Paul B. Thompson

The International Library of Environmental, Agricultural and Food Ethics 10

Food Biotechnology in Ethical Perspective

2nd Edition

Springer

Paul B. Thompson

The International Library of Environmental, Agricultural and Food Ethics 10

Food Biotechnology in Ethical Perspective

2nd Edition

Springer

Food Biotechnology in Ethical Perspective

The International Library of Environmental, Agricultural and Food Ethics

VOLUME 10

FOOD BIOTECHNOLOGY IN ETHICAL PERSPECTIVE

SECOND EDITION

by

Paul B. Thompson
Michigan State University,
East Lansing, MI, USA

Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN-10 1-4020-5790-3 (HB)
ISBN-13 978-1-4020-5790-8 (HB)
ISBN-10 1-4020-5791-1 (e-book)
ISBN-13 978-1-4020-5791-5 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springer.com

Printed on acid-free paper

This book is dedicated to my mother, Joan B. Thompson, with enduring
respect for her appreciation of the influence of both genes and
a character building life environment.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The original 1997 edition contained the following statement of acknowledgement:

> I would like to thank the US National Science Foundation project SBR-9602968 for support of the research for this book. I would also like to thank the Institute for Biosciences and Technology and the College of Liberal Arts at Texas A&M University for extensive long term support of my research on food biotechnology. I would like to mention Charles Arntzen, Fuller Bazer and Benjamin Crouch at Texas A&M as individuals whose efforts on my behalf were of singular importance. On a personal level I would like to thank Rose Gilliver, Colette Holden and Marilyn Grant at Chapman & Hall and especially Daralyn Wallace and Johanna White at Texas A&M for help preparing, editing and indexing the manuscript. The list of people to whom I owe gratitude for help in thinking through the issues in this book is far too long to recount. Most of them would have profound disagreement with something I have written herein, and might well prefer to remain anonymous, anyway.

As the second edition goes to press, the list of unnamed people to whom I owe a debt of appreciation has grown longer still. But a few additional ones do deserve mention. I would like to thank the US National Science Foundation again for support I received through award number SES-0403847, a project to explore links between the agrifood biotechnology debate and the emerging science of nanotechnology. I would also like to acknowledge Michigan State University and the WK Kellogg Foundation for the support extended through the WK Kellogg Chair in Agricultural, Food and Community Ethics. In addition, I would like to thank the Applied Philosophy group at Wageningen University in the Netherlands for the hospitality they extended to me during my sabbatical visit during 2004, when these revisions were originally begun. Bill Hannah has earned my gratitude for his assistance in compiling the index. Thanks also to Fritz Schmuhl at Springer for support and encouragement. Finally I would like to thank Julie Eckinger, without whom the final completion of the manuscript would have been impossible.

P.B.T.

INTRODUCTION

For nearly 25 years, word of changes in our food has percolated through the press, occupied untold bits of memory in computers on the Internet, and occasionally burst into the nightly television news broadcast. Tomatoes will be modified to ripen slowly and taste better, or perhaps they will be changed to resist frost. Plants will produce their own insecticides. Animals will take many new shapes, and familiar food animals may be used for organ transplants. The changes make their way from academic journal articles to scientific magazines to the science pages of major newspapers. From there the stories go to the front page and finally to editorial pages, as the struggle over regulation and approval takes place. Some of these changes seem miraculous and some seem threatening. Some seem threatening *because* they seem so miraculous. A public wizened to the false promises of chemical and nuclear technology may be less willing to greet these changes warmly.

From the standpoint of a working scientist, or of a policy maker in government or corporate organizations, these changes may not seem so sudden. Researchers who began scientific careers at the dawning of enthusiasm about recombinant DNA and its applicability to food and agriculture have progressed well into middle age. Some of the early leaders in the field are now enjoying retirement. To the scientists who did the work, public suspicion or reluctance to move faster with food biotechnology seems irrational, characteristic more of Ned Lud and of nineteenth century suspicion of Darwin than of any well-founded lessons from the unintended consequences of recent technological developments. Yet it was only within the last half of the last decade of the twentieth century that many products became available, and only the last years of that decade that they were tested in terms of consumer acceptance.

Whichever perspective one takes, there appears to be an ethical issue lurking here somewhere. Is it wise to take this course, and can those who will take it be trusted? Is it fair that decades of hard work should be subjected to the whims of an uninformed and superstitious public? Indeed there have been many calls for a review of ethical issues related to these new developments in human food systems, and many authors have included ethically based reflections among their treatments on food biotechnology. Yet such accounts typically make their philosophical points by implication and innuendo, and almost never lay out the foundations or framing assumptions that shape the key ethical claims. This book is an attempt to advance the quality of debate about the ethical implications of food biotechnology by sketching and evaluating arguments that have been or might be made in developing some of the frequent points on which opinion is divided. It is written for an audience that is already somewhat knowledgeable about agricultural biotechnology and the points that have been contested with respect to its use.

A secondary goal of the book relates to agricultural ethics and the philosophy of technology in general. Agricultural and food biotechnology serves as an extended and generalizable case study in the ethics of applied science and technology. Many of the topics discussed in this book would come up in connection with any technology that poses risk to human health and safety, to animals, to the environment or that has the capacity to induce important social changes in the way that people lead their lives. Since almost all agricultural and food technologies fit this description, this book can be read as a general work in the philosophy of technology, with the techniques of genetic engineering applied to farming and food technologies as an extended object lesson. Some of what follows will be relevant to engineering, energy and information technology. Much of it will be relevant for nanotechnology, which like biotechnology is a somewhat ill-defined cluster of techniques. Like biotechnology, nanotechnology will be very likely to emerge in the form of production technologies, rather than consumer products. Thus it will be "in" and "of" the products consumers buy without actually being something that they actually want. Like biotechnology, nanotechnology has already attracted a cadre of promoters and detractors. And of course, much of what goes here goes also for agricultural technologies of all kinds, including agri-nanotechnology. While other types of technology receive only occasional mention throughout the text, one would hope that a discerning reader will be able to generalize the lessons of biotechnology to the other relevant cases.

Most books on social and ethical issues relating to biotechnology either begin with an extended discussion of the science or confine themselves to biography, storytelling and human drama. Although this book will indeed discuss issues where science matters, the best way to get into the ethics of technology is just to get into it, rather than by engaging in extended preliminary discussion of scientific or philosophical ideas. Readers desiring the "short" version of the book are urged to skip the rest of the introduction, and go right to Chapter 1, then Chapter 11. Readers desiring a more leisurely or detailed tour will still find that they can pick up much of what they may not know about either science or philosophy by thinking about the issues, rather than enduring abstract and theoretical tutelage. A few preliminary points may ward off confusion, or help readers interpret what follows, and the next two sections of the introduction summarize those points. As noted, the general goal is to provide an analytic framework and introduction to the ethical issues that arise in connection with food biotechnology. This suggests two key questions for framing the discussion: (1) What is food biotechnology? (2) What is an ethical issue? Since debate over food biotechnology has been so contentious, it is useful to add a third and somewhat unconventional preliminary, namely a statement of the author's stake in readers' final conclusions on the issues reviewed. Finally, introductions usually summarize the organization of the book, and this one ends by explaining how this revised edition differs from the book that appeared with the same title in 1997.

WHAT IS AGRIFOOD BIOTECHNOLOGY?

The term "food biotechnology" that appears in the title is intended to indicate a number of recent technological innovations for producing and processing food. In fact, many of the technologies covered in this volume are used in agriculture. Agriculture is, of course, one of the key stages in food production. In some quarters agricultural and food technology are seen as discrete domains, but that is not the case in these pages. I will, in fact, use the somewhat awkward term "agrifood biotechnology" more frequently than "food biotechnology," in order to remind readers that the focus covers the entire food system. The technological innovations collectively referred to as biotechnology share an emphasis on cellular and sub-cellular manipulation of the organisms and commodities that make up the human food supply. Biotechnology involves the manipulation of plant, animals or microbial cells through physical, chemical or biological means. These cells are then either grown into whole plants or animals, or they are used in other ways to affect the production, processing and distribution of food. The implicit focus of this book is on relatively recent and controversial manipulations, especially genetic engineering and animal cloning.

There is no universally recognized definition for agrifood biotechnology. Some authors include tissue culture, the process of reproducing a whole plant from just a few cells by manipulating their chemical environment; others do not. By far the most controversial forms of food biotechnology apply recombinant DNA techniques in genetic engineering, inserting genes or other sequences of genetic code from one class of organisms into another. However, some techniques such as genomics and proteomics deploy rDNA techniques in projects that not only do not involve genetic engineering, but may not involve the creation of new organisms, at all. In these branches of biotechnology, the goal is to learn the location and function of genes, an activity that might be used to develop a new food product using genetic engineering, but might also be used in conjunction with more traditional techniques of plant or animal breeding. Most people include techniques for transferring and splitting animal embryos—cloning—as forms of biotechnology. Although cloning is one of the more controversial new biotechnologies, embryonic cloning does not necessarily involve the reorganization of genetic code that is usually associated with genetic engineering. At the risk of seeming indecisive, it is best to leave the definition of food biotechnology somewhat vague.

Biotechnology is thus a large class of techniques and agrifood biotechnology involves the use of these techniques in developing methods and products for the production, processing, distribution and perhaps one day even the preparation and consumption of food. The products of biotechnology include transgenic crops and animals, that is, crops that have been modified using genetic engineering to have genes with useful traits. The most common transgenic crops have been modified to resist damage by common herbicides (e.g. herbicide tolerant crops) or to produce the toxin *bacillus thuringiensis* which kills caterpillars. More discussion on specific products of biotechnology ensues in later chapters. Transgenic crops are often referred to popularly as "GM crops" or "GMOs" (where G = Genetic, M = Modified and O = Organism). Many scientists complain bitterly about this terminology, but I will use it occasionally, especially when the context is one in which consumer attitudes are important. In addition to transgenic crops and animals, some products of biotechnology are particular ingredients or substances (such as rennet, the enzyme that causes milk to turn into cheese) that can be produced by genetically engineered micro-organisms. The focus of the book is food and agricultural biotechnology, rather than medical or industrial biotechnology, but there are a number of products that challenge this boundary. Plants that have been transformed to produce non-food substances provide an example. Are these agricultural plants? They probably are, especially if they will be grown on large acreages, as maize plants transformed to be especially useful for fuel production probably will. But it may be quite important to keep these non-food plants out of the food system (especially if they have been transformed to produce pharmacologically active compounds), and some would object to even including discussion of them in a book on food biotechnology. Again, vagueness seems prudent here, for while the main focus is on food, it may be quite appropriate to discuss some agricultural crops (like cotton or tobacco, for example) that we do not normally think of as food.

This book has been written with a primary audience of scientists, policy makers and well-informed lay readers in mind. One of the challenges is to strike a balance between a vocabulary that is so technical that few lay readers will find it accessible and one that takes such extended detours to define terms that the primary audience begins to suffer from boredom. How much does one need to know about biotechnology, recombinant DNA and molecular biology to undertake an evaluation of the ethical issues that arise in conjunction with food biotechnology? Arguably not much. The opening paragraphs of this introduction provide a fair test of whether one's knowledge of biology is adequate to follow the arguments in the rest of the book. That means that when a phrase like "embryo transfer" appears, the reader should be comfortable with the word "embryo" and should be able to infer that moving embryos from one place to another is under discussion. This is far short of knowing what embryo transfer is, much less how or why it is done, but my suspicion is that more detailed knowledge will often be unnecessary, and will otherwise be available in context.

There may be lay readers who desire a bit more introduction, and in that vein, a few texts can be recommended. The introductory sections to Richard Sherlock and John Morrey's *Ethical Issues in Biotechnology* (2002) are concise, readable and up to date. Older books by David Suzuki and Peter Knudtson (1990) and by Colin Tudge (1993) include excellent (if short) discussions of ethical issues along with hundreds of pages on evolutionary biology, reproduction and molecular genetics. Two books by philosophers tilt the balance in the opposite direction. One is Bernard Rollin's *The Frankenstein Syndrome* (1995), which is discussed at some length in Chapter 4. The other is Michael Reiss and Roger Straughan's *Improving Nature?* (1996). Despite all that has happened in biotechnology over the last decade or more, some of the best introductory discussions were among the first to appear (see Fincham and Ravetz 1991; Gonick and Wheelis 1991; British

Medical Association 1992; Lee 1993). There are also a host of books that came out in connection with the early years of the Human Genome Project attempting to explain the science (see Bishop and Waldholz 1990; Wingerson 1990; Wills 1991), and another round that came out in the wake of debates over adult cell cloning (see National Bioethics Advisory Commission 1997; Kolata 1998). Sometime in the late 1990s, publications intended to inform the public about the basic science of biotechnology migrated to the web as their preferred outlet. Some company websites are quite informative on basic terms and methods. The Monsanto Co. maintains an extensive network of websites, and one developed for science teachers http://www.teachingscience.org/ is especially useful. On the other side of the debate, Genewatch UK http://www.genewatch.org/ is a venerable group that is often cited for the scientific quality of their information. In short, readers desiring a bit of biology are not lacking in opportunity.

Yet in my view these publications, especially those produced by official and semi-official scientific committees, appear to be based on some presumptuous beliefs about the level of biological knowledge needed to understand social and ethical issues. They assume (correctly) that less scientifically informed readers have gaps in their understanding of genes, their role in heredity and evolution, and natural order of living species and they presume that people are wont to fill in those gaps with speculation and misinformation. The uninformed, they worry, may draw on science fiction or Hollywood in constructing their own folk biology, resulting in unnecessary fears, and concerns on the one hand, or unreasonable expectations on the other. The implication is that ability to pass a comprehensive college biology examination is the admission ticket to participation in the social and ethical debate on biotechnology. The recent US debate over "intelligent design" and the teaching of evolution in pre-college classrooms has stoked the science community's concern about public attitudes to new heights.

While one should not underestimate the public's capacity for both unwarranted fear and unwarranted enthusiasm, it is questionable whether anything more than the most basic kind of science literacy is a prerequisite for beginning a discussion of ethical and policy issues in food biotechnology. One should know that scientists do not derive their theories by consulting oracles, of course, and one should have a vocabulary that makes sense of words like "cell," and "molecule." Beyond this high-school science, one should know a few very basic things about genes and genetics. One should know that every cell of every living thing contains a molecule of DNA. One should know that this molecule interacts with its cellular environment to do a lot of work for the organism in which it occurs. The interaction between DNA and environment determines the shape or form of the organism: Are its component molecules organized as a flower, a tree, a rhinoceros or you or me? The interaction regulates many of the organism's life functions: when to grow, when to stop, when to reproduce. In sexually reproducing organisms parts of the DNA from each parent recombine to form a new molecule, which in turn interacts with its environment to form an organism with a unique mix of characteristics from each parent.

DNA itself is made up of four bases: guanine (G), adenine (A) thyanine (T) and cytosine (C). These bases connect with one another to form almost unimaginably long strands that fold and bend in the famous double helix shape. However, it will not be necessary to mention their names again. The sequence of bases in the DNA of any one individual of a given species is roughly similar to that of any other, but there are many small differences—differences that manifest themselves in the different size, shape and color of individual organisms. They explain why the individuals of any species (including humans) exhibit such diverse characteristics at the phenotypic level. The fact that differences at the level of an organism are related to differences in the DNA sequence is extremely important for agriculture because farmers, scientists and commercial companies have long sought plants and animals with certain desirable characteristics that are evident in the phenotype, that is, at the organismal level. They want plants that are well suited to a given climate (that don't bloom too early, or mature too late, for example), or that are especially tasty, or that are visually attractive, or that are easy to process or ship. The list of desirable characteristics is long, and many of these characteristics are related to DNA in complex ways that are not currently understood.

But scientists have learned that some of them are related to a specific sequence of bases within the DNA molecule, and I will refer to such specific sequences as genes. The scientific practice here has changed a bit over 25 years, and it is now more typical for scientific sources to use the word "gene" in a more restricted sense that distinguishes sequences that control or regulate other sequences from sequences that code for RNA and become involved in producing the proteins that carry out cellular functions. Like the names of the base pairs, this is a bit of biological detail that can create barriers between scientific and lay audiences. There may be cases where the distinction between coding and regulatory sequences becomes important, but my practice will be to use the term "gene" somewhat broadly and to specify more narrowly in those contexts where specificity makes a difference.

As has over 25 years become widely known, scientists have developed techniques that allow them to remove genes from plant or animal tissue, and to make many copies of the given sequence in a laboratory environment. They have also developed a variety of techniques for reinserting a gene into the DNA of an organism, and they have learned that they can insert genes derived from one species into the DNA of an organism of an entirely different species. In some instances the possibilities that result from such feats of genetic engineering are mind boggling. For example, fish that tolerate sub-freezing temperatures have a gene that can be copied, and when copies are inserted into plants, they too can tolerate sub-freezing temperature. The great enthusiasm among agricultural and food scientists that has accompanied early discoveries in molecular biology comes from a recognition that these laboratory techniques represent new means to accomplish the gradual alteration of agronomically valuable crops or food animals through plant and animal breeding.

Scientists will regard this as an utterly unexceptional account of what biotechnology is about. The ability to make sense of the above paragraphs presupposes more knowledge of biology than many may possess, but it is far less than what