁸⁷ While organized crop breeding increased the demand for genetic resources, genetic erosion that accompanied agricultural modernization threatened the supply of those resources.⁸⁸ The creation of an international network of over 1300 national and regional germplasm collections in addition to eleven international gene banks managed by CGIAR institutions, and with six million accessions is evidence of increased value of genetic resources.⁸⁹

The rise of crop breeding also contributed to the demise of common heritage by changing perceptions about crop breeders and ownership of living matter. After 1900, crop breeders emerged as another type of inventor who manipulated common goods into novel and more useful ones,⁹⁰ so it is not surprising that intellectual property protection for plant breeders soon followed the rise of systematic crop improvement. A progression of different forms of Breeders' Rights ensued, the U.S. Plant Patent Act in 1930, and since this Act, Breeders' Rights have been expanded both in terms of what products are eligible for protection as intellectual property and in the strength of protection afforded to breeders. Utility patents on new crops, their component parts, and processes have thus been added to plant patents and plant variety certificates.⁹¹ The U.S. Supreme Court reaffirmed the legitimacy of utility patents for crops in *J.E.M. Ag Supply v. Pioneer Hi-Bred International*.⁹² Moreover, less developed countries have increasingly adopted Breeders' Rights to stimulate crop improvement and in response to international pressure. Perhaps most importantly, Breeders' Rights are included in the Trade-Related

public science. See, e.g., DEBORAH FITZGERALD, *The Uses of Science: History of the Funk Brothers Seed Company*, in FITZGERALD, *THE BUSINESS OF BREEDING*, *supra*; JACK RALPH KLOPPENBURG, JR., *FIRST THE SEED: THE POLITICAL ECONOMY OF PLANT BIOTECHNOLOGY 1492-2000*, at 105-16 (1988); HENRY A. WALLACE & WILLIAM L. BROWN, *CORN AND ITS EARLY FATHERS*, (Iowa State University Press rev. ed. 1988).

87. LLOYD T. EVANS, *FEEDING THE TEN BILLION* 133 (1998).

88. O.H. Frankel, *Genetic Conservation in Perspective*, in *GENETIC RESOURCES IN PLANTS—THEIR EXPLORATION AND CONSERVATION* 469, 474 (O. H. Frankel & E. Bennett eds., 1970); Jack R. Harlan, *Our Vanishing Genetic Resources*, 188 *SCIENCE* 618, 619 (1975).

89. *STATE OF THE WORLD*, *supra* note 80, at 98, 107.

90. FOWLER, *supra* note 34, at 89.

91. Nicholas J. Seay, *Intellectual Property Rights in Plants*, in *INTELLECTUAL PROPERTY RIGHTS*, *supra* note 43, at 61, 66.

92. 534 U.S. 124, 130 (2001).

Aspects of Intellectual Property Rights (TRIPS) Agreement⁹³ and are part of the package of national policies required for membership in the World Trade Organization (WTO).⁹⁴ While the TRIPS agreement allows countries to fashion their own (*sui generis*) approach to Breeders' Rights,⁹⁵ the need to conform to international standards encourages adoption of a system resembling the International Union for the Protection of New Varieties of Plants (UPOV) approach.

The development of plant breeding, the expansion of Breeders' Rights, and the recognition of genetic erosion as a social cost of agricultural development seemed to portend the inevitable demise of common heritage. The apparent failure of the common heritage system to contain the degradation of crop genetic resources conforms to the Tragedy of the Commons scenario.⁹⁶ This failure is attributed to the open access quality of the common heritage system that allowed breeders to benefit from using resources without bearing the cost of maintaining them. Hardin⁹⁷ and others⁹⁸ argued that privatizing common pool resource was the way to arrive at socially acceptable levels of use and conservation, and this argument was easily extended to genetic resources.⁹⁹

The North/South political discourse took up the availability of Breeders' Rights in industrialized countries and their absence elsewhere as evidence of an imbalance in the stream of benefits flowing from genetic resources.¹⁰⁰ Breeders were accorded the right

93. GRAHAM DUFFIELD, INTELLECTUAL PROPERTY RIGHTS, TRADE AND BIODIVERSITY 78 (2000); MARTIN A. GIRSBERGER, BIODIVERSITY AND THE CONCEPT OF FARMERS' RIGHTS IN INTERNATIONAL LAW 135 (Thomas Cottier ed., 1999); Dan Leskien & Michael Flitner, *Intellectual Property Rights and Plant Genetic Resources: Options for a Sui Generis System*, ISSUES IN GENETIC RESOURCES NO. 6 (International Plant Genetic Resources Institute (IPGRI), June 1997, at 2.

94. Carlos A. Primo Braga & Carsten Fink, *Reforming Intellectual Property Rights Regimes*, 1 J. ECON. INT'L L. 537, 539 n.3 (1998).

95. Leskien & Flitner, *supra* note 93, at 48.

96. Hardin, *supra* note 33, at 1243.

97. *Id.*

98. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347 (1967).

99. Roger A. Sedjo, *Property Rights and the Protection of Plant Genetic Resources*, in SEEDS AND SOVEREIGNTY 293 (Jack R. Kloppenburg, Jr. ed., 1988).

100. Jack R. Kloppenburg, Jr. & Daniel Lee Kleinman, *Seeds of Controversy: National Property Versus Common Heritage*, in SEEDS AND SOVEREIGNTY, *supra* note 99, at 173, 173-74.

to tangible, private benefits while farmers had to rely on indirect, public benefits. The reciprocity of the common heritage system functioned through providing public goods such as new crop varieties, education, and development infrastructure rather than in private goods that directly connected the farmer and crop breeder. The critical ambiguity of whether common heritage should apply to all genetic resources or only to those in fields and farm stores became a political liability. The relatively low visibility of the reciprocity provided a basis for claims of exploitation under the label "biopiracy."¹⁰¹ Odek's definition of biopiracy as the "uni-directional and uncompensated appropriation" of genetic resources¹⁰² pointedly ignored the reciprocity of the international system of collecting, conserving, using, and redistributing crop genetic resources. More generally, this reciprocity was undervalued by arguments that contractual collection arrangements are needed to ensure equitable returns.¹⁰³ Finally, the rise of the "neo-liberal" policy agenda in international development after 1980¹⁰⁴ and the increasing pressure for more participatory and non-governmental programs¹⁰⁵ favored market solutions to development problems such as conserving crop resources.

By 1992, these strands had converged to create conditions for a bold move against common heritage, and a potential *coup de grâce* was delivered in the 1992 CBD that defined genetic resources as belonging to nation states. The initialing of the CBD at the 1992 U.N. Conference on the Environment and Development (UNCED) in Rio de Janeiro marks a watershed in the management of crop genetic resources.¹⁰⁶ UNCED sought to forge a new framework for

101. VANDANA SHIVA, *BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE* 5 (1997).

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

103. WORLD RESOURCES INSTITUTE (WRI), WORLD CONSERVATION UNION (IUCN), UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP), *GLOBAL BIODIVERSITY STRATEGY: GUIDELINES FOR ACTION TO SAVE, STUDY, AND USE EARTH'S BIOTIC WEALTH SUSTAINABLY AND EQUITABLY* 94 (1992).

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

105. R. CHAMBERS, *RURAL DEVELOPMENT: PUTTING THE LAST FIRST* 168 (1983).

106. Lyle Glowka et al., Int'l Union for the Conservation of Nature, *A Guide to the Convention on Biological Diversity*, ENVTL. POLICY AND LAW PAPER NO. 30, 1994, at 1.

confronting environmental problems.¹⁰⁷ This new framework intended to defuse increasing North/South polarization of the pre-UNCED era with a cooperative approach involving unbinding (“soft law”) agreements such as Agenda 21, community based forms of action, inclusion of non-governmental organizations (NGOs), and voluntary reporting.¹⁰⁸ UNCED also followed a period of heightened awareness of the trans-national nature of environmental problems and somewhat fitful attempts to negotiate individual, legally binding conventions, such as the U.N. Convention on the Law of the Sea.¹⁰⁹

The post-UNCED system for managing crop genetic resources was characterized by national ownership of crop resources overlying professional practices inherited from the pre-UNCED (common heritage) period and the creation of management tools that would be appropriate to the UNCED principles of sovereign ownership and equitable sharing of benefits from the use of biological resources. Two contradictory pressures, however, are evident in the spirit of UNCED. The emphasis on sovereign ownership suggested a move to regulate access to national resources through bilateral contracting mechanisms that became known as bioprospecting agreements.¹¹⁰ The second pressure in UNCED was to eschew legally binding international conventions¹¹¹ in favor of a more cooperative “soft law” approach¹¹² based on voluntary mechanisms.

These pressures have had different effects in reshaping access to genetic resources depending whether pharmaceutical and natural product resources or crop resources are involved. Access to resources

107. Jacqueline Roddick, *Earth Summit North and South*, 7 GLOBAL ENVTL. CHANGE 147, 147 (1997).

108. DARRELL A. POSEY & GRAHAM DUTFIELD, BEYOND INTELLECTUAL PROPERTY 120 (1996); see also Roddick, *supra* note 107.

109. See generally U.N. DIV. FOR OCEAN AFFAIRS & THE LAW OF THE SEA, THE LAW OF THE SEA (1997) (reproducing the text of the agreement with index and excerpts from the Final Act of the Third United Nations Conference on the Law of the Sea).

110. Walter V. Reid et al., *A New Lease on Life*, in BIODIVERSITY PROSPECTING: USING GENETIC RESOURCES FOR SUSTAINABLE DEVELOPMENT 1 (Walter V. Reid et al. eds., 1993); Sarah A. Laird & Kerry ten Kate, *Biodiversity Prospecting: The Commercial Use of Genetic Resources and Best Practice in Benefit-Sharing*, in BIODIVERSITY AND TRADITIONAL KNOWLEDGE: EQUITABLE PARTNERSHIPS IN PRACTICE 241, 243 (Sarah A. Laird ed., 2002).

111. Roddick, *supra* note 107, at 156.

112. Francesco Mauro & Preston D. Hardison, *Traditional Knowledge of Indigenous and Local Communities*, 10 ECOLOGICAL APPLICATIONS 1263, 1266 (2000).

for pharmaceutical development tended toward regulation by bilateral contracts while access to resources for crop development has tended toward open, multilateral mechanisms.¹¹³ Three differences between these two genetic resources explain this outcome. First, pharmaceutical resources tend to involve relatively discrete traits and perhaps single genes while crop resources involve quantitative traits that are controlled by multiple genes. Second, crop resources are dependent on human stewardship and have resulted from collective management and selection. Third, pharmaceutical resources lacked the international infrastructure of collection, conservation, public breeding, and exchange that was developed for crop resources.¹¹⁴ The Merck/InBio contract¹¹⁵ epitomized bioprospecting contracts for pharmaceutical and natural product development. Comparable agreements between suppliers and users of crop genetic resources are rare, but in their place, suppliers of crop resources have promoted the use of material transfer agreements.¹¹⁶ These mechanisms are sometimes informational rather than financial contracts. For instance, the instruments developed by the international gene banks of the CGIAR system inform the recipient of germplasm that it is for research and breeding purposes only and inveigh him/her to forgo future claims of intellectual property.¹¹⁷ These mechanisms retain

113. Brendan Tobin, *Biodiversity Prospecting Contracts*, in BIODIVERSITY AND TRADITIONAL KNOWLEDGE, *supra* note 110, at 287; COMMISSION ON INTELLECTUAL PROPERTY RIGHTS (CIPR), INTEGRATING INTELLECTUAL PROPERTY RIGHTS AND DEVELOPMENT POLICY 69 (2002), at http://www.ipccommission.org/papers/pdfs/final_report/ciprfullfinal.pdf.

114. Perhaps because of the extremely large number of species kept at botanical collections and herbariums, their policy is to make specimens available to researchers. *See, e.g.*, Royal Botanic Gardens, Kew: Collections: Herbarium (last visited Dec. 26, 2004), at <http://www.rbgekew.org.uk/collections/herbcol.html>. No comparable system exists for plant resources for pharmaceuticals to the one for crop resources, which involves the exchange of seed as well as information about the accessions. *See* BIODIVERSITY IN TRUST: CONSERVATION AND USE OF PLANT GENETIC RESOURCES IN CGIAR CENTRES (Dominic Fuccillo et al. eds., 1997); PLUCKNETT ET AL., *supra* note 30.

115. Reid et al., *supra* note 110, at 2.

116. John H. Barton & Wolfgang E. Siebeck, *Material Transfer Agreements in Genetic Resources Exchange—The Case of the International Agricultural Research Centres*, ISSUES IN GENETIC RESOURCES NO. 1, May 1994, at 11; *see also* Michael A. Gollin, *Elements of Commercial Biodiversity Prospecting Agreements*, in BIODIVERSITY AND TRADITIONAL KNOWLEDGE, *supra* note 110, at 310, 313.

117. *See, e.g.*, CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT), MATERIAL TRANSFER AGREEMENT (2001), available at <http://www.ciat.cgiar.org/pgp/mta.htm>.

common heritage aspects of the pre-UNCED era and avoid moving to more rigid contractual agreements that specify benefit flows that are found in bioprospecting agreements for pharmaceutical and other natural products.¹¹⁸ In other cases, however, countries have turned to the Mutual Transfer Agreement (MTA) as a contractual mechanism to transfer genetic resources. An example of this is the use of MTAs by the National Biodiversity Institute of Costa Rica that accompany the transfer samples to partner organizations and have contractual power recognized by national law.¹¹⁹

Civil society organizations, nations, regional coalitions, and international agencies have responded to the closure of the biological commons with a variety of programs and implements aimed at protecting the public domain. One program is to register traditional knowledge practices and innovations and thereby define them as a prior art so that they cannot be directly appropriated as intellectual property. The American Association for the Advancement of Science has initiated the Traditional Ecological Knowledge * Prior Art Database where plant names and associated knowledge can be registered.¹²⁰ At the international level, the negotiation of the International Treaty for Plant Genetic Resources for Food and Agriculture represents the culmination of an enduring effort to maintain crop resources as common pool goods.

IV. THE INTERNATIONAL TREATY FOR PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Besides material transfer agreements, the international crop resource system responded to national sovereignty with negotiations that eventually reconfirmed the principles of relatively unfettered and uncompensated germplasm exchange. Negotiations involving the Consultative Group for International Agricultural Research (CGIAR),

118. Reid et al., *supra* note 110.

119. Jorge Cabrera Medaglia, *Costa Rica: Legal Framework and Public Policy*, in SANTIAGO CARRIZOSA ET AL., *ACCESSING BIODIVERSITY AND SHARING THE BENEFITS* 101 (2004).

120. AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS), AAAS PROJECT ON TRADITIONAL ECOLOGICAL KNOWLEDGE, at <http://shr.aaas.org/tek> (last visited Sept. 20, 2004).

the FAO Commission on Plant Genetic Resources for Food and Agriculture, and numerous nations resulted in two international agreements that confirmed common heritage. In 1994, the collections of the international gene banks of the CGIAR centers were placed under the auspices of the FAO, to be managed as an international public good by the gene banks, excepted from intellectual property claims, and freely available to crop breeders.¹²¹ Second, the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was negotiated in 2001¹²² and has now been signed by seventy-eight countries, including the U.S.¹²³ Having reached the required number of national instruments of ratification, acceptance, approval or accession, the treaty went into force on June 29, 2004.¹²⁴

The ITPGRFA takes a multilateral approach that reaffirms common heritage for the crop genera that are included in list of crops covered by the pact. States retain sovereign rights over their genetic resources, including the right to designate genetic material and whole plants as intellectual property. The core provisions of the ITPGRFA (Articles 10–12) place the resources of thirty-six genera of crops and twenty-nine genera of forages in the public domain and guarantees access to these resources for breeding and research. Germplasm from the multilateral system will be available with an MTA that may include provisions for benefit sharing in the event of commercialization. The Treaty stipulates that

Recipients shall not claim any intellectual property or other rights that limit the facilitated access to plant genetic resources for food and agriculture, or their genetic parts or components, in the form received from the Multilateral System.¹²⁵

121. PISTORIUS & VAN WIJK, *supra* note 34; CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH (CGIAR) SYSTEM-WIDE GENETIC RESOURCES PROGRAMME, 1999 ACTIVITIES (2000), at <http://sgrp.cgiar.org/1999activities-policy.html>.

122. International Treaty on Plant Genetic Resources of Food and Agriculture (ITPGRFA), Commission on Genetic Resources for Food and Agriculture, U.N. Food and Agricultural Organization (FAO) (2001), at <ftp://ext-ftp.fao.org/ag/cgrfa/it/itpgrfa.pdf>.

123. ITPGRFA, U.N. FAO Legal Office (last visited Dec. 26, 2004), at <http://www.fao.org/legal/treaties/033s-e.htm>.

124. *Id.*

125. ITPGRFA, *supra* note 122, art. 12.3.d.

The phrase "in the form received" may be interpreted as allowing intellectual property claims once significant, inventive manipulation has occurred.¹²⁶ The interpretation of this issue and others will be negotiated by parties to the treaty that will comprise the Governing Body of the International Undertaking. The FAO serves as the proprietor of the international crop collections that are held in trust by the CGIAR, and the CGIAR system has repeatedly confirmed its adherence to open access to these collections.¹²⁷

Article 13 of the ITPGRFA lays out a procedure for benefit sharing by stipulating that commercialization of a new plant variety will trigger a financial contribution to the multilateral system. Again, the approach is multilateral rather than contractual between the genetic resource provider and the person who commercialized a product using that resource. The level, form, and conditions of payment (for instance, whether small farmers are exempt) is not resolved in the treaty and will be subject to further negotiations within the Governing Body of the International Undertaking.¹²⁸ The benefit-sharing mechanism of the ITPGRFA faces serious logistical difficulty because of the long lag time between access to genetic resources and commercialization. Moreover, identifying the contribution of a specific resource within the complex pedigree of an improved crop variety poses a major obstacle to negotiating benefit sharing. Nevertheless, the treaty provides a mechanism for negotiating these obstacles while access to crop resources remains open. Another obstacle is the increasing propensity of commercialization of crop varieties based on patents of transgenic components such as *Bacillus thuringiensis* (Bt) and tolerance to glyphosate herbicides.¹²⁹ Because these traits do not derive from

126. CIPR, *supra* note 113, at 69.

127. Susan Bragdon & David Downes, *Recent Policy Trends and Developments Related to the Conservation, Use and Development of Genetic Resources*, ISSUES IN GENETIC RESOURCES NO. 7 (IPGRI), June 1998, at 17, available at <http://www.ipgri.cgiar.org/policy/igr7.pdf>.

128. The terms of benefit sharing are to be determined by the Governing Body of the treaty, comprised of all contracting parties. See ITPGRFA, *supra* note 122, art. 13.2.d.ii.

129. See, e.g., Greg Graff et al., *Agricultural Biotechnology in Developing Countries*, in PERSPECTIVES IN WORLD FOOD AND AGRICULTURE 2004, at 417, 423–24 (Colin G. Scanes & John A. Miranowski eds., 2004); Janice A. Kimpel, *Freedom to Operate*, 37 ANN. REV. OF PHYTOPATHOLOGY 29, 38 (1999). Moreover, besides reliance on intellectual property in agricultural biotechnology, there is evidence of increasing concentration in this research sector.

traditional agricultural knowledge, commercialization of crops based on these traits may not contribute to the multilateral system developed by the ITPGRFA.¹³⁰

This treaty grew out of nearly two decades of negotiation at the FAO concerning an international system for managing crop genetic resources.¹³¹ Following UNCED, the system of international germplasm exchange faced the rise of bilateral agreements which the CBD sovereignty clause invited, but four factors pushed treaty negotiation toward a multilateral framework. First, replacing the open system with one defined by bilateral contracts would entail steep transaction costs that might exceed the value of the resources.¹³² Second, the process of creating a new access regime based on bilateral contracts posed the threat of interrupting germplasm exchange because of an anti-commons¹³³ resulting from the claims of different parties to control over access.¹³⁴ Third, increasing evidence suggested heavy dependence by poor countries on outside germplasm resources,¹³⁵ contradicting the conclusion that industrial countries were more dependent on germplasm from developing countries.¹³⁶ Fourth, accessions from large and valuable collections of the CGIAR network and industrial countries, such as the National Seed Storage

James F. Oehmke & Christopher A. Wolf, *Measuring Concentration in the Biotechnology R&D Industry*, 6 *AGBIOFORUM* 134, 135 (2003).

130. Article 11.2 of the ITPGRFA specifies that "[t]he Multilateral System . . . shall include all plant genetic resources for food and agriculture listed in Annex I that are under the management and control of the Contracting Parties and in the public domain." ITPGRFA, *supra* note 122, art. 11.2. Agbiotech components, such as the Bt and herbicide tolerance traits, are transgenes that are inserted into crop plants outside the context of national and privately owned gene banks. See Gerald C. Nelson, *Traits and Techniques of GMOs*, in *GENETICALLY MODIFIED ORGANISMS IN AGRICULTURE 7* (Gerald C. Nelson ed., 2001).

131. FOWLER & MOONEY, *supra* note 46, at 187.

132. VISSER ET AL., *supra* note 74.

133. See generally Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 *HARV. L. REV.* 622 (1998) (introducing the anticommons as a tool in property theory and showing how awareness of anticommons can shape legal policymaking); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 *SCIENCE* 698 (1998).

134. See POSEY & DUTFIELD, *supra* note 108, at 128; CARLOS M. CORREA, *OPTIONS FOR THE IMPLEMENTATION OF FARMERS' RIGHTS AT THE NATIONAL LEVEL* (Instituto Agronomico per l'Oltremare (IAO), Working Paper No. 8, Dec. 2000).

135. Evenson & Gollin, *supra* note 13; Fowler et al., *supra* note 13.

136. Jack Kloppenburg, Jr. & Daniel Lee Kleinman, *The Plant Germplasm Controversy*, 37 *BIOSCIENCE* 190, 190 (1987).

Laboratory of the U.S., remained openly available to crop breeders.¹³⁷ As long as these germplasm collections were managed as common heritage resources, bilateral contracts for the same type of resources were untenable.

Uncertainty over whether a new international order for crop genetic resources reconfirmed or undermined common heritage as plant breeders understood had bogged down negotiations about the International Undertaking at the FAO.¹³⁸ The ITPGRFA finally overcame the conflict by shifting emphasis toward open-access to crop resources and away from the issue of compensation. Avoiding the long-term disputes about patenting life forms and gene sequences also aided the agreement on the status of international collections. Finally, by separating the issue of gene bank access from Farmers' Rights and accepting the co-existence of Breeders' Rights and common-pool rights, the ITPGRFA gained acceptance from over 100 countries and avoided any specific national opposition.¹³⁹

V. FARMERS' RIGHTS

The FAO Commission's International Undertaking on Plant Genetic Resources provided a forum for negotiating three different international goals: (1) conserving crop germplasm, (2) ensuring its exploration and availability, and (3) addressing equity interests of farmers in developing nations.¹⁴⁰ A primary strategy for meeting the last goal was the movement to create a program of Farmers' Rights. These were conceived as a way to address the imbalance between genetic and economic wealth found in industrial and developing countries;¹⁴¹ but at their inception, Farmers' Rights were also linked

137. The history of germplasm distribution from CGIAR center gene banks is documented in Fowler et al., *supra* note 13. The U.S. policy is described in Shands & Stoner, *supra* note 41. See also Allan K. Stoner, *Celebrating a Century of Plant Exploration*, 46 AGRIC. RES. MAG. 2 (1998).

138. FOWLER & MOONEY, *supra* note 46, at 197.

139. Earth Negotiations Bulletin, Sixth Extraordinary Session of the Commission on Genetic Resources for Food and Agriculture, June 25–30, 2001, at <http://www.iisd.ca/biodiv/excgrfa-6>.

140. See Bragdon & Downes, *supra* note 127, at 13.

141. FOWLER, *supra* note 34, at 201; see also José Esquinas-Alcázar, *Farmers' Rights, in AGRICULTURAL VALUES OF PLANT GENETIC RESOURCES* 207, 209 (Robert E. Evenson et al. eds., 1998).

to an agenda to curtail Breeders' Rights. FAO Commission Resolution 8/83, which established the International Undertaking on Plant Genetic Resources in 1983, had stressed the common heritage principle that plant genetic resources should be available without restriction. It provides a sweeping definition of genetic resources as incorporating not only wild and weedy crop relatives and farmers' varieties, but also newly developed "varieties" and "special genetic stocks (including elite and current breeders' lines and mutants)."¹⁴² In classifying all types of crop genetic resources as a single category, this formulation suggested that the International Undertaking was a vehicle to challenge Breeders' Rights. NGOs presented the idea of Farmers' Rights to the FAO Commission in 1985.¹⁴³ The authors of the Farmers' Rights idea were antagonistic to Breeders' Rights,¹⁴⁴ believing perhaps that international acceptance of Farmers' Rights would undermine individual rights.¹⁴⁵

The gambit to undermine Breeders' Rights through a binding international resolution¹⁴⁶ endorsing unrestricted access to all genetic material failed because of political, practical, and conceptual problems. Politically, Farmers' Rights were opposed by states that provided for Breeders' Rights.¹⁴⁷ The availability of large stocks of genetic resources in open collections¹⁴⁸ used by nations in Vavilov Centers¹⁴⁹ undercut the possibility of financing Farmers' Rights through restricting the flow of crop genetic resources. Dufield discusses conceptual problems in defining the term "farmer" in relation to Farmers' Rights, ambiguity in who might hold these rights, and inconsistency in the fact that not all traditional farmers or farming communities conserve genetic resources.¹⁵⁰ In addition, the possible reliance on a contractual mode of defining Farmers' Rights

142. Res. 8/83, *supra* note 34, Annex, art. 2.1.2.v.

143. Pat Mooney, *Viewpoint of Non-Governmental Organisations, in* AGROBIODIVERSITY AND FARMERS' RIGHTS 40 (M.S. Swaminathan ed., 1996).

144. *Id.*

145. FOWLER, *supra* note 34, at 187.

146. DUTFIELD, *supra* note 93, at 103 (2000).

147. Pat Roy Mooney, *The Law of the Seed Revisited: Seed Wars at the Circo Massimo*, 1 DEV. DIALOG 1985, at 139, 150 (1985).

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

149. Fowler et al., *supra* note 13, at 189.

150. DUTFIELD, *supra* note 93, at 104.

may well exclude numerous farmers who create, maintain, and exchange crop genetic resources.¹⁵¹ The future of Farmers' Rights, therefore, depended on accepting the coexistence of different rights for farmers and breeders. FAO Resolution 5/89 concluded that the two types of rights were not incompatible, and defining Farmers' Rights as:

[R]ights arising from the past, present and future contributions of farmers in conserving, improving, and making available plant genetic resources, particularly those in centres of origin/diversity . . . [T]hese rights are vested in the International Community as trustees for present and future generations of farmers, for the purpose of ensuring full benefits to farmers, and supporting the continuation of their contributions.¹⁵²

Like intellectual property, Farmers' Rights were justified as a mechanism to encourage the creation of socially valuable goods (plant genetic resources). Farmers' Rights differed from Breeders' Rights in that they were to be vested in the "International Community" rather than in individuals. However, in not specifying what genetic materials were covered or who could claim ownership, the FAO definition created a problematic category. Even though the Farmers' Rights idea was carried into Agenda 21, negotiations for implementing the CBD, and the Global Plan of Action for the Conservation and Sustainable use of Plant Genetic Resources for Food and Agriculture (the 1996 Leipzig Conference),¹⁵³ the idea has remained an elusive goal. Its early association with the anti-Breeders'-Rights agenda, and its ambiguities regarding materials and holders of the rights thwarted its acceptance as an international principle or program. Following the ITPGRFA negotiation, the fate of Farmers' Rights will be determined at the national level.

The U.K. Commission on Intellectual Property Rights observes that Farmers' Rights are not intellectual property rights but rather

151. Stephen B. Brush, *Bio-Cooperation and the Benefits of Crop Genetic Resources: The Case of Mexican Maize*, 26 *WORLD DEV.* 755, 761 (1998).

152. *STATE OF THE WORLD*, *supra* note 80, at 278.

153. *Id.* at 312; GIRSBERGER, *supra* note 93, at 183.

represent a mechanism to counterbalance Breeders' Rights.¹⁵⁴ Farmers' Rights differ from intellectual property by the rights conferred, the title holder, subject matter, and duration,¹⁵⁵ and they are ambiguous for three of these criteria. The nature of the rights conferred by Farmers' Rights hinges on the economic benefit that connected recognition of resources provided in the past and benefit sharing in the future. While these goals are embedded in the justification for Farmers' Rights, no estimate of value or widely accepted method to estimate value of crop genetic resources are available. Consequently, the right to compensation for past contributions and benefit sharing for current and future use is largely metaphorical. Estimating value is obstructed by the absence of methods and data to assess the historic economic contribution of farmers' varieties from Vavilov Centers and the lack of calculations of the cost of conserving them on-farm. Estimating the historic contribution of farmers' varieties ideally requires one to separate the economic contribution of germplasm from other factors such as the development of physical infrastructure and human capital. The difficulty in doing this relegates the estimate to anecdotal evidence.¹⁵⁶ Likewise, estimating the cost of Farmers' Rights is hampered by the lack of a program for how the stream of benefits to farmers might be used to achieve conservation goals.¹⁵⁷ How holders of individual rights plan to use the benefits from intellectual property is not an issue because finite monopoly rights are expected to encourage more invention. If continued stewardship is the goal of Farmers' Rights, then the recipients of an international stream of benefits who are acting on behalf of farmers need a plan. Bioprospecting contracts¹⁵⁸ to overcome the lack of economic valuation are inappropriate for crop genetic resources. These contracts are likely to be ineffective

154. CIPR, *supra* note 113, at 68.

155. See CORREA, *supra* note 134.

156. Rural Advancement Foundation International (RAFI) of the U.N. Development Programme, Conserving Indigenous Knowledge—Integrating New Systems of Integration, (1995), available at <http://www.undp.org/csopp/cso/newfiles/dociknowledge.html>.

157. See STEPHEN B. BRUSH, FOOD AND AGRIC. ORG. OF THE U.N., PROVIDING FARMERS' RIGHTS THROUGH IN SITU CONSERVATION OF CROP GENETIC RESOURCES (Aug. 1994), available at <ftp://ext-ftp.fao.org/ag/cgrfa/bsp/bsp3e.pdf>.

158. Tobin, *supra* note 113, at 287.

conservation tools and may have detrimental economic effects. Because collecting genetic resources tends to be "single shot,"¹⁵⁹ collecting fees are unlikely to have a long-term conservation effect. I have written that contracts are likely to arbitrarily favor single communities or regions who have no special claim to crop germplasm.¹⁶⁰ Barrett and Lybbert argue that bioprospecting windfalls may be exclusionary or even regressive.¹⁶¹ The reaction of groups who were excluded from bioprospecting agreements confirms that exclusion is a liability.¹⁶²

Possible titleholders of Farmers' Rights include farming communities and states.¹⁶³ The diffuse and obscure origin of most crop resources in Vavilov Centers can lead to challenges of one community's claims for rights to a specific landrace or other crop resource by other communities. Transaction costs to settle such disputes may be higher than the value of the right, and arbitrary allocation presents ethical problems of favoring one community over others.¹⁶⁴ If conceived as a market situation between community "sellers" and seed company "buyers," Farmers' Rights exist in a monopsony environment in which a multitude of farmers with genetic resources face an extremely limited set of potential "buyers." Mendelsohn observes that this situation leads to market failure and argues that a monopoly acting on behalf of farmers is necessary.¹⁶⁵ Because preexisting agreements such as the CBD and the ITPGRFA recognize state ownership of genetic resources, Farmers' Rights will logically be held by the state. Because Vavilov Centers cross national boundaries, a broad definition of protected material under Farmers'

159. Christopher B. Barrett & Travis J. Lybbert, *Is Bioprospecting a Viable Strategy for Conserving Tropical Ecosystems?*, 34 *ECOLOGICAL ECON.* 293 (2000); Brush, *supra* note 151, at 759–60.

160. Brush, *supra* note 151, at 760.

161. Barrett & Lybbert, *supra* note 159.

162. Ronald Nigh, *Maya Medicine in the Biological Gaze: Bioprospecting Research as Herbal Fetishism*, 43 *CURRENT ANTHRO.* 451 (2000).

163. See CORREA, *supra* note 134.

164. Brush, *supra* note 151, at 760.

165. Robert Mendelsohn, *The Market Value of Farmers' Rights*, in *AGRICULTURE AND INTELLECTUAL PROPERTY RIGHTS* 121 (Vittorio Santaniello et al. eds., 2000).

Rights confronts the likelihood of disputes between countries. This possibility gave rise to a consortium approach by Andean nations.¹⁶⁶

The subject matter of Farmers' Rights is equally ambiguous. The most commonly used term to describe crop genetic resources that are managed by farmers is "landrace," but no widely accepted definition exists.¹⁶⁷ Characterization of landraces with gene bank collections is limited, and much of the material is stored without adequate documentation to identify farmers who might be considered as the sources.¹⁶⁸ Defining knowledge rather than genetic resources as the subject matter of Farmers' Rights is equally problematic because farmers' knowledge is local, widely shared, changeable, and orally transmitted. Lastly, the concept does not specify whether wild relatives of crops, which have provided valuable traits to crop improvement but are not known or used by farmers, are covered by Farmers' Rights. Examples of wild crop relatives that have provided valuable germplasm include wild tomatoes in Peru¹⁶⁹ and wild rice in Mali.¹⁷⁰

The final criterion that distinguishes Farmers' Rights from intellectual property is their duration.¹⁷¹ The monopoly right of a grant of the intellectual property is made to be temporary as a way to balance the goal of increased invention over the goal of open competition. The unlimited duration of Farmers' Rights foregoes this balance, a policy of dubious merit if other communities or nations have valuable genetic resources or prove to be more effective conservationists.

In specifying national sovereignty, the CBD does not *per se* recognize or value the contributions of farmers in maintaining or providing genetic resources nor provide a vehicle for transferring

166. Liliانا M. Davalos et al., *Regulating Access to Genetic Resources Under the Convention on Biological Diversity*, 12 BIODIVERSITY & CONSERVATION 1511, 1514 (2003); see also Manuel Ruiz, *Decision 391: The Common Regime on Access to Genetic Resources in the Andean Pact*, in BIODIVERSITY AND TRADITIONAL KNOWLEDGE, *supra* note 110, at 379.

167. A.C. Zeven, *Landraces: A Review of Definitions and Classifications*, 104 EUPHYTICA 127, 129 (1998).

168. Peeters & Williams, *supra* note 79, at 24–25.

169. Hugh H. Iltis, *Discovery of No. 832: An Essay in Defense of the National Science Foundation*, 3 DESERT PLANTS 175 (1982).

170. Pamela C. Ronald, *Making Rice Disease-Resistant*, 227 SCI. AM. 100, 101 (1997).

171. See CORREA, *supra* note 134.

value to communities where crop resources existed. However, prior to the CBD, Farmers' Rights had run as a subtext beneath negotiations about regulating access to crop genetic resources,¹⁷² and farming communities' interests were recognized in Agenda 21's discussion of rural development that precedes the section on biodiversity conservation.¹⁷³ Nevertheless, in the 2001 final draft of the ITPGRFA, Farmers' Rights remained largely programmatic and without specific implementing instruments. These rights survive in Article 9 of the ITPGRFA as an acknowledgement of the contributions of farmers to the welfare of humankind. The ITPGRFA moves away from the initial strategy of a binding international resolution to create Farmers' Rights and confirms that realizing Farmers' Rights rests with national governments. The treaty inveighs on its Contracting Parties to provide for these rights in three ways:

- (a) protection of traditional knowledge relevant to plant genetic resources for food and agriculture;
- (b) the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; and
- (c) the right to participate in making decisions, at the national level on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture.¹⁷⁴

As in the *ex ante*, common heritage period, farmers are not granted a favored status as owners of genetic resources that they have inherited and maintained. The ITPGRFA does not vest farmers with a property right allowing them to exclude others from using or benefiting from crop resources.

Negotiating Farmers' Rights at the national level faces obstacles that were not critical in the international arena, such as political

172. See, e.g., Final Consensus Report: Global Initiative for the Security and Sustainable Use of Plant Genetic Resources, Keystone International Dialogue Series on Plant Genetic Resources, Oslo Plenary Session (1991).

173. Secretary General of the Conference, *Promoting Sustainable Agriculture and Rural Development*, UNCED Doc. A/CONF.151/PC/100/Add.19, in *AGENDA 21 & THE UNCED PROCEEDINGS 397* (Nicholas A. Robinson ed., 1992).

174. ITPGRFA, *supra* note 122, art. 9.2(a)-(c).

weakness of the traditional farming sector, urban and consumer demand for low cost commodities, and the need to promote agricultural development. Although the CBD does not distinguish crop genes as a special category of biological resource, negotiations for Farmers' Rights will have to separate crop genes and acknowledge the regime established by the ITPGRFA. We have gained appreciation of traditional farmers' varieties, or landraces, as collective inventions and metapopulations rather than as assets that are privately derived and managed.¹⁷⁵ Significant proportions of most nations' agricultural sectors have benefited from adopting new technology, including new crop varieties, but landraces still meet farmers' needs in specific agricultural niches.¹⁷⁶ The demand for crop genetic resources is greatest in developing countries,¹⁷⁷ while in industrial countries it is modest and satisfied by resources that have already been collected.¹⁷⁸ Finally, a large number of parties have direct interest and influence in negotiating a new regime for biological resources.¹⁷⁹ For crop genetic resources these interests crosscut national boundaries, public and private sectors, and rural and urban communities. At the very least, the parties who are direct stakeholders in the issue include subsistence and commercial farmers, crop breeders in the public and private sectors, national and international gene banks, the agricultural development service sector, private seed companies, and crop scientists.

Experience gained in research and negotiation about possible mechanisms to protect farmers' knowledge offer four guidelines for crafting national Farmers' Rights programs:

175. See Louette, *supra* note 59; KARL S. ZIMMERER, CHANGING FORTUNES: BIODIVERSITY AND PEASANT LIVELIHOOD IN THE PERUVIAN ANDES 113 (1996).

176. Stephen B. Brush, *In Situ Conservation of Landraces in Centers of Crop Diversity*, 35 CROP SCI. 346 (1995); see also David A. Cleveland et al., *Do Folk Crop Varieties Have a Role in Sustainable Agriculture?*, 44 BIOSCIENCE 740, 745 (Dec. 1994).

177. SMALE ET AL., *supra* note 13.

178. D.R. Marshall, *Limitations to the Use of Germplasm Collections*, in THE USE OF GERMPASM COLLECTIONS 105-20 (A.H.D. Brown et al. eds., 1989); see also John P. Peeters & Nick W. Galwey, *Germplasm Collections and Breeding Needs in Europe*, 42 ECON. BOTANY 503 (1988).

179. Charles V. Barber et al., *Developing and Implementing National Measures for Genetic Resources Access Regulation and Benefit-Sharing*, in BIODIVERSITY AND TRADITIONAL KNOWLEDGE, *supra* note 110, at 363, 385.

1. The goals of Farmers' Rights are to balance Breeders' Rights and encourage farmers to continue as stewards and providers of crop genetic resources.
2. Farmers' Rights are held collectively rather than by individual farmers or communities.
3. Farmers' Rights are not exclusive or meant to limit access to genetic resources.
4. Mechanisms are needed to share benefits received by the international community from genetic material from farmers' fields or international collections.

These principles frame the ITPGRFA and they are evident in two models for implementing Farmers' Rights: India's Act No. 53, for the Protection of Plant Varieties and Farmers' Rights¹⁸⁰ and the Organization of African Unity's African Model Legislation for the Protection of the Rights of Local Communities, Farmers and Breeders, and for the Regulation of Access to Biological Resources.¹⁸¹

VI. FARMERS' RIGHTS AT THE NATIONAL LEVEL

GRAIN reports that six countries¹⁸² (Bangladesh, Brazil, India, Panama, Peru, and the Philippines) and the Organization of African Unity (OAU) have drafted legislation or model legislation relating to Farmers' Rights. Bangladesh, India, and the OAU envision these rights as part of national systems for plant variety protection, while Brazil, Panama, Peru, and the Philippines envision special rights for traditional knowledge that possibly includes crop materials as collective property. In some instances, such as Costa Rica's¹⁸³

180. The Protection of Plant Varieties and Farmers' Rights Act, India Act 53 (2001) [hereinafter India Act], available at http://grain.org/brl_files/india-pvp-2001-en.pdf.

181. OAU, AFRICAN MODEL LEGISLATION FOR THE PROTECTION OF THE RIGHTS OF LOCAL COMMUNITIES, FARMERS AND BREEDERS, AND FOR THE REGULATION OF ACCESS TO BIOLOGICAL RESOURCES (2000) [hereinafter AFRICAN MODEL LEGISLATION], available at http://grain.org/brl_files/oau-model-law-en.pdf.

182. Genetic Resources Action International (GRAIN), Farmers' Rights (Sept. 9, 2004), at <http://grain.org/brl/?typeid=45>.

183. Ley de Protección de los Derechos de los Fitomejoradores, Costa Rica Law 15.487 (2003) [hereinafter Costa Rica Law]; India Act, *supra* note 180.

proposed Law for the Protection of Plant Breeders' Rights,¹⁸⁴ Farmers' Rights are provided by following policies in plant variety protection¹⁸⁵ that allow farmers the right to re-sow, exchange, segregate, and sell the produce from protected varieties described in the 1978 version of the UPOV system.¹⁸⁶ In other instances, such as India's Protection of Plant Varieties and Farmers' Rights Act,¹⁸⁷ Farmers' Rights are expanded beyond this to include the right to benefits from collection and use of landraces to produce commercially registered varieties. Collective rights systems, such as those in Panama¹⁸⁸ and Peru,¹⁸⁹ regulate use of collective property through national registers and in the case of Peru through licensing of collectively owned biological resources. The collective rights approach is primarily aimed at protecting folklore, artistic expression, and plant knowledge associated with natural products and medicines rather than crops per se.

India's Act No. 53, Article 16d, affirms that farmers or a community of farmers may petition to register a new variety as the breeder, but it goes beyond this logical extension of Breeders' Rights to recognize Farmers' Rights in four ways. First, farmers' roles as keepers of genetic resources and sustainers of crop evolution are to be recognized and rewarded through a National Gene Fund. This

184. John H. Barton, *Acquiring Protection for Improved Germplasm and Inbred Lines*, in INTELLECTUAL PROPERTY RIGHTS IN AGRICULTURAL BIOTECHNOLOGY 19, 22 (Frederic H. Erbsich & Karim M. Maredia eds., 1998); see also Silvia Salazar, *Costa Rica*, in INTELLECTUAL PROPERTY RIGHTS IN AGRICULTURAL BIOTECHNOLOGY, *supra*, at 179, 184; Costa Rica Law, *supra* note 183.

185. UPOV, the International Union for the Protection of New Varieties of Plants (Union Pour la Protection des Obtentions Vegetales) is an intergovernmental organization with headquarters in Geneva (Switzerland). UPOV was established by the International Convention for the Protection of New Varieties of Plants, adopted in Paris in 1961 and it was revised in 1972, 1978 and 1991. Barton, *supra* note 184; see also Robert E. Evenson, *Intellectual Property Rights, Access to Plant Germplasm, and Crop Production Scenarios in 2020*, 39 CROP SCI. 1630, 1631 (1999).

186. UPOV, *The UPOV System of Plant Variety Protection* (2002), at http://www.upov.int/en/about/upov_system.htm.

187. India Act, *supra* note 180.

188. Regimen Especial de Propiedad Intelectual Sobre los Derechos Colectivos de los Pueblos Indigenas, Panama Law No. 20 (June 26, 2000), *translation available at* <http://grain.org/brl/?docid=461&lawid=2002>.

189. Propuesta de Regimen de Protección de los Conocimientos Colectivos de los Pueblos y Comunidades Indígenas Vinculados a los Recursos Biológicos, Peru Law 27,811 (June 10, 2002), *translation available at* <http://grain.org/brl/?docid=81&lawid=2041>.

Fund will be used for benefit sharing and to support *in situ* and *ex situ* conservation, and it will be financed by annual fees levied on breeders of registered varieties, depending on the value of the royalty earned from a registered variety. Benefit sharing to communities that provided germplasm used in a registered variety will be determined according to the extent and nature of the use of genetic material in the registered variety and the commercial value of the variety.¹⁹⁰ Second, India's Act No. 53 establishes the farmers' exemption that was present in early plant variety protection regimes of the U.S. and UPOV,¹⁹¹ allowing farmers to "save, use, sow, resow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before the coming into force of this Act."¹⁹² Third, breeders are required to disclose in their application for registration information regarding tribal or rural families' use of genetic material used in the breeding program. Failure to disclose this information is grounds for rejecting an application for variety registration. Fourth, any interested party may file a claim on behalf of a village or local community stating its contribution to the evolution of a registered variety. If this claim is substantiated, the breeder is required to pay compensation to the National Gene Fund.

The African Model Legislation establishes Farmers' Rights in four ways. First, it allows farmers to certify their varieties as intellectual property without meeting the criteria of distinction, uniformity, and stability that breeders must meet. This certificate provides farmers with "the exclusive rights to multiply, cultivate, use or sell the variety, or to license its use."¹⁹³ Second, farmers are given the right to "obtain an equitable share of benefits arising from the use of plant and animal genetic resources."¹⁹⁴ The African Model Law Article 66 establishes a Community Gene Fund to accomplish benefit sharing and to be financed by royalties fixed to registered breeders'

190. India Act, *supra* note 180, art. 26(5).

191. David J. Houser, *Exemptions Under Patents and Certificates Covering Plants and Comments on Material Transfer Agreements*, in INTELLECTUAL PROPERTY RIGHTS, *supra* note 43, at 107, 108.

192. India Act, *supra* note 180, art. 39(iv).

193. *African Model Legislation*, *supra* note 181, art. 25.

194. *Id.* art. 26.

varieties. Third, farmers are guaranteed an exemption to Breeders' Rights restrictions to "collectively save, use, multiply and process farm-saved seed of protected varieties."¹⁹⁵ Fourth, farmers' varieties are to be certified as being derived from "the sustainable use [of] a biological resource."¹⁹⁶ This certificate does not imply financial reward.

A pattern for Farmers' Rights is evident in the provisions of the ITPGRFA, India's Act No. 53, and the African Model Legislation. All three accept the co-existence of Breeders' Rights along with Farmers' Rights, and all intend to accomplish benefit sharing through a centralized funding mechanism and the duties levied on income streams from Breeders' Rights. This same benefit sharing mechanism is present in the Genetic Resources Recognition Fund (GRRF) of the University of California that imposes a licensing fee on the commercialization of patented plant material involving germplasm from Developing Countries.¹⁹⁷ The ITPGRFA and GRRF envision this mechanism as a generic tool for reciprocity rather than one to reward specific farmers or communities. The African Model Legislation goes furthest in signifying individual communities as the beneficiaries. India's Act No. 53 combines both the generic and specific uses of compensation through the centralized gene fund. Farmers' Rights are also provided in farmers' exemptions to restrictions embedded in Breeders' Rights. Contradicting the view that Farmers' Rights are not a form of intellectual property,¹⁹⁸ the Model African Law goes beyond the ITPGRFA and India's Act No. 53 in granting exclusive rights to farmers over their varieties.

Implementation of national systems for Farmers' Rights is still untested, although the Indian plan has been passed by both houses of the Indian Parliament and received the President's support.¹⁹⁹ The

195. *Id.* art. 26(1)(f).

196. *Id.* art. 27(1).

197. Pamela Ronald & Stephen Brush, *Genetic Resources Recognition at the University of California, Davis*, 35 *IN VITRO REP.* 8 (2001); KERRY TEN KATE & AMANDA COLLIS, *THE UNIVERSITY OF CALIFORNIA, DAVIS, BENEFIT-SHARING CASE STUDY*, available at <http://www.biodiv.org/doc/case-studies/abs/cs-abs-ucdavis.pdf> (last visited Dec. 26, 2004).

198. W. Lesser, *Intellectual Property Rights Under the Convention on Biological Diversity*, in *AGRICULTURE AND INTELLECTUAL PROPERTY RIGHTS*, *supra* note 165, at 35; see also CIPR, *supra* note 113.

199. Asha Krishnakumar, *For Farmers' Rights*, *FRONTLINE*, Feb. 16–Mar. 1, 2002,

success of rights set forth in India's Act No. 53, the ITPGRFA, and the African Model Legislation hinge on the value of certified crop varieties that use germplasm obtained from farmers and the transaction costs of determining which farmers should be beneficiaries.

The value of certified varieties is not fully known in India or Africa, but two factors indicate that their value will offer meager resources to finance Farmers' Rights. First, the experience of Western, industrialized countries shows that plant variety certificates have relatively low or negligible value. Lesser looked at the value of plant variety certificates for soybeans in New York State, determined that the price premium associated with certified seed was only 2.3%, and concluded that this form of protection is too weak to be an incentive to breeders.²⁰⁰ A similar result in India would not generate any appreciable revenue to fund Farmers' Rights. It is possible that "stronger" intellectual property means, such as utility patents, would increase revenue, but both India and the OAU reject patenting of plants. Second, modern breeding programs increasingly are dependent on the use of "elite" breeding lines that are several generations removed from farmers varieties and show increasingly complex pedigrees involving crop genetic resources from many sources.²⁰¹ Although India is a net exporter of landraces as breeding material, foreign landraces are as important to India's rice program as are national landraces.²⁰² Because African agriculture is heavily dependent on crops originating in other regions, dependence on international germplasm is high. For instance, in Nigeria's rice breeding program, 180 out of 195 landrace progenitors used in breeding were borrowed from other countries.²⁰³ Estimating the contribution of a single landrace or collection to the value of a

available at <http://www.flonnet.com/fl1904/19040800.htm>.

200. W. Lesser, *Valuation of Plant Variety Protection Certificates*, 16 REV. AGRIC. ECON. 231 (1994).

201. M. Smale et al., *Dimensions of Diversity in Modern Spring Bread Wheat in Developing Countries from 1965*, 42 CROP SCI. 1766 (2002).

202. Douglas Gollin & Robert E. Evenson, *An Application of Hedonic Pricing Methods to Value Rice Genetic Resources in India*, in AGRICULTURAL VALUES OF PLANT GENETIC RESOURCES 139 (Robert E. Evenson et al. eds., 1998).

203. Douglas Gollin, *Valuing Farmers' Rights*, in AGRICULTURAL VALUES OF PLANT GENETIC RESOURCES 233 (Robert E. Evenson et al. eds., 1998).

modern variety has not been accomplished and is likely to become more difficult as pedigrees become more complex.²⁰⁴

Transaction costs in determining which farmers or communities should receive compensation through the national gene funds are equally problematic to financing Farmers' Rights. If equity is a concern, it is inappropriate to simply assign rights to the community where collection occurred because of the metapopulation aspect of landraces.²⁰⁵ Exclusionary rights have proven to be politically unacceptable because of this issue.²⁰⁶ Even if an arbitrary recognition of rights is made, farmers who are excluded but who have the same resources may offer their resources at competitive prices setting off a downward price spiral that is unfavorable to farmers and conservation.²⁰⁷ Transaction costs can be lowered by establishing a national monopoly²⁰⁸ but this contradicts the terms of India's Act No. 53 and the African Model Legislation.

In sum, Farmers' Rights are a moral but largely rhetorical recognition of the contribution of farmers to the world's stock of genetic resources. They provide only a limited mechanism to share the benefits of using crop genetic resources or to promote their conservation.

VII. TRADITIONAL AGRICULTURAL KNOWLEDGE

The interplay between biological variation and its control through selection makes crop and natural evolution similar to one another, but the two differ by virtue of the role of "artificial" selection by humans in crop evolution.²⁰⁹ Darwin laid out the basic framework of crop evolution that distinguishes two types of human selection: methodical and unconscious.²¹⁰ According to Darwin, unconscious selection is

204. Gollin & Evenson, *supra* note 202.

205. Brush, *supra* note 151, at 760-61.

206. Nigh, *supra* note 162, at 462.

207. Mendelsohn, *supra* note 165; Barrett & Lybbert, *supra* note 159.

208. Mendelsohn, *supra* note 165.

209. HAWKES, *supra* note 9; C. M. Donald & J. Hamblin, *The Convergent Evolution of Annual Seed Crops in Agriculture*, 36 *ADVANCES IN AGRONOMY* 97, 99-100 (1983).

210. 20 CHARLES DARWIN, *Variation of Animals and Plants Under Domestication, Volume II*, in *THE WORKS OF CHARLES DARWIN* 153 (Paul H. Barrett & R.B. Freeman eds., New York University Press 1988).

inadvertent and arises when people generally favor a superior cultivar without specific selection for individual traits.²¹¹ More recent models of crop evolution re-label unconscious selection as “nonspecific selection.”²¹² Methodical, or conscious selection, which is methodical and specific, is the more important contribution of humans to the evolution of crops.²¹³ For the vast majority of crop evolution, conscious selection has been decentralized and managed by farmers. In the past century, the organization of crop breeding programs has centralized selection and given an important role in crop evolution to scientists, public agencies, and seed companies.²¹⁴

Conscious selection by farmers implies the use of knowledge systems about the crop and its environment, which are subsets of more general traditional and indigenous knowledge systems.²¹⁵ While “traditional knowledge” and “indigenous knowledge” are not synonymous, they share many attributes, such as being unwritten, customary, pragmatic, experiential, and holistic. The terms are frequently used in the same context to distinguish the knowledge of traditional and indigenous communities from other types of knowledge, such as the knowledge of scientific and industrial communities.²¹⁶ Indeed, the primary distinction between traditional and indigenous knowledge pertains to the holders rather than the knowledge *per se*. Traditional knowledge is a broader category that includes indigenous knowledge as a type of traditional knowledge held by indigenous communities.²¹⁷

211. *Id.*

212. See, e.g., Daniel Zohary, *Unconscious Selection and the Evolution of Domesticated Plants*, 58 *ECON. BOTANY* 5 (2004); EVANS, *supra* note 15, at 267.

213. HARLAN, *supra* note 10, at 127; David Rindos, *Darwinism and its Role in the Explanation of Domestication*, in *FORAGING AND FARMING* 27, 29 (David R. Harris & Gordon C. Hillman eds., 1989).

214. Poehlman, *supra* note 28.

215. Roy Ellen & Holly Harris, *Introduction*, in *INDIGENOUS ENVIRONMENTAL KNOWLEDGE AND ITS TRANSFORMATIONS* 1, 7 (Roy Ellen et al. eds., 2000); Paul Sillitoe, *The Development of Indigenous Knowledge*, 39 *CURRENT ANTHRO.* 223, 226–29 (1998).

216. Arun Agrawal, *Dismantling the Divide Between Indigenous and Scientific Knowledge*, 26 *DEV. & CHANGE* 413, 422 (1995); Nuno Pires de Carvalho, *From the Shaman's Hut to the Patent Office*, 17 *WASH. U. J.L. & POL'Y* 111 (2005); Manuel Ruiz, *The International Debate on Traditional Knowledge as Prior Art in the Patent System* (Center for International Environmental Law 2002), at http://ciel.org/Publications/PriorArt_ManuelRuiz_Oct02.pdf; Sillitoe, *supra* note 215.

217. John Mugabe, *Intellectual Property Protection and Traditional Knowledge*, in *World*

While traditional knowledge has emerged in international discourse on new legal mechanisms,²¹⁸ indigenous knowledge is a term long in use by anthropologists and other investigators of non-industrialized societies;²¹⁹ because of this history, indigenous knowledge enjoys a more elaborated discussion and definition than the more inclusive term. Nevertheless, apart from the designation of the type of holder, the definitions applied to indigenous knowledge apply also to traditional knowledge. While Kongolo observes that “[t]raditional knowledge is rarely defined within the national, regional, and international frameworks,”²²⁰ indigenous knowledge has been extensively analyzed by ethnobotanists and others,²²¹ so it behooves us to utilize the analysis of indigenous knowledge to grapple with traditional knowledge. Both are associated with folk nomenclatures and taxonomies of plants²²² and the environment²²³ and in practical domains such as disease etiology²²⁴ and agricultural practices.²²⁵ Distinguishing between indigenous knowledge and other knowledge systems has proven to be problematic,²²⁶ but anthropologists and others argue that a number of criteria can be used to differentiate indigenous knowledge from other knowledge systems. Indigenous knowledge’s distinguishing characteristics include (1)

Intellectual Property Organization (WIPO), INTELLECTUAL PROPERTY AND HUMAN RIGHTS 97 (1999).

218. Thomas Cottier, *The Protection of Genetic Resources and Traditional Knowledge*, 1 J. INT’L ECON. L. 555, 561–68 (1998); Pires de Carvalho, *supra* note 216; W.B. Wendland, *Intellectual Property, Traditional Knowledge and Folklore: WIPO’s Exploratory Program*, 33 INDUS. PROP. & COPYRIGHT L. 485 (2003).

219. Sillitoe, *supra* note 215, at 223.

220. Tshimanga Kongolo, *Towards a More Balanced Coexistence of Traditional Knowledge and Pharmaceuticals Protection in Africa*, 35 J. WORLD TRADE 349, 357 (2001).

221. BRENT BERLIN, ETHNOBIOLOGICAL CLASSIFICATION 4 (1992); Sillitoe, *supra* note 215.

222. BRENT BERLIN ET AL., PRINCIPLES OF TZETAL PLANT CLASSIFICATION 25–28 (1974); Scott Atran et al., *Folkecology and Commons Management in the Maya Lowlands*, 96 PROC. NAT’L ACAD. SCI. USA 7598, 7600 (1999).

223. See, e.g., Deirdre M. Birmingham, *Local Knowledge of Soils: The Case of Contrast in Côte d’Ivoire*, 111 GEODERMA 481, 484 (2003); Jeffery W. Bentley & Gonzalo Rodríguez, *Honduran Folk Entomology*, 42 CURRENT ANTHRO. 285, 289–95 (2001).

224. See, e.g., ELOIS ANN BERLIN & BRENT BERLIN, MEDICAL ETHNOBIOLOGY OF THE HIGHLAND MAYA OF CHIAPAS, MEXICO: THE GASTROINTESTINAL DISEASES 54 (1996).

225. MARGOT BEYERSDORFF, LEXICO AGROPECUARIO QUECHUA (1984); ROBERTO J. GONZÁLEZ, ZAPOTEC SCIENCE 130–54 (2001).

226. See Agrawal, *supra* note 216, at 425.

localness, (2) oral transmission, (3) origin in practical experience, (4) emphasis on the empirical rather than theoretical, (5) repetitiveness, (6) changeability, (7) being widely shared, (8) fragmentary distribution, (9) orientation to practical performance, and (10) holism.²²⁷ These same characteristics apply to traditional knowledge.

Traditional agricultural knowledge is understandably responsible for guiding the past and present accomplishments of most of the world's farmers. The primary development of crops and cropping systems occurred before the relatively recent discoveries of agricultural chemistry and crop biology,²²⁸ and most of the world's farmers still rely on traditional knowledge rather than on formal, scientific knowledge. The hyperbolic growth of agricultural production may now rely on formal science, but it is built on foundations developed by traditional farmers.

Traditional knowledge for crop genetic resources has both cognitive and biological aspects. The cognitive aspect is embodied in the nomenclatures, classificatory systems, and cultural practices of farmers, while the biological aspect is embodied in crop germplasm from generations of observation, election, exchange, and maintenance. Both aspects of traditional knowledge have fuzzy boundaries because of their protean and fragmented nature. Traditional knowledge has been described for numerous farming systems,²²⁹ and its value is evident in such specific activities as designing and managing irrigation,²³⁰ coping with marginal farming environments,²³¹ enhancing production with local inputs,²³² and developing crop diversity.²³³

227. Ellen & Harris, *supra* note 215, at 4–5.

228. EVANS, *supra* note 87, at 90.

229. See GONZÁLEZ, *supra* note 225, at 130ff.

230. FRANCESCA BRAY, *THE RICE ECONOMIES* 68 (1986).

231. PEDRO A. SANCHEZ, *PROPERTIES AND MANAGEMENT OF SOILS IN THE TROPICS* 377 (1976); Karl S. Zimmerer, *Soil Erosion and Labor Shortages in the Andes with Special Reference to Bolivia, 1953–91*, 21 *WORLD DEV.* 1659, 1661 (1993).

232. GENE C. WILKEN, *GOOD FARMERS: TRADITIONAL AGRICULTURAL RESOURCE MANAGEMENT IN MEXICO AND CENTRAL AMERICA* 46–69 (1987) (describing soil management using organic amendments).

233. Daniela Soleri & David A. Cleveland, *Farmers' Genetic Perceptions Regarding Their Crop Populations: An Example with Maize in the Central Valleys of Oaxaca, Mexico*, 55 *ECON. BOTANY* 106 (2001).

While the existence and accomplishments of traditional agricultural knowledge are unquestioned, its defining characteristics pose severe obstacles for its valuation and protection by farmers and outside interests such as conservationists, indigenous rights activists, and rural development agencies. Indeed, outside efforts to value, promote, and protect traditional knowledge appear inevitably to distort it and its social context.²³⁴ A severe obstacle to valuation and protection is the disarticulation of different types of knowledge when that information is local, orally transmitted, practical, and fragmentary in distribution. Agricultural knowledge is comprised of numerous substantive domains such as soil types, pests, pathogens, and crop genotypes, domains for environmental conditions such as rainfall and temperature patterns, and management domains such as irrigation techniques, soil amendments, planting patterns, pest control, weed control, and crop selection. Brookfield and Stocking add organization as a third domain that includes tenure arrangements, resource allocation, and dependency on alternative production spheres.²³⁵ These domains are demarcated by distinct lexicons and nomenclatures such as crop variety names or terminology for management practices. Traditional knowledge is rife with "covert categories"²³⁶ and unlabeled, intermediate domains²³⁷ that may link substantive and management domains but require intensive research to understand. These substantive and management domains are logically articulated in the minds and memories of individual farmers, but they may appear disarticulated in a wider social context and to outsiders.

Capturing the knowledge in a single domain by collecting its nomenclature, such as crop variety names, is relatively easy but of limited use. The content of a single domain may be ordered taxonomically, but revealing taxonomy requires elaborate analysis similar to biological systematics that sift and winnow the clutter and

234. Michael R. Dove, *Center, Periphery, and Biodiversity*, in VALUING LOCAL KNOWLEDGE 41 (Stephen B. Brush & Doreen Stabinsky, eds., 1996).

235. Harold Brookfield & Michael Stocking, *Agrodiversity: Definition, Description and Design*, 9 GLOBAL ENVTL. CHANGE 77, 79 (1999).

236. BERLIN, *supra* note 221, at 176.

237. Stephen B. Brush, *Ethnoecology, Biodiversity, and Modernization in Andean Potato Agriculture*, 12 J. ETHNOBIOLOGY 161, 163-67 (1992).

noise of variation.²³⁸ Folk nomenclatures are unevenly distributed and disparate among individuals and localities.²³⁹ Because traditional knowledge is most developed when a domain's salience is high,²⁴⁰ nomenclature for crops and agriculture is often embellished, for instance, in the wealth of variety names found in small regions.²⁴¹ Unfortunately, the elaboration of folk nomenclature for crops is greatest at the variety (infra-specific) level that is often judged as having dubious value by botanists²⁴² and ethnobotanists.²⁴³ Since variety names are orally transmitted, repetitive, widely shared, and fragmentary, name lists cannot be used directly to estimate genetic diversity or population structure above the farm level.²⁴⁴ Synonyms may, in fact, be known to some farmers but not marked or widely recognized. Problems of over- and under-classification of genetic variation can only be resolved by careful agronomic and genetic characterization, a step that would seem to obviate the need to collect folk names. The fact that traditional knowledge is orally transmitted and changeable creates problems in identifying truly local and autochthonous knowledge.²⁴⁵ The fact that traditional knowledge is local, empirical, and holistic suggests that indigenous people do not have to worry about consistency over wider areas, as plant collectors and geneticists must if they are trying to find traits that are locally abundant but not widespread.²⁴⁶

Linking nomenclatures of substantive domains to one another and to management domains is complicated by the inherent qualities of localness, oral transmission, and fragmented distribution. The best studies showing linkage between different domains (e.g., crop

238. BERLIN, *supra* note 221.

239. Quiros et al., *supra* note 6.

240. BERLIN, *supra* note 221, at 255.

241. Brush, *supra* note 237; HAROLD C. CONKLIN, HANUNOO AGRICULTURE: A REPORT ON AN INTEGRAL SYSTEM OF SHIFTING CULTIVATION IN THE PHILIPPINES 112-13 (1957) (reporting over ninety rice varieties among the Hanunoo of the Philippines).

242. See B.L. Burt, *Infraspecific Categories in Flowering Plants*, 2 BIO'L J. LINNEAN SOC'Y 233 (1970).

243. BERLIN, *supra* note 221, at 34.

244. Brush et al., *supra* note 56, at 1191; Quiros et al., *supra* note 6, at 256.

245. Dove, *supra* note 234.

246. D.R. Marshall & A.H.D. Brown, *Optimum Sampling Strategies in Genetic Conservation*, in CROP GENETIC RESOURCES FOR TODAY AND TOMORROW 53 (O.H. Frankel & J.G. Hawkes eds., 1975).

diversity and local ecological conditions or disease etiology and ethnobotany) are executed in single communities or micro-regions.²⁴⁷ Linking multiple domains, such as crop type, soils, and plant diseases, or showing how domains are linked across regions are daunting tasks and generally not attempted in research on traditional agricultural systems. Of course, formal science overcomes the linkage problem by institutionalizing knowledge through educational curricula, instruction and examination, technical manuals, peer review, publication, and intellectual property.

These characteristics and problems of traditional knowledge have limited its use by crop scientists and others outside of local farming systems. Because detailed information on farmer knowledge is usually not part of the passport data accompanying crop resources and may be difficult to interpret or verify, crop scientists who are looking for particular traits test collections according to ecological background or, more commonly, use well known germplasm ("elite breeding lines") developed in experiment station research. Wellhausen et al., who pioneered research on maize diversity in MesoAmerica, opined that indigenous people had consciously contributed little to the evolution of maize under domestication.²⁴⁸ Only recently have plant collectors and crop conservationists begun to collect traditional knowledge along with other ecological information.²⁴⁹ Usually only the local name is collected as part of the passport data that accompanies collections.²⁵⁰

VIII. PROTECTING TRADITIONAL AGRICULTURAL KNOWLEDGE

Agricultural development, through the expansion of crop land, improved management, inputs to crop production, and increasing yield potential, has allowed exponential population growth without a

247. BERLIN & BERLIN, *supra* note 224; Mauricio R. Bellon & J. Edward Taylor, "Folk" *Soil Taxonomy and the Partial Adoption of New Seed Varieties*, 41 ECON. DEV. & SOC. CHANGE 763 (1993).

248. E. J. WELLHAUSEN ET AL., RACES OF MAIZE IN CENTRAL AMERICA 29 (1957) (National Academy of Sciences, National Research Council, Publication 511).

249. IPGRI, *Indigenous Knowledge Documentation* (2001), at <http://www.ipgri.cgiar.org/regions/apo/ik.html>.

250. IPGRI, *Multi-Crop Passport Descriptors* (2005), available at http://www.ipgri.cgiar.org/publications/pubfile.asp?id_pub=124.

Malthusian calamity. However, projected global population expansion to ten billion people is likely to exceed historic and important sources of agricultural growth, such as the addition of crop land and irrigation.²⁵¹ Consequently, satisfying demand for additional agricultural production will depend on enhancing the biological capacity of major crops.²⁵² The two most important sources of crop genes for this enhancement will be gene banks and farmers' fields where traditional crops and crop evolutionary processes continue. Crop scientists and agricultural developers have prepared for this exigency by assembling large collections of genetic resources in gene banks and making them available for crop improvement.²⁵³ By 1970, an international framework for collection, conservation, utilization, and exchange was in place. This framework was epitomized by the creation of the International Board for Plant Genetic Resources, world collections of principal crops at international agricultural research centers such as the International Rice Research Institute, and national collections such as those of the National Seed Storage Laboratory in Fort Collins, Colorado.²⁵⁴

Both the cognitive and biological aspects of traditional agricultural knowledge are endangered in the contemporary world by such processes as population growth, market development, technology diffusion, and cultural change. We have long accepted the notion that traditional agricultural knowledge is valuable and worth saving, and individuals, nations, and international groups have invested in conserving that knowledge for future generations.²⁵⁵

Achieving the goal of protecting traditional agricultural knowledge may mean either protecting the cognitive or the biological aspects of crops. For most crops, protection against loss of traditional agricultural knowledge has given almost exclusive priority to *ex situ* (off-farm) measures for conserving germplasm in gene banks,

251. EVANS, *supra* note 15, at 368; Paul E. Waggoner, *How Much Land Can Ten Billion People Spare for Nature?*, 17 TECH. IN SOC'Y 17 (1995).

252. NATIONAL RESEARCH COUNCIL (NRC), *MANAGING GLOBAL GENETIC RESOURCES: AGRICULTURAL CROP ISSUES AND POLICIES* (1993).

253. STATE OF THE WORLD, *supra* note 80, at 140.

254. *Id.* at 83; PISTORIUS & VAN WIJK, *supra* note 34, at 98; PLUCKNETT ET AL., *supra* note 30, at 110.

255. STATE OF THE WORLD, *supra* note 80, at 53, 60ff.

breeders' collections, and botanical gardens.²⁵⁶ While *ex situ* conservation has become institutionalized at both national and international levels,²⁵⁷ crop scientists increasingly recognize the need to conserve crop genetic resources *in situ* in the habitats where they have evolved.²⁵⁸ Because elemental processes of crop evolution, such as selection, exchange, and dispersal, are guided by farmers' knowledge, the preservation of farmers' knowledge systems is essential to ongoing crop evolution.

Conserving the cognitive aspects of traditional agricultural knowledge takes on added value because crop scientists and conservationists now accept the idea that crop genetic resources and crop evolutionary processes should be conserved *in situ* (on-farm).²⁵⁹ *In situ* conservation for crop resources takes place on farms and with the management of crop populations by farmers through selection, use, exchange, and bequest. *In situ* conservation is distinguished because it is dynamic, decentralized, and aimed at conserving dynamic crop evolutionary processes rather than a static inventory of crop types.²⁶⁰ Rather than preserve diversity *per se*, *in situ* conservation aims to preserve decentralized selection, farmer seed production and exchange, and gene flow among crop varieties and with wild relatives. While *in situ* conservation and the preservation of traditional agricultural knowledge may be seen as synonymous, it is erroneous to imagine that traditional agricultural knowledge can be preserved as a given inventory of information, nomenclature, or local understandings of crops and crop ecology. Because both crops and knowledge systems are dynamic, *in situ* conservation can preserve

256. David Wood & Jillian M. Lenné, *The Conservation of Agrobiodiversity On-Farm*, 6 BIODIVERSITY & CONSERVATION 109, 110 (1997); Brian D. Wright, *Crop Genetic Resource Policy*, 41 AUSTRALIAN J. AGRIC. & RES. ECON. 81, 87 (1997).

257. Garrison Wilkes, *Germplasm Collections*, in INTERNATIONAL CROP SCIENCE I 445 (D.R. Buxton et al. eds, 1993).

258. NRC, *supra* note 252, at 117; N. Maxted et al., *Complementary Conservation Strategies*, in PLANT GENETIC CONSERVATION 15, 17 (N. Maxted et al. eds., 1997).

259. STATE OF THE WORLD, *supra* note 80, at 351.

260. M.S. Swaminathan, *The Past Present and Future Contributions of Farmers to the Conservation and Development of Genetic Diversity*, in MANAGING PLANT GENETIC DIVERSITY 23, 26 (Johannes M.M. Engels et al. eds., 2002); P.K. Bretting & D.N. Duvick, *Dynamic Conservation of Plant Genetic Resources*, 61 ADVANCES IN AGRONOMY 1, 4 (1997); N. Maxted et al., *Towards a Methodology for On-Farm Conservation of Plant Genetic Resources*, 49 GENETIC RES. & CROP EVOLUTION 31, 32-33 (2002).

the context of practice of traditional knowledge rather than the knowledge itself.

However, institutions or programs similar to those that have been established for *ex situ* conservation are either lacking or underdeveloped for protecting *in situ* resources. Crop scientists and others have made initial but important steps toward developing methods for achieving *in situ* conservation.²⁶¹ These steps include means to increase the value of traditional crops to farmers through collaborative plant breeding and market development and improving the supply of traditional varieties and seed through diversity fairs and farmer networks. Numerous pilot research and conservation projects have been implemented in Vavilov Centers with financial support from private foundations, such as the McKnight Foundation's Collaborative Crop Research Program²⁶² and international agencies such as the Global Environmental Facility.²⁶³ *Ex situ* conservation agencies, such as the International Plant Genetic Resources Institute²⁶⁴ have moved to support *in situ* conservation as part of the overall effort to protect crop resources, and several countries have adopted the goal of promoting *in situ* conservation of crop resources as part of their national biodiversity agenda.²⁶⁵ Nevertheless, protecting the cognitive aspect of traditional agricultural knowledge is ad hoc, tentative and programmatic rather than institutionalized. Funding a broad and institutionalized program of *in situ* conservation will most likely be accomplished through conventional bilateral and multilateral mechanisms that have successfully managed international

261. T.M. Worede et al., *Keeping Diversity Alive: An Ethiopian Perspective*, in GENES IN THE FIELD: CONSERVING PLANT DIVERSITY ON FARMS 143, 152 (Stephen B. Brush, ed., 1999); Mauricio R. Bellon et al., *Participatory Landrace Selection for On-Farm Conservation: An Example from the Central Valleys of Oaxaca, Mexico*, 50 GENETIC RES. & CROP EVOLUTION 401 (2003).

262. McKnight Foundation Collaborative Crop Research Program (CCRP), About the CCRP (Dec. 8, 2004), at <http://mcknight.ccrp.cornell.edu/about>.

263. GLOBAL ENVIRONMENTAL FACILITY (GEF), GEF OPERATIONAL PROGRAM #13 ON CONSERVATION AND SUSTAINABLE USE OF BIOLOGICAL DIVERSITY IMPORTANT TO AGRICULTURE, available at http://gefweb.org/operational_policies/operational_programs/op_13_english.pdf (last visited Dec. 26, 2004).

264. D. Jarvis & T. Hodgkin, *Farmer Decision Making and Genetic Diversity*, in GENES IN THE FIELD: ON-FARM CONSERVATION OF CROP DIVERSITY 261 (Stephen B. Brush, ed., 1999).

265. Worede, *supra* note 261.

agricultural development in the past.²⁶⁶ The bioprospecting alternative is too limited in the number of farmers and duration to be adequate for the needs of national *in situ* conservation in Vavilov Centers or elsewhere.

IX. CONCLUSION

Numerous parties and participants have struggled with the issue of protecting traditional agricultural knowledge and crop resources through binding international resolutions, formal contracting, and non-contractual benefit sharing mechanisms. The impetus for this was the recognition that resources and knowledge were eroding under the pressures of modernization, such as rapid population growth and commercialization of agriculture, but it also grew out of the North/South dialog of the mid-twentieth century. The move to end common heritage as a management scheme for genetic resources is understandable as both a liberal ideology to overcome the Tragedy of the Commons²⁶⁷ and an anti-colonialist tool to stop uncompensated acquisition of resources from the South.²⁶⁸ However, both of these sources for justifying the closure of the genetic commons are problematic because they are based on inaccurate caricatures of traditional resource managers and the international crop germplasm system. The Tragedy of the Commons overlooks successful and long-lived systems of managing common pool resources,²⁶⁹ and the North/South dialog assumes that farmers are barefoot equivalents of crop breeders, overlooking incremental, collective invention,²⁷⁰ networks of interdependence among farming communities,²⁷¹ and farmers' links to a global flow of crop material.²⁷² Moreover, the

266. Robert W. Herdt, *Assisting Developing Countries Toward Food Self-Reliance*, 95 PROC. NAT'L ACAD. SCI. USA 1989, 1990 (1998); Bruce Trotter & Ann Gordon, *Charting Change in Official Assistance to Agriculture*, 25 FOOD POL'Y 115, 120 (2000).

267. Hardin, *supra* note 33.

268. MOONEY, *supra* note 52; Thomas Cottier, *The Protection of Genetic Resources and Traditional Knowledge*, 1 J. INT'L ECON. L. 555, 559 (1998).

269. OSTROM, *supra* note 38, at 58.

270. Robert C. Allen, *Collective Invention*, 4 J. ECON. BEHAV. & ORG. 1 (1983).

271. D. 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 ed., 1999).

272. Gollin, *supra* note 203.

North/South dialog understates the value of global public goods²⁷³ and international cooperation involving both North/South and South/South transfers.

Arguably, it is time to move beyond both the Tragedy of the Commons and North/South dialog as bases for developing mechanisms to protect traditional agricultural knowledge and crop resources. This conclusion is embedded in the negotiated settlement of the ITPGRFA that returns to common heritage for the world's most important crops. The weakness of that treaty, however, is that it does not give proper emphasis to the obligations of industrial countries and developing countries alike to support conservation of crop resources beyond funds raised in connection to commercializing improved crop varieties. This mechanism faces the same limitations as the Indian and OAU gene funds and is likely to be inadequate for meeting conservation budgets that are already inadequate.²⁷⁴ Rather, benefit sharing must come from a more traditional transfer of international capital: development assistance focused on programs to improve rural incomes in Vavilov Centers. An assortment of tools now exist to use those funds in a way that increases production and income without replacing traditional crop populations.²⁷⁵ Bilateral and multilateral development assistance that funds rural development activities and benefits the stewards of the world's crop resources can be justified as part of the reciprocal obligations of industrial nations to developing nations. Multilateral efforts such as the Global Environmental Facility's Program on Conservation and Sustainable Use of Biological Diversity Important to Agriculture²⁷⁶ and the McKnight Foundation's Collaborative Crop Research Program²⁷⁷ embody reciprocity through international financial assistance. The irony of this conclusion is that it reverts to tools and principles that were established before the assault on common heritage.

273. Inge Kaul et al., *Introduction*, in GLOBAL PUBLIC GOODS xix, xxvi (Inge Kaul et al. eds., 1999).

274. NRC, *supra* note 252, at 117.

275. Jan Engeles & Bert Visser, *Strategies and Methodologies in Genetic Diversity Conservation*, in ENCOURAGING DIVERSITY 26, 27 (Conny Almekinders & Walter de Boef eds., 2000); Swaminathan, *supra* note 260, at 26.

276. GEF, *supra* note 263.

277. CCRP, *supra* note 262.