An Agricultural Law Research Article

Searching for Sustainability

by

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Comments: Searching for Sustainability

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I shall be brief, since I realize that I am now the remaining hurdle between symposium participants and cocktail hour! My intention is mainly to supplement Bill Clark's comments, rather than to take major issue with his oral presentation or his article. Both forms of his message deserve an A+ for thoroughness and thoughtfulness, and for summarizing an enormous body of useful information. If I have problems with Clark's analysis, they are with issues of priorities, scale, and sequencing. Even good governments can only do two or three things at one time. Figuring out which two or three initiatives the government should undertake is a terribly important task. Unfortunately, I do not see this kind of sequencing guidance emerging from Clark's catalog of suggestions.

By contrast, Clark is exceptionally clear about the importance of proper national and international policies for achieving or maintaining ecological sustainability. Bad policies drive out good projects and programs. However, good *projects* that are capable of replication can help inform *policy* and can create sound *programs* with sufficient scale to make a quantitative impact at the national level. I agree with him that "top down versus bottom up" or "policies versus projects" are dichotomies without much merit anymore.[1]

My main points today, therefore, focus on poverty and hunger and their relationship to sustainability. More specifically, I have chosen to concentrate on biotechnology, the new

* Farnsworth Professor of International Agricultural Policy, Stanford University, and Chairman, International Maize and Wheat Improvement Center (CIMMYT). These comments were transcribed at the Environment 2000 Symposium. They are a very preliminary and condensed version of Walter P. Falcon, *Globalizing Germplasm: Barriers, Benefits, and Boundaries*, *in* PROCEEDINGS OF THE TWENTY FOURTH INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS (G. H. Peters ed.) (forthcoming 2001).

1. WILLIAM CLARK, *A Transition Toward Sustainability*, 27 ECOLOGY L.Q. 1021 (2001).

institutional arrangements governing germplasm (seed) development, and the related problems of intellectual property. I speak as a faculty member from Stanford, but also as a practitioner confronting these issues on behalf of the less developed countries of the world. Recent legal decisions on patents,[2] combined with recent developments in biotechnology, have created a very different world for public and non-profit institutions— groups that have previously focused their research efforts on providing public goods. The International Maize and Wheat Improvement Center (CIMMYT), located in Mexico, which I chair, is actively engaged both in internal discussions and in negotiations with the private sector on how to manage new biological opportunities within the changed legal circumstances so as to best meet CIMMYT's global responsibilities.[3] This challenge is daunting because many of the world's hungry people live in the poorest seventy countries— countries that are mostly ill-equipped, legally and scientifically, to obtain access to the new technology. Since two-thirds of the wheat acreage in all developing countries comes partially or wholly from CIMMYT germplasm, I hope everyone will understand why I am so concerned.

In the remarks that follow, I say little about environmental issues *per se*. I assume that everyone here today understands the following two tenets: (1) poverty is a terribly toxic agent to the environment, and (2) hungry households, in trying to keep alive, often do great environmental damage— not because they are unaware or uncaring, but because they have few alternatives other than to feed themselves at high short-run costs to the environment.

Unfortunately, large portions of the development profession seem to have forgotten what seems to me to be the first rule of development economics for really poor countries— there are *two* strong reasons for worrying about agriculture: producing enough grain and providing sufficient jobs. There is instead a tendency to focus on only one— the size of the "global pile of grain"— and to forget the other problem of productivity and rural employment in the poor countries themselves. Most people are hungry, not because they are stupid or lazy, but because they do not have productive jobs. For many developing countries, increasing agricultural productivity is virtually the only way to create the

2. *See infra* notes 9-10 and accompanying text.

3. For more information about CIMMYT and the Consultative Group (CGIAR) of which it is a part, see http://www.cgiar.org/cimmyt (last visited Sept. 29, 2000).

"double development dividends"—jobs in the countryside to create income for farmers, while at the same time providing basic food staples at reasonable prices for the urban poor. Many leading development theorists and development agencies seem to have forgotten this point and believe, somehow, that leapfrogging to the electronics industry or to internet companies is the best way for countries to develop quickly, whatever their stage of development.

It can be said without equivocation that the current world food situation is in serious disarray. There are some 840 million people who do not get enough calories to lead normal, active lives.[4] But the agencies in developed countries, which ought to be taking the lead in working on this problem, have largely turned their attention elsewhere. The World Bank's agricultural lending is down substantially both in absolute terms and in relative terms as a percentage of its total loan portfolio.[5] This reduction is particularly noteworthy in light of Clark's call for integrated regional planning. The World Bank's efforts with integrated rural development projects in Africa were largely failures.[6] Vast sums were invested in these projects; the widespread realization that these projects were not working is a primary reason why World Bank lending for rural development has declined so precipitously. Similarly, the Agency for International Development (USAID) focuses little on agriculture. Perhaps the small bit of good news is that both the World Bank and USAID are significant contributors—a combined total of about $75 million in 1999—to the sixteen international agricultural research centers of the Consultative Group on International Agricultural Research (CGIAR).[7] The much larger problem, of course, is a general unwillingness on the part of the leaders of industrialized countries to place food and agricultural issues on the agenda of their joint meetings. For them, the primary food and agricultural problems are low prices and large agricultural surpluses in the North, rather than hunger and poverty in the South. Overcoming the paradox of surpluses and starvation has proven to be an incredibly difficult task over the

4. VACLAV SMIL, FEEDING THE WORLD: A CHALLENGE FOR THE TWENTY FIRST CENTURY (Cambridge ed., MIT Press 2000).

5. WORLD BANK, RURAL DEVELOPMENT: FROM VISION TO ACTION, ENVIRONMENTALLY AND SOCIALLY SUSTAINABLE DEVELOPMENT STUDIES AND MONOGRAPH SERIES NO. 12 168 (1997).

6. *See id.*

7. CGIAR SECRETARIAT, CGIAR: 1999 FINANCIAL REPORT 38 (2000).

years— a task that promises to become even more difficult in the next half-century.

Pamela Matson, in *Our Common Journey*, reminds everyone that cereal output needs to double in the next fifty years.[8] This is an immense task, especially given the limited global opportunities for sensible and sustainable expansion of arable land. However, if yields do not increase on land already being cropped, the agricultural sector will gobble up habitat— eating it for lunch, literally and figuratively. In addition to raising yields and total factor productivity, there is an urgent need to stabilize production in less favorable ecosystems. A large proportion of the rural poor live in areas that are marginal with respect to moisture, soil type, and land degradation. In short, the base from which agricultural development begins has serious technological and institutional constraints. The world must now add to this shaky base the tasks of doubling food output, doing so at reasonable food prices if the poor are to be protected, and also doing so in a manner that does not destroy significant parts of the environment in the process. Thus, the world, and especially the poor countries where food demand will grow most rapidly, needs all the help it can get in expanding output in a sustainable manner.

Given the magnitude and nature of the tasks ahead, I wish to raise four interrelated questions: (1) what role can biotechnology play in solving the future hunger and poverty problems outlined above?; (2) are new legal rulings on patenting— and, more generally, on intellectual property rights— helping or hurting this process?; (3) are the views of developing countries being heard adequately in the many discussions about biotechnology?; (4) do new forms of public and private sector partnerships in agricultural research hold promise for the twenty-first century?

The brief answers to these four questions are lots, hurting, no, and yes, respectively!

I firmly believe that, over the next several decades, biotechnology has a key role to play in the sensible development of the food sector. It carries with it risks, as do all technologies, that will need to be managed in careful, thoughtful ways. Moreover, while it will not solve all of the food problems, it can help solve several of them.

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8. *See* BD. ON SUSTAINABLE DEV., NAT'L RESEARCH COUNCIL, OUR COMMON JOURNEY: A TRANSITION TOWARD SUSTAINABILITY (1999).

Although few people would know it from reading the popular press, biotechnology embraces much more than genetically modified organisms (GMOs), whereby a gene from one species is inserted into another. The discussion about "Frankenfoods," besides its largely hysterical quality, has missed a key point. The ability to pinpoint the location of specific genes using the techniques of modern biotechnology has been one of the major breakthroughs in accelerating the useful results from classical breeding. Interestingly, these so-called "molecular markers" are not controversial, but they are exceedingly important. The extension of this process, the mapping of all genes for a species, including their functions, is what genomics is all about. Here too progress has been rapid and mostly uncontroversial, and it is increasingly being published in ways that keep this vital information in the public sector as a public good.

The real controversies surround transgenic manipulations, where genes or sets of genes are moved from one species to another. The consequences of our ability to sequence, clone, and transfer genes, thereby creating transgenic organisms, form the common thread to the four questions just asked.

Vital technical advancements in science have been instrumental, but it has been the legal system that changed the fundamental institutional arrangements for agricultural research. In a 1980 case, *Diamond v. Chakrabarty*,[9] the U.S. Supreme Court ruled, in a 5-4 vote, that a live micro-organism, constructed by gene-transfer technology, was patentable.[10] *Chakrabarty* and later decisions created great uncertainty regarding what was patentable, and how broad or narrow the patent coverage could be. Given this uncertainty, there were understandable pressures for firms to maximize the number of biotechnology patents, and to do so as rapidly as possible—reminding one of speculative land grabs in an earlier era. Initially, the bar on gene claims was perceived to be low, and the number of patent applications exploded during the 1990s. With little prior history, the United States Patent and Trademark Office (USPTO) had great difficulties in implementing the "utility" aspect of applications, that is, in determining whether or not a new proposal had merit. Although there was widespread scientific agreement that short sections of DNA (deoxyribonucleic acid) containing part of a gene— sometimes called expressed sequence tags— were too narrow a basis for patenting; more

9. Diamond v. Chakrabarty, 447 U.S. 303 (1980).
10. *Id.* at 309-10.

than a million such claims were filed with USPTO.[11] There were equal concerns that patent claims might be unreasonably broad. In a case especially notorious and worrisome to developing nations, the USPTO issued broad protective rights in the United States for a type of yellow bean grown commonly throughout Mexico.[12]

The USPTO is apparently now in the process of raising the claims bar with respect to "utility." Nevertheless, numerous lasting problems arise from the way new patent processes affect poor countries. First, thousands of relevant patents have already been issued that affect the "creation" of modern agricultural germplasm appropriate for developing countries. Intellectual property coverage includes genes, traits, molecular constructs, and transformation procedures— so-called "enabling technologies." For important genetic modifications, dozens of patents can be involved in a single transformation. The multiple-patent problem, in turn, has been a powerful force in concentrating the industrial structure in the private seed and biotechnology sectors; this problem also effectively forces the public sector to use alternative research methods if crucial patents are unavailable for use on products important for poor countries. Second, the fear that bio-pirates will patent existing products, such as yellow beans, has left national agricultural research systems and the international agricultural research centers in a quandary as to whether or not to employ patenting as a defensive strategy against bio-piracy. Third, any research institution— public or private— wishing to use either the seeds or the enabling technology, as a practical matter, must now have commercial relationships or alliances with some or all of the half-dozen megafirms now dominating the seed/biotechnology sector. Fourth, the control of patents and seed distribution exercised by these companies has substantially increased the barriers, effectively preventing new firms from entering the field of germplasm development. Fifth, given the profitability needs of these companies, much of their research has been aimed at innovations that can generate linked sales of seeds and chemicals. Sixth, the need for private-profitability has created many "orphan" crops and countries— commodities and nations that are simply unprofitable for the private sector to pursue.

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11. For a brief history of recent trends in gene patenting, see Martin Enserink, *Patent Office May Raise the Bar on Gene Claims*, 287 SCI. 1196, 1196-97 (2000); *see also* John H. Barton, *Reforming the Patent System*, 287 SCI. 1933, 1933-34 (2000).

12. J. Friedland, *As Two Men Vie to Sell Yellow Beans, Litigation Sprouts*, WALL ST. J., Apr. 15, 2000, at A1.

Unfortunately, in my view, most of the debate on patents and transgenics has been in northern countries, over such issues as Roundup Ready™ corn and soybean seeds, which in this specific case are linked to the sale of Monsanto's major herbicide. The greater problem more generally, however, is that voices from the South are rarely heard in such discussions. Yet, I believe that it is in these poorest countries where biotechnology and transgenic plants could play their most important role.

One recent transgenic example, vitamin-A enhanced rice, illustrates the controversy. As a recent issue of *Time* stated on its cover: "This rice could save a million kids a year . . . but protesters believe such genetically modified foods are bad for us and our planet."[13] Representatives from developing countries, in discussions at CIMMYT, have pointed out the great value of vitamin, mineral, and protein enhanced crops. They also have discussed how the development of apomixis— a form of asexual reproduction in which the seed from a hybrid plant retains the genetic characteristics of the mother plant— would be invaluable to them for regions not well served by the commercial seed industry. Similarly, they assert that drought and pest resistance or control of *Striga* (a parasitic weed) in Africa might be the difference between life and death for millions of people on that continent, yet might only add to maize surpluses in the United States. In short, most groups in most developing nations believe that each nation should make its own decision on transgenics. They fear particularly that the transgenic products first introduced by the private sector have needlessly fueled the GMO debate. Policymakers from developing countries fear that, if that debate, in turn, kills some or all of the incentive for firms to develop the new technology, that the technology's potential will not be mobilized for food-security improvements— for which there otherwise would be little controversy. They also fear that any involvement on their part with GMOs may jeopardize aid funds from a number of donors.

The foregoing issues are not trivial, for they go to the heart of seed-technology transfer to poor countries. I thus close with two remaining thought experiments. First, could the original Green Revolution, which brought high-yielding rice and wheat seed

13. J. Madeleine Nash, *Grains of Hope*, TIME, July 31, 2000, at 38, 38-46. For a more technical version of the vitamin A story, see Mary Lou Guerinot, *The Green Revolution Strikes Gold*, 287 SCI. 241, 241-43 (2000). For an excellent legal review of the patent dimensions of vitamin A rice, see D. Kryder, S. P. Kowalski & A. F. Krattiger, *The Intellectual and Technical Property Components of Pro-Vitamin A Rice: A Preliminary Freedom-to-Operate Review* (ISAAA 2000), at 56.

varieties to most of the Third World, have occurred if current legal rulings had been in place in 1960? Second, if the situation is as serious as I believe, what can be done to alleviate the very real problems that now exist with respect to the transfer of genetic resources to poor countries?

A key feature of the Green Revolution was the strategic use of dwarfing genes in rice and wheat plants to prevent lodging (falling over) of plants under the growth made possible by high-fertilizer regimes. As Lloyd Evans has stated, "The greatest impact on world food production as the population grew towards 4 billion came from the deployment of dwarfing genes in wheat and rice in the 1960s."[14] For example, a phenomenal seventy-seven percent of the area devoted to wheat in developing countries is currently planted to CIMMYT lines (or lines with CIMMYT ancestors), virtually all of which include the Norin 10 dwarfing gene.[15]

Could a comparable sequence of events have taken place under current institutional circumstances? This point is certainly debatable; in my view, the probability is low. The key assumption in this thought experiment is whether or not the dwarfing gene would have been patented or kept in the public domain. If patented, how hard would the patent holder have worked to promote this characteristic in a crop that is self-pollinated, not easily subject to hybridization, and, therefore, not a great generator of seed sales? Perhaps an entire new line of hybrid wheat would have been developed, but would it have reached three-fourths of the areas of less developed countries? Unlikely. Would CIMMYT or some other agency have been in a position to send out seed samples, which in 1994 alone totaled 1.2 million packets— three-fourths to developing countries and almost all carrying the dwarfing gene? Probably not. Would global yields of wheat have been lower, more mountain- and forestland lost to crop production, and more people left food-insecure? Probably so.

Other scenarios could be written about the dwarfing gene, and certainly other factors in the world food economy have changed since 1960. However, the analysis just presented ought to be sufficiently plausible to persuade everyone that the combined issues of patenting and germplasm flow are *important*

14. L. T. EVANS, FEEDING THE TEN BILLION: PLANTS AND POPULATION GROWTH 137 (Cambridge University Press 1998).

15. Paul Heisey et al., *Assessing the Benefits of International Wheat Breeding*, *in* P. PENGALI, WORLD WHEAT: FACTS AND TRENDS (Mexico D.F.: CIMMYT 1999).

as well as *interesting*. The dwarfing example also suggests several of the future institutional modifications that should be made in the interests of global food security.

It seems quite clear to me that the world food economy would have been better off if the Supreme Court had ruled differently in the *Chakrabarty* case. But turning the clock backwards is not now an option. The real issue, therefore, is what can be done given the new institutional setting.[16]

I could present a very long list of useful changes that would help poor countries gain easier access to modern seed technology; many of those changes must be put in place by the poor countries themselves. Given limited time, however, let me offer comments about only three issues on which I believe outsiders have a key role to play.

If poor countries are to reap the benefits of twenty-first century research, they will need help. Part of this assistance can come from intermediary agencies, which can help transform, adapt, and develop new forms of technology for orphan crops and lagging regions. But there are severe limits to what outsiders can accomplish—just as there are severe limits to what technology alone can do to solve problems of food security. Inadequate investments in human resources within these countries are a major part of the problem, and recent investments in education and research and development are not at levels that should make either developed or developing countries very proud. While it is true that the number of trained personnel in sub-Saharan Africa was greater in 1991 than it was in 1961, as Philip Pardey and others show in their important study, it is also true that sub-Saharan numbers are still pitifully small.[17] In 1991, the total number of agricultural research workers in twenty-one countries of sub-Saharan Africa was less than 7,000, and total expenditures (in 1985 dollars) for agricultural research in that region were less than $700 million.[18]

16. I remain agnostic about the effects of the *Chakrabarty* ruling on the pharmaceutical industry, where transgenics are also very important. That industry's long lead times with product development, its regulated environment, and the high cost of human trials *may* make conclusions about patenting qualitatively different for health-related industries than those for agriculture.

17. *See* Philip G. Pardey et al., *Investments in African Agricultural Research*, 25 WORLD DEV. 409, 409-423 (1997).

18. By way of ludicrous comparison, Stanford University alone had a consolidated budget of $875 million in 1991, also measured in 1985 dollars. *See id.*

Since the poorest countries are precisely the places that private-sector firms are least likely to serve, a rapid upgrading of national research capabilities is vital for *all* forms of technology development and transfer. Unfortunately, this sobering conclusion far overshadows my more specialized discussion today of improving germplasm flows.

A second obvious way to assist poor countries is via disclosure processes that preclude patenting of key genetic mechanisms. Such processes could keep germplasm and genetic technologies in the public domain, thereby providing the freedom to operate for agencies producing public goods. This approach has long been a hallmark of the public sector; interestingly, it is also becoming a feature of some firms within the private sector. Monsanto's recent willingness to share genomic information on rice is one important example. Novartis has also set forth a new policy that offers its proprietary information on plant genetics to most poor countries with zero or minimal licensing costs.[19]

On the other hand, protection is afforded only to that which has been disclosed and not to the "surrounding" data or constructs. Partial disclosure may give others clues that result in their patenting the rest of the genetic mechanism in question—an action that the initial disclosure was specifically trying to prevent. Therefore, in spite of the widespread progress with keeping genomics in the public domain, the specific technologies that govern function, use, and manipulation of these genes, or sets of genes, are increasingly likely to be held under some form of intellectual property protection. Such protection provides both the opportunity and the forcing mechanism for new partnerships and alliances within and between the public and private sectors.

More than anything else, during the next twenty-five years, I believe that successfully transfering plant genetic materials to the poorest countries will require new types of partnerships, alliances, and market sharing. Neither the public nor the private sector institutions will be completely comfortable with these arrangements, but the limited experience to date suggests that several forms are indeed workable. These mechanisms include licensing under varying cost and technology-sharing arrangements, market segmentation between rich and poor nations, technology grants, joint ventures, alliances, and various

19. *E.g.*, Dennis Normile, *Monsanto Donates Its Share of Golden Rice*, 289 SCI. 843 (2000); Press Release, Novartis, Novartis Agribusiness: New agricultural technologies for developing countries (July 11, 2000), *available at* http://www.seeds.novartis.com/news/news_article.asp?room=novapress&ArtID=79.

kinds of direct research support. There is a high probability that almost any of these forms of cooperation can be made to work, provided that: the partners know specifically what they wish to achieve; each party has something to offer others in the partnership; and everyone is willing to spend sufficient time to understand each other's concerns and to build trust.

Institutional arrangements designed to use biotechnology in support of poor countries are in their infancy, but progress *is* being made. For example, Novartis presented the International Rice Research Institute (IRRI) with the *Bacillus thuringiensis* (Bt) (Ceiba) gene construct for rice as a gift in 1995.[20] CIMMYT began a strategic alliance in 1998 with Institut de Recherche pour le Développement (IRD) and three private companies (Novartis, Limagrain, and Pioneer) for the development of an apomictic strain of maize. CIMMYT has also begun a very specific collaborative arrangement with Monsanto on the development of hybrid wheat, and the International Livestock Research Institute (ILRI) has joined with the Institute for Genomic Research (TIGR) on sequencing research related to the parasite that causes East Coast Fever in cattle.[21] These are only a subset of examples, but they are important examples because they demonstrate the diversity of arrangements now being undertaken.

Several preliminary but important conclusions can be drawn from these early CGIAR experiences. It *is* possible to negotiate effective public-private arrangements, even those involving several private companies in non-exclusive relationships; however, the negotiations tend to be neither quick nor easy. (Negotiating time appears to go up by the square of the number of parties involved!) It has also proved feasible to provide preferential access to research findings for particular national agricultural programs. Mexico, in the case of CIMMYT's apomixis project, is an especially noteworthy case in that this nation is a center of origin for maize.

Market sharing usually is a key element in most of the early agreements. The private partner typically retains the rights to distribute, sell, or license products in the developed countries, whereas the public or non-profit agency retains rights for the developing world. Many countries fall neatly into one category or another; countries such as China and India, however, typically

20. IRRI, LISTENING TO FARMERS, 1995-96 ANNUAL REPORT (1996).

21. *See* Press Release, Institute for Genomic Research, J. Craig Venter Donates Proceeds of King Faisal Science Award to TIGR to Fund Genome Sequencing of Deadly Cattle Disease (May 14, 2000), *available at* http://www.tigr.org/new/kingfaisal.shtml.

cause contention between public and private parties in regards to determining who should have jurisdiction in the market-segmentation agreements. Although relatively poor in per capita income terms, both of these countries are large in terms of aggregate national incomes, and both also have strong agricultural research systems. (Issues of this type help explain why negotiations between the public and private sectors are rarely easy or short.) Indeed, establishing principles of market segmentation— including product liability responsibilities— and the development of prototype agreements for public-private partnerships appear to be important areas for further research.

Finally, there is the generosity factor. Much has been written about the short-run profit imperative for private firms— a point that at one level is obviously correct. However, the CGIAR's early negotiating experience indicates, on balance, that companies in the private sector have had a genuine concern with poverty issues and have been generous with respect to legitimate use of their technologies in support of poor countries. It has indeed been possible, if not easy, to find win-win solutions that embrace both the public and private sectors. These new kinds of partnerships seem to me to represent the greatest hope for improving germplasm flows into poor countries during the twenty-first century.