

SECOND EDITION

FIRST THE SEED

THE POLITICAL ECONOMY OF PLANT BIOTECHNOLOGY



JACK RALPH KLOPPENBURG JR.



First the seed

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Second Edition

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For Thomas Robinson Kloppenburg

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Preface to the second edition

Sixteen years after the initial publication of *First the Seed*, I am presented with the opportunity to revisit my work and evaluate it against the backdrop of subsequent events. I find I am both pleased and disappointed. I am pleased by the accuracy with which I limned the historical trajectories that were shaping the development and the deployment of that expanding set of knowledge, techniques and technologies that is still referred to generically as “biotechnology.” I am disappointed that those trajectories have not been materially altered as much as they need to be.

Commodification has not just continued, it has been considerably accelerated. Given the recent flood of patents granted not just on genes (of humans as well as other species) but on short sequences and DNA fragments of unknown function, the initial reluctance in 1985 of the U.S. Patent and Trademark Office (PTO) to countenance the extension of patents to whole plants now seems almost quaint. Further, the advent of patents on research materials and techniques has reinforced long-standing trends in the social *division of labor* characteristic of the plant sciences. If in the 1980s public breeders were still struggling to maintain the capacity to release finished varieties, today they all too often must obtain a license from a corporate patent-holder in order to do their work at all. The clear asymmetries in the regime of *germplasm transfer* made “biopiracy” a central topic of debate during the 1990s in international fora from Rio to Seattle to Johannesburg. After twenty years of “seed wars,” an International Treaty on Plant Genetic Resources for Food and Agriculture was signed in 2001, but its implications are uncertain. There is recognition of “Farmers’ Rights” in principle, but of intellectual property rights in practice. The treaty is harmonized with the requirements of the World Trade Organization (WTO), but not with the interests either of peasant farmers or indigenous peoples.

Still, my disappointment that these trajectories so far have not been redirected much is tempered by a sense that conditions are developing in which they plausibly *could* be diverted onto substantially more progressive headings.

The world is a rather different place in 2004 than it was in 1988 when *First the Seed* was initially released. This is true both in regard to the social and natural circumstances immediately surrounding the development and deployment of biotechnology, and with reference to the larger political economy in which those processes are embedded. Seed nevertheless remains the vehicle in which many of the products of biotechnology – GMOs (genetically modified organisms) in the current argot – must be embodied and valorized. As both food and means of production, seed sits at a critical nexus where contemporary struggles over the technical, social, and environmental conditions of production and consumption converge and are made manifest.

The major difference between 1988 and 2004 is that over the last decade, opposition to the way in which private industry has chosen to develop biotechnology has emerged in robust, globally distributed, and increasingly well organized forms. In a new final chapter I show that opposition is expressed not just by advocacy and activist groups but has materialized within the public plant science community as well. I am grateful to the University of Wisconsin Press for giving me the occasion to explore how an alliance between civil society organizations and public agricultural research institutions might be made manifest, and how such a partnership could facilitate the realization of new, more just, and more sustainable trajectories for crop improvement. Truly, *still* the seed!

Jack R. Kloppenburg, Jr.

Madison
July 2004

Preface to the first edition

It is only March 8, but I planted today. It has been one of the mildest winters on record here in Wisconsin. Warmed by the heat reflecting off the stone facade of my house, the soil in my south-facing front garden has already thawed. When the temperature reached 71 degrees yesterday, I couldn't resist putting a spade to the soil to see how it turned. The earth fell cleanly away from the blade, and I crumbled the clods to a fine and receptive tilth. I prepared two beds. And then today I planted a few rows of "Easter Egg" radishes, "Red Sails" lettuce, and a line of the marvelous "Sugar Snap" peas. I never need much encouragement to – in the argot of seed packet instructions – "plant as soon as the soil can be worked." Really, it is too early for even these hardy species. There is no small bit of winter to go as yet, and these initial sowings probably will not survive. But they might; where there is seed and soil there is always hope of a harvest.

In the simple act of planting I was engaged in one of the most universal – and certainly one of the most important – of all human activities. I share the act of planting and my hope for a harvest with most of the world's population and with unnumbered previous generations. People must eat. And the chain of production processes that finally delivers food to our mouths – long for the New Yorker, short for the Thai peasant – begins everywhere with the sowing of seed. This is no less true of the animal products we consume, for milk or bacon is really nothing more than transformed grain. Crop production is the necessary foundation upon which the complex structures of human society have historically been raised. And the seed is the irreducible core of crop production. Truly, as the motto of the American Seed Trade Association has it, "First – the seed."

Despite the pivotal importance of the seed as the very stuff of the great American granary and as the fundamental input of the global "Green Revolution," the parallel development of plant breeding and the seed industry has received little attention from social scientists. This book seeks to redress this deficiency by providing a social history of both the scientific and com-

mercial aspects of plant improvement. I trace the historical transformation of the seed from a public good produced and reproduced by farmers into a commodity that is a mechanism for the accumulation and reproduction of capital. While the development of scientific understanding in the plant sciences provides a narrative structure for the book, the central focus of my analysis is the interaction of scientific advances with three themes of political economy: (1) progressive commodification of the seed, (2) elaboration of a social division of labor between public and private plant breeding, and (3) asymmetries in global patterns of seed commerce and exchange between the less developed countries of the South and the advanced industrial nations of the North.

Further, I am interested in the history of plant breeding not only for what can be learned of the past but also for what the past can tell us of the present and even for what it can reveal of prospects for the future. As Russell Hoban expressed it in *Riddley Walker*, "What ben makes tracks for what will be." Recent advances in genetics and molecular biology have given scientists access to the fundamental building blocks of life. The emergent "biotechnologies" constitute a crucial, perhaps epochal new technical form. One of the principal areas of application for the new biotechnologies is plant improvement, and the raw material of the plant genetic engineer is germplasm – the genetic information encoded in the seed. In this book I show that the weight of the past does indeed shape the present and bear upon future possibilities in concrete and specifiable ways. Contemporary issues such as the nature of global flows of germplasm, genetic erosion and vulnerability, the restructuring of research institutions, changing university-industry relations, and the development of patent rights for new crop varieties can be adequately understood only when viewed in historical perspective.

Such a historical perspective, as the title of this book implies, must encompass the year 1492. Contact between the Old and New Worlds touched off what has been called the "Columbian exchange," a dramatic and unprecedented movement of plants around the globe. In 1986, the celebration of the Statue of Liberty's centennial highlighted the central role that immigration has played in American history. Yet it is seldom recognized that our population of agricultural plants is as immigrant in character as the nation's human population. None of the crops that today make the United States an agricultural power is indigenous to North America. Had new crop plants not been introduced from other regions of the world, there would not have been a plant genetic base sufficient to provide an agriculture capable of sustaining the tide of human immigration. And the importation of "raw" plant genetic material for further processing in the test plots of American seed companies and agricultural colleges is a phenomenon of enduring importance. The pea, for example, originated in Asia Minor, and the germ-

plasm that put the “sugar” in the “Sugar Snap” peas I planted today was derived from East Asian material. The evolution of global patterns of access to and control over plant genetic resources has materially conditioned the development of plant breeding in both the public and private sectors.

That plant breeding is not today an exclusively private endeavor is an interesting anomaly for American capitalism. The development of a private presence in plant breeding has historically faced two obstacles, one biological and the other institutional. First, the very reproducibility of seed made the farmer the commercial seed company’s prime competitor and constrained private investment in plant improvement. Into this vacuum of investment moved the state to become an institutional obstacle to the expansion of a commercial seed industry. Whereas in other sectors of the economy the state may act indirectly to shape the character of a product through regulation, in plant breeding it has done so directly by actually creating the product – the new plant variety. Public breeders have thus significantly limited the possibilities for capital accumulation by private breeders by directly competing with them.

The social history of plant breeding in the twentieth century is essentially a chronicle of the efforts of private industry to circumvent these twin obstacles. These efforts have involved the elaboration of two distinct but intersecting solutions to the constraints facing seed companies. One involves the use of science to make the seed more amenable to commodification. The prime example of this technical solution is hybridization, a breeding technique that is capable of providing more productive plants but that eliminates the possibility of saving and replanting seed. The hybridization of corn, the archetypal success story of the plant breeder’s art and science, served the interests of capital by bringing farmers into the commercial seed market every year. A second solution is the extension of property rights to plant germplasm by legislative fiat, as with passage of the Plant Variety Protection Act in 1970. The act conferred patent-like rights on breeders of new plant varieties. So, my Burpee’s seed catalog not only describes my “Sugar Snap” peas as the “#1 All-Time All-America Vegetable,” but also warns “Unauthorized propagation prohibited – U.S. Protected Variety.” As the private seed trade has grown stronger, it has been able to continuously redefine the social division of labor in plant improvement, with public breeders becoming increasingly limited to activities complementary to rather than competitive with those of private capital.

It is clear that the new biotechnologies contain tremendous potential for increasing the productivity of agricultural crops. For private industry, they also offer the prospect of facilitating continued movement on the two paths of commodification along which capital has historically penetrated plant breeding. There is also the possibility that the new biotechnologies will

produce significant externalities, for new technologies always carry liabilities as well as benefits. As a society, I think we would like to use our enhanced capabilities for manipulating the genetic code to develop and deploy new plant varieties in ways that are economically productive, socially equitable, and ecologically benign. Will we be able to do so?

To answer this question, we need to look both back into history and forward into tomorrow; hence the parameters 1492-2000 in the subtitle of this book. As plant breeder Norman Simmonds has noted, "There can be no better basis for a view of the future of a crop than a thorough understanding of its past." The extensive social impacts – both positive and negative – stemming from the introduction of hybrid corn were clearly evident in the United States *before* the inauguration of the international Green Revolution of the 1960s. Had social scientists been attentive to those impacts, they would not have been so surprised by the appearance of certain negative consequences associated with the introduction of Green Revolution plant types. Indeed, they might even have been in a position to have avoided or mitigated some of them.

If, as many believe, we are indeed on the threshold of a biorevolution, it would be both dangerous and socially irresponsible to move into the age of synthetic biology as blindly as we did into the Green Revolution. This book is written with the conviction that we need not do so.

Jack R. Kloppenburg, Jr.

Madison
8 March 1987

Acknowledgments

It is with mingled senses of relief and pleasure that I complete this book. It is the fruit of a project begun some four years ago as a graduate student at Cornell University. In my work at Cornell I was fortunate to have had the advice and guidance of Charles Geisler and Frederick Buttel. Both were instrumental in creating the intellectual and institutional space in which I could pursue the social analysis of seeds and biotechnology.

Having achieved another milestone in my intellectual journey, I also want to acknowledge the assistance of George Dalton. It was he who first set me on the path I am traveling, and the example he sets as scholar and teacher has helped me to stay there.

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Harriet Friedmann and Jean-Pierre Berlan both reviewed the original

manuscript. Their insights and criticism resulted in many changes and a much improved book. I am especially grateful to Harriet Friedmann for helping me clarify the central issues and work through the sticky problem of integrating conceptual and chronological order. What deficiencies remain in the book are not the responsibility of these reviewers, but are mine alone. For their efficient management of the literary production process I thank my editors, Jim DeMartino, Frank Smith, and Louise Calabro Gruendel. Mary Lybarger is responsible for the fine illustrations and graphs. Pat Cartwright's editorial assistance eased the burden of multiple rereadings of my own prose.

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Without the contributions and succor of these people and organizations, I would not be in the happy position in which I find myself today. The poverty of my words stands in inverse proportion to the magnitude of my debt.

Abbreviations

| | |
|------------|---|
| AAA | Agricultural Adjustment Act |
| AAACES | Association of American Agricultural Colleges and Experiment Stations |
| ABA | American Breeders Association |
| AGS | Advanced Genetic Sciences, Inc. |
| ARI | Agricultural Research Institute |
| ARS | Agricultural Research Service |
| ASA | American Society of Agronomy |
| ASTA | American Seed Trade Association |
| <i>B.t</i> | <i>Bacillus thuringiensis</i> |
| CBD | Convention on Biological Diversity |
| CBI | Council for Biotechnology Information |
| CGIAR | Consultative Group on International Agricultural Research |
| CMS | Cytoplasmic Male Sterility |
| DNA | Deoxyribonucleic acid |
| DNAPT | DNA Plant Technology, Inc. |
| EPA | Environmental Protection Agency |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| FDA | Food and Drug Administration |
| FTO | Freedom to operate |
| GAO | General Accounting Office |
| GMOs | Genetically modified organisms |
| GRAIN | Genetic Resources Action International |
| GURTs | Genetic Use Restriction Technologies |
| HYV | High yielding variety |
| IARC | International agricultural research center |
| IBPGR | International Board for Plant Genetic Resources |
| ICGB | International Cooperative Biodiversity Grants |
| ICIA | International Crop Improvement Association |

| | |
|---------|--|
| LGU | Land-grant university |
| MNC | Multinational Corporation |
| MTAs | Materials Transfer Agreements |
| NAS | National Academy of Sciences |
| NASULGC | National Association of State Universities and Land-Grant Colleges |
| NBF | New biotechnology firm |
| NCCPB | National Council of Commercial Plant Breeders |
| NEPA | National Environmental Policy Act |
| NF | Nitrogen fixation |
| NIH | National institutes of Health |
| NRC | National Research Council |
| NSF | National Science Foundation |
| NSSL | National Seed Storage Laboratory |
| OSTP | Office of Science and Technology |
| OTA | Office of Technology Assessment |
| PBR | Plant breeders' rights |
| PGRs | Plant genetic resources |
| PIPRA | Public-Sector Intellectual Property Resource for Agriculture |
| PTO | United States Patent and Trademark Office |
| PVPA | Plant Variety Protection Act |
| RAC | Recombinant DNA Advisory Committee |
| rBGH | Recombinant bovine growth hormone |
| rDNA | Recombinant deoxyribonucleic acid |
| RTLAs | Reach Through Licensing Agreements |
| SAB | Scientific advisory board |
| SAES | State agricultural experiment station |
| TRIPS | Trade-Related Aspects of Intellectual Property Rights |
| TUA | Technology Use Agreement |
| UPOV | International Union for the Protection of New Varieties of Plants |
| USDA | United States Department of Agriculture |
| WTO | World Trade Organization |

Introduction

Darwin has directed attention to the history of natural technology, i.e. the formation of the organs of plants and animals, which serve as the instruments of production for sustaining their life. Does not the history of the productive organs of man in society, of organs that are the material basis of every particular organization of society, deserve equal attention? And would not such a history be easier to compile, since, as Vico says, human history differs from natural history in that we have made the former, but not the latter? Technology reveals the active relation of man to nature, the direct process of the production of his life, and thereby it also lays bare the process of the production of the social relations of his life, and of the mental conceptions which flow from those relations.

Karl Marx, *Capital I* (1977)

This book is a political and economic history of what has been one of the most fundamental of humanity's "productive organs": plant biotechnology. Whatever the historical period, whatever the mode of production, plants and their products have been necessary components of the material base on which the complex structures of human societies have been raised. We must all eat, and what we eat is ultimately derived from plant material. What is a steak, after all, but embodied corn? As the prophet Isaiah phrased it: "All flesh is grass." And plants have provided us not only with food but also with the raw materials needed for the production of a multitude of useful goods ranging from cotton cloth to life-saving drugs. Moreover, the domestication and subsequent improvement of numerous plant species also represent instances in which, contrary to Vico, humanity has in some measure made natural history.

"Biotechnology" is broadly defined by the Congressional Office of Technology Assessment (OTA 1984) as "any technique that uses living organisms (or parts of organisms) to make or modify products, to improve plants or animals, or to develop microorganisms for specific uses." Though the term has only recently been added to our lexicon, it encompasses human activities of considerable antiquity. The fermentation of beer, the making of cheese, and the baking of bread can all be considered "biotechnological" processes given the use they make of yeasts.

More important than the manipulation of microorganisms, however, has been the breeding of plants and animals. Crop improvement is as old as

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