Manufacturing Plants:
Notes on the Culture of Nature and the Nature of Culture

Lawrence Busch

The terms "culture" and "nature" have ambiguous meanings in most Western societies. Culture is used to denote the totality of socially transmitted customs and behavior patterns of a given society as well as to denote the cultivation of plants or microorganisms in a petri dish. Nature is used to refer to those aspects of the world that are beyond us as well as to that which is taken for granted as "natural" or normal. This ambiguity is particularly well reflected in current debates about plant biotechnology and germplasm conservation.

The thesis of this paper is that the nature/culture distinction has outlived its usefulness. The new biotechnologies illustrate in the most dramatic of ways how we make and remake nature, while the issues surrounding germplasm conservation show that we have been collectively engaged in making nature for thousands of years. Thus, nature is not natural; it is a product of culture. Put another way, nature is always cultured. Similarly, culture is a product of nature; it is natural in its origins if not in its content.

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Galileo separated the essence of the world — number, shape, size, motion— from its appearance. The former he called the primary qualities and the latter secondary. Primary qualities were found in the world, while secondary qualities were found in language. Of course, Galileo was rejecting peripatetic philosophy. He was trying to awaken his contemporaries to the empirical world that was often obscured by virtual worship of the works of Aristotle (Drake, 1978).

This Galilean separation is still with us today even though many philosophers of science would find it inadequate at best. For example, one scientific text divides quality into two sorts: subjective and objective. Subjective quality "is based on the investigator's opinion,.... Examples include flavor, odor, color, tactile [sic], or texture" (Gould, 1983:196). In contrast, we learn that "Objective quality evaluation is based on observations that exclude the investigator's attitude. As recognized standard scientific tests, they are applicable to any sample of the product or products without reference to its previous

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history or ultimate use. They are representative of modern quality control because the human element is excluded" (1983:197). Similarly, risk analysts distinguish perceived risks, those noted through ordinary experience, from real risks, calculable as statistical probabilities of harm (Zeckhauser and Viscusi, 1990; cf. Thompson, 1990).

This attempt to exclude the human element, and to see nature as it really is, is common to much of the contemporary practice of science and is even shared by some philosophers of science (Nagel, 1979). It is paralleled by a sharp separation between nature and culture. Natural scientists, we are told, study nature, while social scientists study culture. Natural scientists describe a world of facts while social scientists (often) study values that people hold.

The distinction is also manifested in the divisions between and within agriculture and food preparation. Agriculture, we are told, is a rational, scientific enterprise (or at least it ought to be) reserved for males, while home food preparation is an art, and is (largely) the province of women. Agricultural colleges are still staffed largely by men, while colleges of home economics are staffed largely by women (Randolph and Sachs, 1981). Within the Galilean framework, agriculture concerns itself with the primary qualities, the essences of things, while food preparation focuses on appearances, on secondary qualities.

In this paper, I explore the origins and consequences of this division between nature and culture, with special emphasis on food and agriculture. First, I make some observations on the natural sciences. Then, I examine the history of agriculture followed by a parallel history of food. This is followed by a discussion of the problems associated with germplasm conservation. I conclude by asking how food and agriculture might be reunited in a post-Galilean world[1].

Some Thoughts on the Natural Sciences

Science, like all human endeavors, is a social institution. Scientists belong to communities that include not only other scientists but interessees (Radnitzky, 1973) or clients (Busch and Lacy, 1983). To begin, it is useful to conceptualize science, and especially the agricultural sciences, using an "economic" model of science (Busch et al., 1991).

In this model we note that science has both a supply and a demand, but this supply and demand are not always mediated by a market; indeed, they are more often mediated by negotiations, persuasion, and even coercion (Busch, 1980). Consider the supply first. Scientists, at any given point in time, are able to investigate many aspects of nature. For example, wheat breeders might breed for yield, disease resistance, insect resistance, drought tolerance, grain quality, or earliness, to name just a few possibilities. Being mortal, however, they can never investigate all of the possible paths. They must choose between them. There are several ways that a scientist can choose among these multiple goals. For example, he or she can rely on the work of other scientists, do what is easy to do, do what can be done within a particular time frame, do what he or she finds to be interesting, or listen to (potential) clients. Latour (1983, 1984) has noted that Pasteur specificly chose those topics that appeared likely to permit his laboratory to succeed in its work. In addition, Pasteur insisted that farmers using his new anthrax vaccine restructure their barns to look more like his laboratories. Finally, note that the supply of science, unlike the supply of widgets, is heterogeneous and hypothetical. Only after the science has reached its final stages —after it has become material— can a product be said to exist at all.

At the same time, clients have various things or processes that they desire or need. However,

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these are demands for hypothetical products, for things that do not as yet (or may never) exist. These form the "demand" for science and other social changes. Krohn and Schafer (1983) have noted that Justus Liebig developed the entire field of Agricultural Chemistry as a result of societal demands. Agricultural chemistry was to be a chemistry applied to the problems of agriculture, and specifically to the problems of plant nutrition. Of course, not all farmers but only a select few urged the development of agricultural chemistry. The same would doubtless be true of other demands for science as the needs of clients are not (normally) homogeneous. They vary greatly by status, class, ethnicity, region, etc. Moreover, some clients are more articulate than others in expressing their needs or desires. Finally, only a small portion of the needs of clients are addressable through science and technology.

Of course, neither scientists nor their clients are entirely free to make the world over as they please. Both operate within a political economy defined by structures which are themselves subject to negotiation in other contexts. In capitalist societies, as Kautsky noted nearly a century ago, science and business are intimately linked, particularly within the agricultural sector (Banaji, 1980).

In short, nature is literally made or "manufactured" through the efforts of scientists (Knorr-Cetina, 1981) within the structural limitations posed by the larger society. Plants are made shorter or taller, more or less ripe, faster growing, sweeter tasting, more resistant to lodging. Animals are made to produce more milk, to be leaner, to grow faster on a given ration, to be docile when attended by humans. And, raw nature —the wilderness— is made to retreat, is replaced by the manufactured nature that we have produced collectively.

Other creatures also make nature in this way. Birds rearrange dead wood and other objects into nests for their young. Ants build complex underground habitats with miles of tunnels. Bees build hives. But none of these other creatures appear to do it on the scale or in the enormously diverse and systematic ways that are common to human beings. Nor do they appear to do it knowingly. This suggests that the social production of nature is not a new phenomenon, that it has its roots in —but transcends— biology[2]. It also makes it clear that it has not grown out of the natural sciences, much less the new biotechnologies. It is as old as human history. Therefore, to understand its origins, we must turn first to the history of plant improvement.

Historical Perspective on Plant Improvement

We may divide the history of plant improvement[3] into five more or less distinct periods each building on the previous one. The first period was marked by the creation of agriculture. Probably beginning with the clearing of brush from in front of dwellings, people learned that individual seeds could be planted to yield crops (Rindos, 1980). Over the centuries farmers selected seed from the plants with the largest yields of edible parts for replanting the following year, resulting in the hypertrophy of those parts over the centuries (Bannerot, 1986). These selections were based nearly entirely on appearance, on what Galileo called the secondary qualities. All of the crop plants that we eat today were radically changed by this process. Most have been domesticated in the full sense of the word: they cannot exist without human intervention just as we cannot exist without them. To put it another way, we have co-evolved.

The second phase in plant breeding only began in the eighteenth century when commercial plant breeders began to appear. These persons were the first to separate the occupation of breeding from that of farming. However, the techniques they employed were much like those of farmers. Trial and error was widely employed, supplemented by more careful searches for exotic materials,

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something for which most farmers had little time. By the nineteenth century commercial breeding as a separate enterprise was so widespread that Darwin was able to base his theory of natural selection on the domestic selection of breeders (Mulkay, 1979).

The third phase of plant breeding came into being with the so-called rediscovery of Mendel(4) at the turn of the century. Unlike the centuries of breeding that came before it, the Mendelian approach offered the possibility of theoretically guided experiment. Moreover, Mendelian genetics postulated the existence of "factors" (i.e., genes) that could account for the variation displayed to the senses. Put differently, Mendelian genetics posited the existence of primary qualities invisible to the naked eye that created what appeared. Mendelian genetics speeded up the rate of progress in breeding, but it also took the selection process away from farmers. A turn of the century guide to wheat breeding was still able to argue that any farmer could undertake a breeding program (Carleton, 1900). By the 1930s, this was entirely out of the question.

The fourth phase in plant breeding was the development of double-cross hybrids. These cultivars represented another step toward the displacement of secondary with primary qualities. Moreover, while there is considerable dispute over whether hybrids display heterosis (hybrid vigor), these new seeds were of interest to a segment of the plant improvement community for other reasons (Berlan and Lewontin, 1986). In particular, unlike varieties, hybrids would not breed true so the seed of hybrids could not be planted to obtain a crop in the following year. Seed became an input to be purchased off the farm on an annual basis (Kloppenburg, 1988). In the terms used by Goodman, Sorj and Wilkinson (1987), seed production (at least for hybrid crops) was fully appropriated from the farm.

It is important to note that much of this change in the third and fourth periods occurred in the US in the name of efficiency. The Progressive era of the early part of the century brought concerns about efficiency, organization, and productivity to the farm (Hays, 1959). The Country Life Commission, headed by leading agricultural scientists of the day, saw the twin goals of organization and efficiency as the clear path through which rural America would keep up with the rest of the nation (Country Life Commission, 1911). And, with Taylorism rampant in the factories of the nation, American scientists were busily attempting to increase the efficiency of the farm. That the very processes then set into motion would transform the values they wished to maintain went unnoticed by the reformers.

The last decade has been marked by the fifth and final phase of plant improvement: the advent of the new biotechnologies. These new technologies hold within them the potential to transform nature in ways far more profound than ever before (Busch et al., 1991). They hold the promise of even ending farm production entirely and its replacement with off-farm production (Rogoff and Rawlins, 1985). These new technologies mark the final step in the socialization of nature, in the transformation of nature into resources, in the transformation of relations between Man and nature into relations between people and the environment.

Consider the consequences. Each stage in the history of plant improvement has been marked by the social construction of nature. But, at the same time, each stage has been marked by a growing awareness of the very fact of social construction itself. Our remote ancestors filled nature with spirits and gods. Nature was to be feared, because it was populated by evil spirits, because it was to be found outside of the boundaries of the known. Yet, the personifications of nature—that made nature known as that which is unknowable— were entirely the product of human imagination.

With the rise of modern science, and the abandoning of secondary for primary qualities, nature was demythologized. The

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anthropomorphisms used to describe it were removed. At the same time, the goals of knowledge were gradually transformed from understanding to an explicit recognition of control (Leiss, 1972). Nature was to be made more human by removing human imagery from it. It was to be restructured, reshaped, recreated to meet the needs and desires —not to say whims— of human civilizations. Nature was to be viewed as mere resources, as what Heidegger (1977) called "standing reserve," there and available for the taking by whosoever had the power to take and transform them. Each stage in the history of plant improvement marks both the increasing ability to make nature in our own image and the increasing inability to find our image in nature. On the brink of obtaining almost Promethean control over the forms that we shall make nature take, at the moment when nature is more than at any moment ours, we find nothing recognizable in nature.

At the same time, nature is itself replaced almost imperceptibly, by the environment. The transformation in language is revealing since we define nature as the essential or constitutive character of the world. We are a fundamental part of nature and it is a part of us. The environment, on the other hand merely surrounds us. Like a cloak it may be removed and even discarded.

Historical Perspective on Food

The other side of agriculture is food. Much of what is grown in the field is transformed into food products. The ingestion of food occupies a peculiar status in human societies since it involves the entry of foreign matter into the body. If nature was once the unknown, then food represents a fundamental way in which we communicated with that unknown. Food consumption in all societies in not merely a matter of ingesting nutrients, but always a matter laden with symbolism and meaning. The imagery of the Last Supper, of bread and wine, the prohibition against pork in Judaism and Islam, against beef in Hinduism are all part of the complex and varied ways that food permits a communion with nature. Moreover, in non-industrialized societies, food production and consumption are intimately linked; what happens in the fields is inextricably tied to what happens in the kitchen.

Even when it is possible to do so, food is almost never consumed without some sort of transformation. The raw is turned into the cooked not only because cooking aids digestion or makes the food easier to consume, but because cooking removes pollution and enhances purity. What enters the body must first be purified by the ritual of cooking (Levi-Strauss, 1969). Eating, too, required certain rituals to purify further the food and to prepare the body to receive it. Such rituals include washing hands before eating, not using the left hand, saying grace, as so on.

The transformation of food has proceeded alongside that of agriculture, but it has taken several paths. First, agriculture and food have been institutionally separated. Second, certain aspects of food selection and preparation have been removed from the kitchen. Third, the kitchen itself has been transformed so as to make it conform more satisfactorily to the new norms. Let us briefly examine each of these in turn.

Anyone who has ever grown a few vegetables in a small garden and later cooked and eaten them knows the pleasure of eating that which one has produced. Until the eighteenth century virtually everyone had this small pleasure. However, the combined effects of the enclosures, the rapid growth of industry, and the specialization of farmers in the production of just a few commodities began the still ongoing severance of farming and food preparation. It also meant the beginning of the decline of local knowledge of both farming and food preparation. This period should not in any sense be seen as idyllic; nevertheless, it was a time in which craft knowledge was essential. Farmers might be forced to work for others, but the knowledge they had could not be easily appropriated by the ruling

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class. Similarly, people might cook for others but the ruling class would not appropriate the knowledge of cooking itself. This situation endured until about two centuries ago when a significant transition began.

Consumers were gradually distanced from the fresh produce they were accustomed to consuming. First, more and more of what people consumed was purchased in the market. This drastically reduced the purchaser's knowledge of the origins of the foods. However, it was still possible to rely on direct observation to discern the quality of the food to be purchased. Later, as canned and frozen foods were introduced, it became much less clear just what was being purchased. Contents labelling replaced visual inspection and although pictures were often printed on the labels, the actual contents frequently was of considerably lower quality than the contents. Government agencies were established to insure that what was in the package was accurately described on the outside, and that minimal health and safety precautions were followed.

However, the ingredients of packages remained relatively comprehensible to consumers. Only a few preservatives whose origin was unknown to consumers were included in processed foods. Thus, food remained both comprehensible—fitted within the generally accepted categories of experience as ingredients —and apprehensible—immediately recognizable as a known substance. A few ingredients did begin to appear that were not apprehensible (e.g., BHT) and probably incomprehensible to most consumers.

The next phase in the transformation of food occurred with the shifting of the grounds of discourse away from ingredients to nutrients. Under the new regime, nutrients were to be listed as to quantity (in the United States always in grams while packages are in English measure) and percent of recommended daily allowances (RDAs). In contrast, ingredients were merely to be listed on packages in descending order by weight. The introduction of nutrient labelling and the gradual downplaying of ingredients moved the discourse to "things" that are clearly non-apprehensible (e.g., carbohydrates) and perhaps incomprehensible to most consumers. Put differently, the primary qualities were gradually allowed to take precedence over the secondary ones. As a result, instead of choosing foods from a limited number of food groups, consumers were faced with the much more complex (and more mystifying) task of choosing foods based on nutrient content and contribution to RDAs.

The final stage in the transformation of food occurs when the product is reconstituted in such a way that it is no longer comprehensible. This is occurring in two ways that, so to speak, operate from different ends but arrive at a central point where they join together. On the one hand, the creation of fabricated foods treats agricultural products as raw materials to be used in the manufacture of food products. As one proponent of fabricated foods puts it, these foods "differ from conventional foods in that their basic components—proteins, fats, and carbohydrates—may be derived from many sources and combined, along with necessary micronutrients, flavors, and colors, to form an alternative product" (Stanley, 1986:65). Of particular note here is that the products created this way and offered to consumers would not have to resemble, even superficially, existing food products, although for reasons of advertizing, companies might well prefer to give them recognizable form. Such recognition would be only superficial, somewhat like the plastic food items displayed in Tokyo restaurant windows. In other words, the **appearance** would give no clue as to the contents of the product. The Galilean distinction between primary and secondary qualities would finally hold since the secondary qualities would have been rendered truly illusory!

At the same time, the use of biotechnology to

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transform plants and animals will make possible the creation of "functional attribute crops" that are particularly amenable to food fabrication. Such crops would be designed by incorporating genetic materials from other organisms (and perhaps eventually wholly new organisms?) so as to maximize or optimize the production of wanted nutrients and chemicals. The two would meet where biotechnology was used to produce new foods that truly are "without reference to ... previous history," and that require little or no transformation after they are grown in order to be sold to consumers. Such foods might even be advertised as "natural."

However, this is only a part of what is happening. Two other phenomena are of great importance here. First, the continued differentiation of food products has led to bewilderment in the supermarket. No consumer, no matter how well educated, can possibly afford the time to make rational choices amongst the 30,000 or more items on supermarket shelves. Moreover, that number is growing daily at a phenomenal rate. Thus, the knowledge of appearances that guided food preparation for millenia is being (not so gradually) eroded by the restructuring of the food industry. At the same time, the local knowledge of secondary qualities that consumers have is being replaced with scientific knowledge of primary qualities in a kind of self-fulfilling prophecy: As the food system becomes more and more complex, local knowledge of taste, texture, color, and flavor become less and less meaningful. The beautiful round red tomato may be all but inedible. No longer can freshness be judged by direct observation; foods in sealed containers can only be judged fresh according to dating systems that are themselves the product of lengthy and continued negotiation. Similarly, no longer can one casually glance at foods and determine something about their nutritional value. Food becomes merely a simulation fabricated by the food companies in the name of nutrition! And, as Baudrillard (1983) has suggested, there may be nothing at all behind the simulation.

Moreover, the same quest for efficiency and organization that transformed farming, also transformed the kitchen. In particular, the appropriation and substitution that Goodman, Sorj, and Wilkinson (1987) note on the farm also occurred in the kitchen. Paradigmatic of these changes is the work of Fanny Farmer. Until that and other similar cookbooks were published in the late nineteenth century, cooking proceeded by guesswork and practical experience. A pinch of salt or a dash of pepper, a measure of flour or a spoonful of sugar were the commonly used ingredients in food. Fanny Farmer introduced standard weights and measures into cooking transforming it from an art into a science. This simplified greatly the task of learning to cook, but it also removed the source of knowledge about cooking from older generations to the cookbook writers. Moreover, it required not merely that one follow the recipes but that one reorganize the kitchen around the new recipes. New measuring devices had to be purchased, new rules had to be learned, new procedures had to be employed.

Concomitant with the changes in recipes was the move to create efficiency in the kitchen by redesigning it, by reducing the number of steps one had to walk, by standardizing the heights of countertops, the construction of stoves, the design of tables (Giedion, 1975). The open hearth would be replaced by the wood, coal, and later electric or gas stove.

While it is self-evident that the changes noted above have occurred, it is not yet clear just why they occurred. In order to answer that question, we need to pose two others: We need to know how the world was won and we need to know how the world was (made) one.

How the World was won: Botany and Colonialism

The explorations of Columbus and others in the 15th and 16th century marked a turning point

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in world history. Not only were empires built; botanical exchanges of enormous magnitude transformed agriculture and food preparation and even whole ecosystems.

The botanical gardens were the first line of offense in the development of colonial empires (Brockway, 1979). By establishing the gardens, European nation states were able to transfer systematically plant materials from one habitat to another. In the tropical colonies, where most temperate crops did poorly, industrial crops replaced food crops. Rubber was taken from Brazil to establish plantations in Malaya. Tea was taken from China to establish plantations in India and Ceylon. Coffee was removed from Ethiopia to found plantations in Brazil and elsewhere in Latin America. Cocoa was introduced in Ghana and the Ivory Coast. Oil palm and coconut palm plantations were established in numerous colonies. In smaller areas spice plantations were established along similar lines. These changes had the combined effect of removing millions of peasants from the direct production of their own subsistence and facilitating or forcing their entry into the global economy. Moreover, it had the simultaneous effect of devaluing the knowledge of farmers (made useless by the change of crops) and splitting the procurement and preparation of food for the household from the process of farming. From that time forward in the tropics, food and agriculture would begin to be divorced.

A different tactic was taken with respect to the temperate colonies. There, cultivated plants and animals from Europe were introduced, replacing much or all of the native ecosystems with European crops. This process was so profound that Crosby (1986) has used the term "neo-Europes" to describe these areas. In these areas, Western farmers developed more and more specialized farms in which production and consumption were fully separated and in which scientific principles triumphed over local knowledge, in which primary qualities appeared to reveal the inaccuracy and inadequacy of secondary qualities.

The two strategies had the combined effect of restructuring nature along Western lines. In the Neo-Europes Western crops, livestock, and even weeds and pests replaced the traditional agriculture and even eliminated many wild species. In the tropics where Western crops would not grow, the form of Western agriculture could be introduced. Fields henceforth had straight rows and rectangular shape. Animal traction was introduced where it was not used previously. Monocultures replaced polycultures. Nature would be poured into the mold supplied by the west, and more often than not the locals were poured into that mold as well (Goonatilake, 1982a). For example, a century ago one Belgian agronomist, Edmond Leplae, encouraged the forced growing of cotton in the newly founded colony of Congo. Jules Cornet (1965:138), in an apologia for the now defunct Belgian research service, INEAC, quotes Leplae approvingly:

> In a very backward country, the temporary use of obligatory crops is often necessary in order to insure for the indigenous population regular and sufficient nourishment and to introduce export crops, which will be the principal sources of prosperity and well-being for the natives (my translation).

Nevertheless, the colonization of the world was not sufficient to create the uniformity that now is a threat to world agriculture. Nor was it sufficient to create the divorce between food and agriculture that is now visible on a world scale. That would await the development of high yielding varieties in the 20th century.

How the World Was (Made) One: High Yielding Varieties

If the colonial restructuring of agriculture won the world for the European powers, it hardly

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made the world one. The uniformity it produced involved the increasing dependence on a small number of crops but within each crop great variety existed. However, the changes in the world food order during this century fundamentally changed the within-species variance of planted crops by limiting production to a small number of high-yielding cultivars. This was done first in the US in the 1930s with the development of hybrid corn and then later in the developing nations with the Green Revolution varieties of wheat and rice. The net effect was to reduce variation in the field —among both cultivars and farmers— to a precipitous degree.

The net effects of these changes has been to create two crises: a crisis in the fields as agricultural production is haunted by the twin dangers of genetic vulnerability and genetic uniformity, and a crisis in the kitchen as members of households (now in their relatively new roles as consumers) lose control over what they eat and the meanings associated with it.

Conclusions: Manufacturing Plants

We are now on the verge of yet another set of major changes in the nature of what we grow, what we eat, and consequently who we are. However, unlike the previous changes described above that were introduced without much reflexive thought as to their consequences, we have a set of choices open to us. The new biotechnologies can be used to manufacture plants in manufacturing plants (Rogoff and Rawlins, 1985). Or they can be used to reunite food and agriculture in a new way. Let me note what I am not proposing first: There is no way that biotechnology can provide us with a technical fix, a simple way out of the current dilemmas that confront us. Nor can we say that biotechnology represents technology out of control; technology is only out of control if a factory explodes or a vat leaks. Otherwise, technology is always under the control of someone or some organization. On the other hand, the new biotechnologies confront us with a rather awesome question: What kind of nature do we want?[5] If we can answer that question collectively, then we can ask what kind of biotechnologies might be useful in helping us to achieve that kind of nature. But we may go further yet: Since the way that we treat nature is indicative —no, an essential part— of the way in which we treat each other, the nature we want must be one that is humane, caring, and befitting of ourselves as moral beings. This, I submit, we can only accomplish by reuniting food and agriculture once more. Moreover, this cannot be done through some mass return to the land as we have already come too far. It will require instead that we develop new institutional mechanisms to link food and agriculture, institutions that allow us to show our care for each other through our reverence for nature. The need for these institutions is manifested every time that someone looks into a petri dish and sees a new form of culture. The form that culture takes will reveal something about both the cells in the dish and us, for in the final analysis there is no way to separate our cultural evolution from theirs.

In sum, we may need to undo the legacy of Galileo. We may need to recapture the appearances (Barfield. 1965), to revision the world as one in which we co-evolve with other organisms as part of nature. Ironically, this is an old idea that is embedded in many traditional religions around the world. We have spent much of the last 300 years attempting to wipe it from our collective memories. Yet, it still remains in the faces of farmers in the so-called marginal areas of the earth. We need to learn from them what we have forgotten, we need to find and reflect on the appearances (Kass, 1985), because without the appearances, the world begins to lose its meaning and we find ourselves drawn into the abyss. Perhaps Galileo would have done well to

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heed the Zen proverb:

> For the man who is ignorant, trees are trees, waters are waters and mountains are mountains. When that man gains understanding, then trees are not trees, waters are not waters, mountains are not mountains. And when, at last, he attains wisdom, then once again, trees are trees, waters are waters, and mountains are mountains.

Notes:

1. I do not to argue that such a reunification is the "true" way to see the world. In contrast, I do belive that it is a better way. Moreover, as with all positions of this type, its betterness will only be verified by the development of a new consensus.

2. Admittedly, the degree to wich other animals make nature is a speculative topic. It appears that making requires some understanding of the significance of what is being made. If so, then it would appear that most other animals have relatively little consciousness and do they do instinctively. However, see Waddington (1971).

3. As the discussion above suggests, what counts as an improvement is itself the subject of negotiation amongst various parties.

4. The discovery of Mendel suggests that many people in the hybrydist camp knew of the relationship that Mendel had so carefully documented. However, they also knew that they only held for certain characters such as those chosen by Mendel for his experiments. Other characters appeared to occur randomly. In addition, Mendel's work shed light on a debate over continous versus discontinous variation that did not even exist in 1865 (Brannigan, 1981).

5. This is not to say that we have capability of deciding precisely what kind of nature we want. This, too, would bee a naive form of technological utopism. But we can — perhaps, must— decide in what general direction to go, or risk destroying the nature of wich we are a part.

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RESUMEN

INDUSTRIALIZANDO EL CULTIVO:
Notas sobre la cultura de la naturaleza y la naturaleza de la cultura.

Los términos "cultura" y "naturaleza" tienen significados ambigüos en la mayoría de las sociedades occidentales. El de Cultura es utilizado para denotar el conjunto de costumbres y patrones de comportamiento que tienen las sociedades. Asimismo, también significa el cultivo de plantas o de microorganismos en una cápsula de Pietri. El de Naturaleza es utilizado para designar aquellos aspectos del mundo que nos rodean, así como también, para dar por sentado lo que es normal o "natural". Esta ambigüedad está particularmente bien reflejada en los actuales debates sobre la siembra biotecnológica y la conservación de plasma germinal. La tesis de este artículo es que la utilidad de la distinción naturaleza cultura ha terminado. Las nuevas biotecnologías ilustran, a través de las más dramáticas vías, cómo nos apropiamos y rehacemos la naturaleza, mientras miramos los beneficios de la conservación del plasma germinal comprometiendo colectivamente lo que la naturaleza ha hecho en miles de años. De este modo, la naturaleza ya no es natural; ella es un producto de la cultura. Por otro lado, la naturaleza es también culturizada. Similarmente, la cultura es un producto de la naturaleza; ella es naturaleza en sus origen pero no en su contenido.

Lawrence Busch es profesor de Sociología de la Universidad Estatal de Michigan. Es coautor del reciente libro: ***Plants, Power, and Profit: Social, Economic and Ethical Consequences of the New Bieotechnologies*** *(Oxford: Basil Blackwell, 1991). Actualmente está trabajando sobre los problemas asociados a la conservación del plasma germinal en distintas naciones y sobre la reestructuración técnica de los subsectores de la producción agrícola.*

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