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DEBATING THE REAL JURASSIC PARK: AGRICULTURAL BIOTECHNOLOGY AS CULTURE

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Introduction: from scientific to public culture

The title of this conference, "When Science Becomes Culture", has an inherent ambiguity. On the one hand, it recognizes that the "two cultures" debate of the 1960s is passé; nowadays scholars discuss *how*, not whether, science permeates the wider culture. On the other hand, by using the verb "becomes", the conference title implies that scientific *culture* arises as a special form or stage of science – as if, for example, scientific research could somehow exist prior to culture.

On the contrary, science always embodies cultural values, albeit in unacknowledged ways. It mediates the values which contend for influence over the wider society. Rather than ask how science becomes culture, let us ask how scientific culture becomes public culture, as various social forces accept or challenge the values implicit in technoscientific "progress".

Such dynamics arise starkly with the "new biotechnology", based upon genetic engineering, a technique which can transfer genetic material across the species barrier. This technical capacity, with its apocalyptic potential, was dramatized in *Jurassic Park*. Unfortunately, the scientific press responded to the film in a narrow-minded way; for example, pedantic articles disputed the technical feasibility of recreating dinosaurs, or patronising commentaries criticized a public preoccupation with imaginary hazards.

Such responses ignored the cultural conflict which the film depicted. As Michael Crichton (1991) explained in his preface to the novel, he intended *Jurassic Park* to highlight the profit-driven forces which are directing biotechnology. The key characters personify contending scientific cultures manifest in the public debate over releasing genetically engineered organisms. For example, the entrepreneur expresses a fantasy of technological omnipotence, whose genetic-level control will grant society the benefits of nature's cornucopia; in contrast, the mathematician disputes both the possibility and safety of imposing total control over living organisms. (Unfortunately the film script downplays the systemic control issues, e.g., by emphasizing employee sabotage as the cause of the raptors' escape.)

In many ways, *Jurassic Park* resonates with wider hopes and fears for the ultimate human control over nature. Behind hypothetical risks and benefits of biotechnology, there lie value conflicts over how nature is being conceptualized and reconstructed. As a Schering Foundation workshop suggested, "conflicts in this area arise from the tension between recognized social values and the unstated values embedded in scientific developments and technical possibilities" (Roy *et al.*, 1991: 321).

What are these implicit values? As I will argue here, biotechnology R&D invests nature with social metaphors drawn from computer codes, industrial efficiency and commerce. In so doing, agricultural biotechnology treats agronomic problems as genetic ones, treats the reconstruction of nature as a discovery, and so reifies its values as properties of genes. Thus it would be misleading to discuss how biotechnology should enter culture – e.g., how it can be communicated, disseminated or controlled – as if biotechnology were not already a particular cultural mode of control over nature and society. This essay will illustrate such dynamics by sketching three related areas of debate around agricultural biotechnology: environmental security, clean technology, and sustainable agriculture.

Environmental insecurity

In the language of the agricultural biotechnology industry, its progress is necessary to protect the common good from environmental insecurities of three kinds: demographic, commercial and pestilential. Let us examine how these insecurities seem to require genetic remedies.

Demographic insecurity

According to the USA's Industrial Biotechnology Association, our society has temporarily proven Malthus wrong, because "the American farmer has adopted science and technology as rapidly as it has become available, allowing farm production to outpace population growth". However, "Our existence is now dependent upon fewer than 20 species of plants; we must use all available resources to assure that [those] species are genetically fit to survive under the wide range of environmental extremes" (Calder, 1991: 71). Now that genetic uniformity has made agriculture more vulnerable to environmental change, the industry now proposes to secure and expand our food supply by fixing the genes.

Such arguments have extended neo-Malthusian ones: that is, agricultural yield must keep pace with the Third World's growing population in order to avert more famines. According to Britain's single largest seeds merchant, ICI Seeds, "biotechnology will be the most reliable and environmentally acceptable way to secure the world's food supplies"; it provides essential tools for "feeding the world" (Pike, 1989).

Moreover, food shortages in the Third World threaten the security of the West. As one publicist argues, "We will need dramatic progress in the productivity of agriculture to limit starvation and the social chaos which over-population will bring..." (Taverne, 1990: 5). In this account, biotechnology will correct the genetic defects which supposedly limit the food supply. Thus, by helping the Third World, the West can protect itself from immigrant hordes and other environmental threats.

Commercial insecurity

When invoking a demographic threat, industry publicists conveniently ignore the increasing appropriation of Third World resources for producing cash crops for export. In their account, the problem instead appears as over-population and inefficient agriculture. A similar diagnosis underlies structural adjustment programmes, which have further dispossessed and impoverished Third World populations.

The promise of increasing food production, much less "feeding the world", is belied by the R&D priorities of the biotechnology industry. Its own house journal, *Agro-Industry Hi-Tech*, chose a subtitle which acknowledges the priority of making biological materials more plastic and interchangeable: that is, the *International Journal for Food, Chemicals, Pharmaceuticals, Cosmetics as Linked to Agriculture Through Advanced Technology*.

In an Editorial (Anon, 1990) the journal emphasized the political context of reduced farm subsidies, which will make productivity less important in the future: "Agriculture is bound to go for more [high] value-added products, better adapted to demand from downstream industry and the consumer. Hence it is going irresistibly towards a global system where contents matter more than quantities". For example, ICI Seeds has made a strategic shift to R&D for low-volume, high value-added products (Dart, 1988).

In our society, what defines "value added"? According to US Tobacco's Vice-President, "value-added genetics determines the processability, nutrition, convenience and quality of our raw materials and food products" (Lawrence, 1988: 32). For example, some biotechnology companies are developing substitutes for crops or materials hitherto imported from Third World countries (Hobbelink, 1991: 93; Walgate, 1990: 57; Panos, 1993: 12-14). If successful, these new products would undermine the livelihoods of entire Third World communities.

In response to political protest, the biotechnology argues against government regulation on socio-economic criteria: "Let there be no illusions: as with any innovative technology, biotechnology will change economic and competitive conditions in the market. Indeed, economic renewal through innovation is the motor force of democratic societies" (SAGB, 1990: 15). Thus industry euphemistically portrays its disruptive power as democratic progress. As competitive conditions demand more flexible investment strategies, "value-added genetics" enhances the capacity to accommodate and aggravate commercial insecurities.

Pestilential insecurity

Another kind of commercial insecurity faces agrochemical companies in particular. As a Du Pont official warns, "society's raised expectations of food safety and the environment have created a ground swell of public resistance to our most costeffective pest control technology – pesticides”. Partly in response to that political threat, some biotechnology R&D seeks more acceptable methods of crop protection.

One line of research attempts to replace agrochemicals with new biopesticides. Biotechnologists can transfer a gene for a toxin to another microbe which will persist longer or target the pest more effectively. They can even combine genes for different toxins in the same microbe, thus killing a broader range of insect pests.

What problem is this solving? Traditional biopesticides had a narrow host range, which limited their commercial potential. Lamented specialist Sheldon Murphy, “It is like a rifle shot rather than a shotgun shot into a pest group” (quoted in Kloppenburg, 1988: 251). Microbial pesticides occupy only about 1% of the pesticide market, the small share being due to their “lack of environmental persistence, narrow host range, limited virulence, and high production costs” (Cook and Granados, 1991: 217).

Those features, which make biopesticides so attractive ecologically, also make them unattractive economically to companies, regardless of whether the products would be attractive to farmers. As the solution, a genetic redesign can make the biopesticide less specific, more persistent and/or more deadly. In those ways, biotechnology may overcome the economic limitations of traditional biopesticides. Thus “value-added genetics” defines the pestilential problem to be overcome.

Clean Technology

Biotechnology is often promoted as a “clean technology”, in the dual sense of offering a precise, natural control. In effect, biotechnologists are reconceptualizing the type of “clean” nature which will make agriculture safe from pests and pollutants. Let us examine the conceptual shift.

From chemical to genetic defence

After World War II, pesticides were celebrated for keeping agriculture “clean” of intruders. Since the 1960s, however, pesticides have been losing both their clean image and agronomic effectiveness. Genetic uniformity leaves crops more vulnerable to pests and disease. Pesticides eliminate the natural predators of pests and/or generates selection pressure for insect pests resistant to the chemicals. Agriculture faces a “chemical treadmill”, needing new pesticides to keep up with new pest resistance.

Despite applying more and newer pesticides, agriculture has suffered even greater crop losses – widely attributed to intensive monoculture methods, which abandoned traditional practices such as crop rotation (e.g. Pimentel, 1989: 70). Meanwhile, extremely little of the pesticide actually reaches target pests. More and more fertilizer is been needed to sustain crop yields, yet fertilizers assist weeds.

Recently agronomists have been acknowledging the limits of overcoming pest problems through better chemicals alone. However, industry now tends to locate the problem within genetic deficiencies, which can be corrected by inserting extra genetic defences into crops or biopesticides (see section 2.3). Emphasizing the selective precision, one biotechnologist notes that genetic modification provides the plant breeder with “more ammunition to help him hit his target”.

This approach is attributed a natural legitimacy. According to the President of Mycogen Corporation, “What is new is our growing ability to simulate nature in ways that can offer enormous benefits” (Calder, 1991: 75; cf. Goodman, 1989: 49). Biotechnology promises us a safer, cleaner version of nature, in at least two senses: through a precision engineering, it replaces chemical with genetic control.

Within agricultural biotechnology, the greatest investment is directed at making crops resistant to herbicides. Their inserted gene protects the crop from broad-spectrum herbicides, which in turn kill all other vegetation. Previously agronomists had to find herbicides which would selectively spare the crop from damage; now the inserted gene provides the selective protection (Dart, 1988: 9). By inserting a gene which offers resistance to a less persistent herbicide, industry can describe the product as cleaner, in the dual sense of combining a precise defence with a less-polluting chemical.

On this basis, herbicide-resistant crops have been celebrated as the ultimate remedy for the problem of weeds resistant to herbicides. Yet some scientists warn that herbicides could weaken the plant’s natural defences to disease and so necessitate other chemical treatments, as some herbicides have already done (Pimentel, 1987). Environmentalists have challenged herbicide-resistant crops for perpetuating dependence upon chemical herbicides (BWG, 1990).

Biotechnological omnipotence

Implicit in biotechnology R&D is a fantasy of biotechnological omnipotence, which would somehow overcome the limits of intensive monoculture, treated as an external problem of unruly nature. In that vein, imagine a "supercrop" which has been genetically modified for resistance to both insect attack and high doses of herbicide. Such an imaginary crop is depicted in a textbook for schoolchildren, sponsored by Britain's Department of Trade and Industry. This exemplifies the claim by an industry publicist: "if we have the imagination and resources, there is almost no biological problem we cannot solve" (Taverne, 1990: 4).

Not merely rhetorical, such fantasy has roots in the conceptual framework of biotechnology: reprogramming nature for total environmental control. In the 1930s, the new science of molecular biology treated genetic material as interchangeable, universal, coded "information"; molecular-level knowledge would permit the ultimate human control over DNA, as the "essence of life" (Yoxen, 1983). This scientific worldview complements current attempts at making organic material interchangeable. With the cell conceptualized as a natural factory, the "factory farm" also becomes more than a metaphor (Krimsky, 1991: 10).

It is claimed that biotechnology enhances natural characteristics – for example, by "giving nature a little nudge towards greater efficiency", according to ICI. Akin to nature, and protective of nature, it provides an enhanced natural efficiency through "environment-friendly products". Thus a new relation to nature is reified as a natural property of products; through a rhetorical greening, biotechnology can be promoted as "clean technology" (Levidow and Tait, 1991; Levidow, 1991).

According to one definition, clean products and processes are "as subtle and precise as natural processes... [and] as sustainable as nature is without human interference". This begs the question of what values are to be sustained by simulating a natural precision – as if the "human interference" could be neutral. In the case of biotechnology, humans reconstruct nature to embody industrial efficiency; it is an attempt at total biosystems control by manipulating a few genetic and/or chemical parameters (Kloppenburg, 1991).

Like the earlier strategy of purely chemical control, this genetic-level control seeks a technological omnipotence over external natural threats, while denying the internal sources of instability from intensive monoculture. Deploying a precise genetic defence, possibly combined with a broad-spectrum chemical offence, biotechnology offers a clean surgical strike against unruly nature.

Sustainable Agriculture

Biotechnology also generates wider controversy over "sustainable agriculture" – over what is to be sustained. While protagonists may argue about how best to sustain food supplies, their conflict also concerns people's relation to each other and to nature.

Genes as chemical bullets

These issues can be illustrated by conflicting strategies for pest control. A traditional biopesticide, *Bt*, has numerous varieties, each of which produces a toxin specific to certain insects. The corresponding genes are being identified and transferred into more persistent organisms, be they other micro-organisms or even plants. Novo Nordisk, a leading company in biopesticides, portrays their surgical precision with the visual metaphor of a green bow-and-arrow, entitled, "Fighting for a better world, naturally".

Regardless of their precision and natural origin, the new biopesticides pose the hazard of generating selection pressure for resistant pests. If such resistance undermines the effectiveness of traditional biopesticides as well as the new one, then it will eliminate a relatively safe alternative to chemicals, as some environmentalists have warned. Diverse scientists have been debating strategies to avoid generating a "genetic treadmill".

For example, farmers could provide untreated refugia (unsprayed plants), so that the less resistant insects survive; and/or they could vary the pesticidal toxin over space and time. These strategies, amenable to integrated pest management, have been proposed by entomologists and endorsed by some industrialists (e.g.

Goodman, 1989). Yet even proponents of the refugia strategy acknowledge great difficulties in designing and implementing it, partly because the necessary measures would impose commercial disadvantages.

At Plant Genetic Systems, recent research has clarified that pest resistance to the different Bt toxins is controlled independently, by different genes (van Rie, 1991). Such knowledge implies that varying the toxin over time could help prevent pest resistance. However, a key researcher there downplays IPM strategies, arguing instead that a strategy of "insecticide mixtures would be more effective", because few insects will be resistant to more than one toxin (ibid.: 179).

In effect, his research treats genes as chemical bullets for a total extermination strategy. For example, biotechnologists develop "cassettes" for inserting several defence genes at once into a plant or micro-organism (Day, 1993: 39). This strategy accommodates commercial pressures for mixing different toxins in the same "product" – in effect, externalizing the agronomic problem as one of pest genetics.

Moreover, a cornucopian perspective regards any one strain as dispensable, because scientists can always find another strain to kill the same pest. According to Jerry Caulder, President of Mycogen Corporation, insects have understandably acquired resistance to the one strain of Bt which has been used for thirty years, but "We have other bullets in the gun we call Bt" (Cutler, 1991). Thus, in various ways, biotechnological research is developing largely within the omnipotence fantasy that guided the chemical pesticide strategy.

Sustaining which values?

Pest-control strategies have a strong bearing upon farmers' knowledge and control. In effect, the term "biodiversity" comes to mean new combinations of special protective genes in crop strains. Formerly, diverse cultivars (and biopesticides) provided a systemic defence against unanticipated pests or disease; these cultivars now become relegated to gene banks for extracting a few magic bullets. One critic has warned that "supercrops" may encourage farmers to buy seed anew each season rather than sow seed harvested from the previous year's crop; the resulting "global monoculture" will become all the more vulnerable to pests and disease (Bill Duesing, quoted in Day, 1993).

Some critics have located these problems in our intensive monocultural system, driven by the imperatives of profitability (Hobbelink, 1991). They counterpose "holistic" methods of crop protection, such as those which have traditionally helped to avoid weeds, pests and disease: "It is widely agreed that systems approaches – for example, crop rotation and other methods – could avoid the need for the majority of pesticides, both chemical and biological, now and into the future" (Mellon, 1991: 67). From that standpoint, "environment-friendly" would mean a different relation to nature, rather than a property of some new product.

In opposing biotechnology, some critics idealize traditional methods as proximate to nature: "The closer a farming system comes to a natural ecosystem, the most likely it is to be sustainable" (Hobbelink, 1991: 140). This model advocates appropriating benign ecological processes for an agricultural system, kept clean of artificial contaminants, such as genetically engineered organisms and synthetic chemicals.

In effect, conflicting strategies can maximize extermination of pests, or minimize selection pressure for resistant pests, or avoid the intensive monocultural methods which attract pests. Each strategy "sustains" a different social role for genetic expertise in relation to other knowledges. Although protagonists may idealize or demonize some version of external nature, these concepts mediate a struggle over values and power.

For example, industry emphasizes how modern pest control methods can reduce farm management time (e.g. Goodman, 1989: 84-86). In contrast, critics foresee laboratory-based commodities sharpening class divisions within agriculture and dispossessing farmers of their skills, which alternative methods could strengthen (Hassebrook, 1989). The social-scientific division of labour is at stake in contending strategies for pest control.

In that vein, a conference workshop queried whether "sustainable agriculture" signifies only an environmental equilibrium or also a way of life (MacDonald, 1989: 20). The question could be extended, by asking how any scientific model of equilibrium tends to favour one way of life over another. In these ways, biotechnology has elicited contending versions of sustainable agriculture; fundamentally at issue is which cultural values shall be sustained.

Conclusion: Which Scientific Culture?

This essay has sketched ways in which biotechnology enters public debate, in three related areas: environmental security, clean technology, and sustainable agriculture. These controversies may appear to politicize an otherwise neutral technology, as it enters a cultural context. However, given that biotechnology R&D already embodies implicit cultural values, the public debate does not lead science to "become" culture. Rather, through the debate, a particular scientific culture contends for influence as public culture. In each area, protagonists dispute how to define the problem for science to solve; in effect, their problem-definitions promote contending versions of nature and human nature.

This account is intended partly as a rejoinder to current attempts at studying and changing "public perceptions" of biotechnology. Although there is much public ignorance of biotechnology, this cannot explain the public concern about it (as acknowledged, for example, by Durant, 1992: 9). In fact, just the opposite may be the case: public knowledge of biotechnology partly explains the opposition.

In that regard, let us consider a British survey of selected social groups on their attitudes toward biotechnology. Of the two most knowledgeable, one group – environmentally concerned technologists – were generally more suspicious of biotechnology and more more likely to trust environmental bodies for reliable information, even more so than did the population generally. The researchers interpreted their results as follows: when members of a cohesive group are presented with a new issue, "they have a ready-made framework within which to conceptualise it"; and any attempt to change that attitude would have implications for the individual's entire attitude system (Martin and Tait, 1992: 39).

If so, then it would be pointless and even patronizing to explain public distrust in terms of a cognitive deficit. As Brian Wynne (1991) argues, an *apparent* "public misunderstanding" may well demonstrate a social understanding of the organizational forms of science – forms of ownership and control which people often distrust, based on past experience. Indeed, the organizational forms may be embedded in its intellectual content, as we can infer from biotechnology's social metaphors (e.g., codes, efficiency, value-added genetics).

By naturalizing its own cultural values, e.g., correcting genetic deficiencies "discovered" in nature, biotechnology tends to pre-empt a wider democratic debate on priorities for knowledge production. Public policy becomes limited to the misleading issue of societal "understanding" and/or "control" over the technology, as if it were not already a value-laden form of knowledge and control. If we want to democratize technological choices, then we could start by analysing the value conflicts in the current debate.

Finally, let us reconsider the title of this conference, "When Science Becomes Culture". Rather than ask, "When does biotechnology become culture?", we should ask, "How does biotechnological culture become public culture?" That is, how does it succeed or fail in imposing its values? How does biotechnology marginalize other scientific cultures, and how do they respond, by promoting different models of nature and society? Amidst this cultural conflict, how do various public responses demonstrate their own "understanding" of biotechnology? By investigating such questions, we may help to de-reify the prevalent version of technoscientific "progress", and thus enhance prospects for democratizating it.

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