Agriculture Biotechnology: Social Implications and Integration of Landscape and Lifescape

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Humankind has long attempted to select from nature those characteristics within different species that most seemed to meet their needs, both as consumers and producers. Traditionally, this has been done through breeding programs, limited only by the laws of genetics and the life cycle period of the plant, animal, or bacteria in question. Those traits selected were sometimes based on characteristics desired by end-users and sometimes on agronomic characteristics desired by producers. Choices were made on desired expressed traits, often unknowingly associated with other traits. For example, docility and human bonding in foxes, when selectively chosen, resulted in floppy ears and curly tails.

The beginning of agriculture was the beginning of selecting plants for human-desired characteristics. The desires of the producer and end-user were identical since the producer and end-user households were usually the same. Women, the end users of potatoes, still select seed potatoes in parts of the Andes to take with them as part of the dowry they bring to a marriage partnership. Over time, as selection moved from the farm household to off-farm commercial firms, many links were inserted in the chain between producers and end-users. And when biotechnology permitted desired traits to be transferred from one species to another, the agronomic characteristics sought by those who made decisions about inputs — farm owners, farm managers, and crop consultants — were usually unrelated to characteristics sought by end-users. An end-user orientation includes processors, distributors, consumers, and citizens. End-users may look at both intended and unintended traits embodied in the biotechnology, thus raising issues quite different than the concerns of producer decision-makers.

Globalization and Consolidation

Decisions regarding the development and distribution of biotechnology are taking place in the context of a number of important changes in the market, the state, and civil society. The key trends in the market are globalization and industrialization. Decentralization, or devolution, and privatization are key trends in governments worldwide. Polarization and engagement are key trends in civil society.

Globalization, as it is currently configured, is the result of 30 years of removing international barriers. The first 15 years, between 1973 and 1988, were spent removing the barriers to international capital flow. The next 15 years into the present were spent lowering the barriers to the international flow of goods and services. Decreased barriers led to increased competition. Increased competition has lowered profit margins, particularly for undifferentiated commodities, including but not limited to agricultural commodities. Lower profit margins, in turn, have led to the consolidation of many firms throughout the economy. It has only recently impacted agricultural input suppliers and distributors. Now the agriculture input industry, as in most other areas of commerce, is controlled by a very small number of international firms. The recent push toward consolidation, as seen in financial services, telecommunications, and automobiles, is also occurring in biotechnology, food processing, and distribution. This has been accompanied by a sense of insecurity on the part of many individuals and companies.

Concomitant, but independent from globalization and its impacts, is industrialization. Industrialization is a response to increased competition and lower profit margins. An important aspect of post-Fordist industrialization is producing a differentiated product, rather than an undifferentiated commodity. Moving from commodities to products is first coming up with something unique that has more than one characteristic. When farmers purchase Bt corn or Roundup Ready® soybeans, they are buying a product, not a commodity. The major selling feature of both these products is that farmers can produce the same amount for less labor. Farmers have bought the differentiated product (biotechnology engineered seed) to produce an undifferentiated commodity (corn, canola, or soybeans). Debate swirls on whether it is to be differentiated or not. What are the options for segregation? For labeling? Unfortunately, at this point in market history, differentiating harvested of biotechnology crops decreases their value in the market place.

Commodities are generally sold based on weight or volume and sometimes based on one other characteristic, such as protein content, percent butterfat, or grade for meat products. Quality may provide a floor (for example, in wheat percent protein and the filth standard), but the multiple characteristics are merged at the grain elevator.

Industrialization is now decreasing the links in the value chain between producers and end-users, which then enables the product to more nearly meet

the needs of the end-users, commanding a market place advantage. Reducing the links in the value chain is viewed in many industries as providing for more complete information flow up and down the chain, and enhancing product development. In agriculture, reducing links in the value chain has traditionally been viewed as reducing transaction costs of getting commodities to market, not a mechanism to improve the product.

Industrialization allows for capital to accumulate when there is a separation of management from ownership. This first occurred in industry with the publicly held companies and the stock exchange, where owners were very uninterested in what took place on the factory floor and very interested in the value of their stocks and the quarterly profits. Thus, management's job was to meet these two goals of the owners.

This is increasingly happening in agriculture, as fewer and fewer owners are operators. Corporations do not own most land. City-dwelling heirs of farmers and ex-farmers own land. Their bond to the land increasingly is the “wheat check.”

With industrialization there is a decreasing number of core firms and an increasing number of outsourcers. The value chain becomes consolidated, and risk is pushed out to various outsourcers. This is illustrated in contract broiler production, and is emerging in some forms of hog production. The core firms choose not to use their capital to buy the capital equipment needed for production or to employ the workers and managers who grow animal protein. Instead, outsourcing (more sophisticated version of the putting out system, a way of producing before the industrial revolution), is now increasingly a part of an industrial economy.

DECENTRALIZATION

As the market centralizes, governments are decentralizing. More responsibility is going to the local level. Devolution, as this decentralization is called, is based on the principle of subsidiary: a decision should be made at the lowest possible level. Presumably, the people on the ground know the “needs” of the local population and are in the best position to mobilize the resources to meet those needs. One of the goals is to help re-legitimize the state as a social actor, to increase citizen's trust in government.

However, if this principle is not accommodated by a strong policy of democratization, it often means that local elites regain power they may have lost when federal governments demanded that excluded people become part of the local processes, from attending schools to access to credit. We have seen this in farm programs in terms of who has been able to profit by them. Thus, when democratization is not present, de-legitimization of the state is increased by decentralization. Already excluded populations view local powers as neither just nor effective.

Even with high degrees of democracy at the local level, resources often do not accompany the shift of governmental responsibility from federal to state and state to local. The famous unfunded mandate continues on, particularly by states to localities, despite rhetoric to the contrary. Federal and state governments are moving from decisions based in-part on equity to decisions based on efficiency.

Privatization is the logical result of moving from decisions based on efficiency. There is a strong belief in the U.S. that the private sector is more efficient than the public sector, despite some stunning counter examples, such as the failure of the savings and loans in the 1980s.

Across the world we see a movement away from government supported extension services. The government in the past often took the risk in introducing new technology. Extension agents gave away hybrid seed, now a private sector function. They also performed artificial insemination, which likewise has moved to private business. In terms of agricultural technology, extension is increasingly a wholesaler, working with dealers and custom operators, licensing them to apply a variety of technologies that they, in turn, can sell for a profit. This does increase the efficiency of extension, but not necessarily its legitimacy with the tax-paying public.

The move from government oversight to self-regulation is a product of the privatization trend. If there is still some government oversight, serving the public good at lower private cost can be achieved. Hazard Analysis Critical Control Point (HACCP) is a potential example of such a shift. It hopes to move from federal meat inspectors looking at each animal (extremely quickly) to HACCP outcome standards, looking at the entire process. We are moving from design standards, where one is told how to design something that will presumably give required results, to performance standards, which allows company management to determine the best way to meet food safety or pollution reduction guidelines. The move from design to results standards has been extremely effective in the industrial sector, reducing industrial emissions much faster than anticipated. In agriculture, we still seem to spend a lot of time on Best Management Practices (BMPs), with little attention to monitoring environmental performance in terms of ecosystem health.

In civil society, polarization, accompanied in some cases by social conflict, is partially due to the increasing diversity of income, ethnicity, and worldviews coupled with a decreasing ability to deal with difference. As a result, single-issue political mobilization is high. At the local level, the “bums” are thrown out over a single issue, and the reformers are only interested in changing that single issue. They know little else about general governance and the increasing responsibilities that are falling on the local level.

In terms of engagement, we are observing an increasing willingness to be involved where one makes a difference. Thus, while membership in traditional organizations may be decreasing (Putnam 1995), involvement in specific

community activities, such as constructing a playground, is increasing dramatically. Engagement means the formation of flexible information and action networks as one set of individuals or associations get together to address one opportunity and re-forms with different configurations for another. Information sharing becomes an important part of this engagement, as cooperation links the civil society and the market.

Further, there is multiple community activism, with individuals often linked to the new information technology being active on local, state, regional, national, and international stages, bringing those various communities of interest together in new ways.

Biotechnology is embedded in all these trends. As a result of biotechnology, we now have products that agricultural producers value such as increased productivity, as found in BST (Bovine Somatotropin) in milk production and PST (Porcine Somatotropin) in swine production. We also have crops such as corn, canola, soybeans, and cotton with engineered genes that make them resistant to insect pests or to herbicides that kill weeds but not the herbicide tolerant crop. All of these characteristics make it possible for farmers to produce more at the same reduced costs — a situation presumably of great interest to the individual producer but of potential great harm to producers in general. Prices go down as supply goes up.

Many farmers have been convinced by the fallacious equation that the amount of food produced should be a function of the number of people inhabiting the globe. Neither the fact that almost all the countries with a high level of child malnutrition have food surpluses nor falling prices have deterred U.S. farmers from using biotechnology-produced production enhancement tools.

What are the factors that influence acceptance or non-acceptance of particular technologies, especially those that are bio-engineered? Should we automatically accept new biotechnology as a social good? Or should we immediately stop the use of products derived from biotechnology? Neither stand is defensible nor has a sound social science rationale. It is important to look at the roles of the different actors in the producer-end-user equations and the levels of motivations they have for the choices they make. It is important to consider the human element as both consumers and citizens, and look at the different ways civil society interacts with the market and the state that are related to the current and future status of biotechnology.

GROWER MOTIVATION TO ADOPT OR OPPOSE BIOTECHNOLOGY

Motivation to use technology is related to a large number of factors that are layered in social structures and often ignored in the neo-liberal assumption of the rationale economic actor for whom the market only fails when there is incomplete information. In fact, behavior is determined and influenced by a number of mechanisms of social control, which involves both positive and negative factions.

INTERNALIZATION

The first and best mechanism is internalization. Somebody wants to do something and knows how to do it. For example, entrepreneurial farmers (Salamon et al. 1997) who have traditionally been technology innovators, who are known within the community to be the first with the latest, are very likely to adopt biotechnology, just as they have embraced a number of emerging tools/inputs.

Adoption of biotechnology for such entrepreneurial farmers is simply being an innovator. And when technology adoption reduces the application of other technologies (herbicides or insecticides), buying the first round of biotechnology inputs seems self-evident. The system changes that are required — planting conventional crops on 30 percent of the acreage as a bioreserve for Bt corn — obviously decreases average bushels per acre and is counter intuitive. Maybe the farmer will do it next year, when prices are higher — or lower.

Agricultural biotechnology in widespread use today has been designed to be a rather blunt instrument, so as to do just one thing broadly. It is like a simple input substitution for many of these farmers, rather than a systems change. While deeply depressed farm prices may marginally keep inflation in check, most consumers do not identify increasing production as a personally desirable product of biotechnology. This is particularly true when the media documents farm failures as the result of overproduction and low prices and when there is implementation of huge government payments to grain farmers despite the presumed market orientation of the 1996 Freedom to Farm bill.

Despite the concerns about creating refuges when using Bt seeds to control insect pests, there is little evidence that farmers are actually putting in these reserves — or at least to the 30 percent of corn acreage recommended by the North Central research team examining this issue. Studies now underway in Canada suggest that farmers, beset by low prices, are ignoring the reserve label instructions and planting all their land to Bt corn in an attempt to reap enough short term profit to remain in farming.

Internalization also involves another group of farmers — farmers who are suspicious of altering nature, particularly moving genes between species. These are farmers who follow the precautionary principle and want some long-term evidence that it will do no harm, and feel that increased productivity generally results in lower prices and increased marginalization of the farm population. Internationalization in both these cases involves basic values and how people define themselves by what they do.

SOCIAL PRESSURE

When internalization is not in place, social pressure helps reinforce particular behaviors. You gain prestige by being the first with the newest, or you know you ought to adopt it because “people like us do this kind of adoption.” On the other hand, there are those same numbers of people who know they should

not adopt it because of the generalized potential of negative environmental or social affects.

Social pressure can also provide negative sanctions. One example is being laughed at by being too innovative too soon. One loses respect if one does something that results in severe environmental damage. The monarch butterfly effect, first reported in Cornell University laboratories (*Science* 1999) and replicated on Iowa State University experiment stations (Hanson and Obryck 1999) if viewed as credible could increase community level negative social pressure. Civil society, through schools, churches, the family, and other formal and informal groups, provides internalization and social pressure.

ECONOMIC SANCTIONS

If social pressure doesn't work, economic sanctions are brought into play. Both the market and the state provide these economic sanctions. With biotechnology, the positive market economic inducement has been "produce more units, lower cost per unit" and perhaps we'll have new markets. New markets have been provided for seed companies by biotechnology characteristics that are agronomic and thus, producer-oriented. For those producing the commodity, new markets are to emerge due to increased production (cheaper price will increase "our" market share) rather than a new market because of a new product.

Negative economic sanctions include being fined (generally state imposed) or losing a sale (generally market imposed). A grower might be fined if there were actual inspections to determine if reserves are in place according to the "label" on the genetically modified (GM) seed. Both Staley and Acher Daniel Midlands (Brinkman 1999) have recently said that they are not accepting any more Bt corn. This is a definite negative sanction that discourages planting Bt corn.

FORCE

In general, force is only brought into play if none of the other levels of social control work. For example, land near public parks might be zoned as "genetically modified organism free" (GMO-free) in order to protect biodiversity that would occur from pollen drift and out-breeding.

Negative sanctions include physical punishment or imprisonment. These are carried out by the state. In some communities activist opponents have destroyed genetically modified field crops by uprooting them. This is legitimate use of force.

END-USER MOTIVATION TO USE OR REJECT BIOTECHNOLOGY PRODUCTS

Motivation for end-users to either accept or reject GMOs can be seen in the same way. Few biotechnology innovations that are consumer oriented, such as the FlavrSavr™ tomato, have reached the market to date. However, it is useful to look at end-user motivations, the different levels at which they occur, and

to understand the impact of the end-users on biotechnology adoption. Like producers, they have positive and negative sanctions and, like producers, the best sanctions work through internalization.

Some consumers want to try innovative things. Their identity comes from innovation. They believe in science and the governmental mechanisms to protect consumers believing that if it were bad for people or the environment, they (scientists and government officials) wouldn't put it on the market. But, particularly in Europe, where science and government are thought to be ineffectual or even corrupt in enforcing environmental and safety standards, that type of acceptance — it's good for me because they tell me it is — is low. In countries such as Denmark and the Netherlands, where there is greater transparency and participation in food safety and environmental standard setting and enforcement, there is greater trust of the quality and environmental sustainability of food.

Core Values

There are another set of consumers who are cautious about food innovation based on core values of naturalness, concern for the environment, desire for choice, and health concerns (Barling, et al. 1999). First generation GM crops used antibiotic resistance marker genes providing resistance to herbicides (with the fear that it would cross over to weeds) or insect resistance (with the fear that resistant strains would develop and that other insects would be killed, decreasing biodiversity). Many consumers did not feel they gained any benefit from such characteristics — and indeed saw definite risk involved. The general response by industry and university was to state that they did not understand the science involved, thereby heightening opposition.

A variety of surveys have shown that up to 75 percent of the U.S. population identify themselves as environmentalists. When they see that this identity can be reinforced, they look at what they eat. This may be a growing internalization that could influence the utilization of bio-engineered products. Of course, since products are currently not labeled, many people are eating GM crops without knowing it.

Social pressure and economic sanctions

Social pressure also affects consumers. You gain prestige from consuming certain things and thus, one "ought" to do it. Consumers can also be laughed at and lose respect. As consumers, we are increasingly gaining identity in society by what we consume. Some of that identity comes not only from brand and style of sports footwear, but also from what we eat.

When these forms of social control are not effective or are too effective, economic sanctions come into play. These sanctions can include giving lower prices to distributors and providing new markets. The economic costs can be fines to a distributor, for example, who has included some genetically modified

crops in a shipment to Europe. However, because price, an external motivator imposed by the market, must balance the internal motivators provided by civil society, price is not always an effective motivator. A series of studies of consumer behavior demonstrate that people will pay more for a product viewed as environmentally friendly or more humane. Not all consumers have internalized values or have social groups who want to protect the environment or protect animal welfare, but enough do to suggest providing a choice pays. The extra cost of segregating by the way something is produced is thus borne by the consumer.

FORCE

Then there is force. It is almost impossible to eat any processed food today that does not contain a product from a GM crop, most likely from soybeans or corn. For consumers who want to have a choice, this is akin to being forced to participate in a production and consumption process that goes against some cherished values. It can be viewed as a positive form of force. These motivations can affect capital, which are resources to invest in new resources, particularly within society. Capital markets are maintained by contracts. Currently there is a change in the social contract between the supplier of biotechnology and the producer. This is a change from the way farmers have purchased inputs in the past and what was implicit in that sale to what is implicit, and sometimes explicit, in the sale and purchase of biotechnology products.

Biotechnology increases the importance of intellectual property rights. Part of the consolidation in the biotechnology industries occurred because it is cheaper to buy a company than to purchase a license for the technology. The purchasers of GM seeds may not replant or sell to neighbors for planting. The old “brown bag” policy of the producer being able to keep seed for use or sale is now being rigorously prohibited with news and rumors of Pinkerton agents checking to see whether farmers have resown Roundup Ready® soybeans without making the actual purchases. New information systems that link together the inputs farmers buy and circulate them to manufacturers and dealers make it easier to determine which farm enterprises might be seed savers, thereby infringing on the intellectual property rights of the seed supplier. This limited property right is a new impingement on what farmers took to be the social contract between them and their seed suppliers.

Animal welfare consequences, particularly in response to some of the productivity enhancing hormones, are being increasingly revealed. There are many consumers who are willing to pay more if they know that animals have been treated well. Since animal longevity is not a characteristic sought by most animal producers these days, the signs of premature aging as a result of growth enhancement genetic engineering is a characteristic not likely to be addressed by producers, but of concern to some consumers. As a result of these consequences to health, environment, and animal well being, there is an increasing

demand to label biotechnology engineered plant and animal products.

This suggests the need to monitor the numerous aspects of the impact of biotechnology on the various capitals within the community — human capital, social capital, natural capital, and financial and built capital. These come together in a variety of communities that need a healthy ecosystem, a vital economy, and social equity.

Social equity is not the same as social equality. It does not mean that everyone has the same thing, but it does mean that all members of the community have access to the wide variety of resources available in the community if they meet universal standards to which all can aspire. Some unanticipated consequences are a decline in human capital, a decline in social capital, a decline in natural capital, and in financial and built capital.

HUMAN CAPITAL

Human capital includes education, skills, health, values, and leadership. There is concern about the health aspects of biotechnology, both positive and negative, as the use of biotechnology-engineered nutraceuticals is getting closer to delivery. Human capital involves values, which intersect with biotechnology in a wide variety of ways. Monitoring the impacts of biotechnology involves the increased use of the knowledge, skills, and abilities of the local people. It means identifying local capacities, enhancing local capacities, and recombining local capacities.

The next generation of biotechnology products probably will be much more sophisticated, targeted, directed, and likely to be end-user oriented rather than simply producer-oriented. Using the skills of local community producers and processors to evaluate and utilize new technology will be a critical piece of biotechnology development, adoption, and utilization.

SOCIAL CAPITAL

Social capital consists of mutual trust, reciprocity, groups, collective identity, a sense of a shared future, and a working together. As we monitor this capital, we would expect to see strengthened relationships and communication, increased interactions among unlike groups within the community, increased interactions among unlike groups outside of the community, and increased availability of information and knowledge. At this time, we have seen biotechnology forming a wide variety of new networks among public and private scientists.

Other kinds of linkages, particularly those of producers and citizens groups, are not developing as rapidly. One way of building these is to help monitor the impact of biotechnology. For example, those who are concerned about negative impacts can specify what those are, and working with producers and consumer groups, negotiate indicators that can be monitored by representatives of all sides of the controversy. Other indicators to be monitored would be the benefits that the proponents feel would be gained.

Natural capital

The impact of biotechnology on natural capital is increasingly an area for greater monitoring. What happens to air quality? Water quantity and quality? Soil quality? Biodiversity? And even the landscape with biotechnology? Can these characteristics, of great interest to end-users, be part of the biotechnology design? Can we be sure that they are not the unintended victims of biotechnology adoption? Thus, we look for sustainable healthy ecosystems with multiple community benefits, human communities that plan and act in concert with natural systems, ecosystems that are used for multiple community benefits, and one where those with alternative uses of the ecosystem seek common ground.

This suggests that biotechnology should engender enormous discussions and reasoned debates in rural and urban communities so as to identify what is important to monitor, so that we can be sure any damage is minimized. These rapidly developing technologies tend to be introduced at the stage they are developed. Unless there are clear community standards, enforced by government regulation and oversight, marketing will lead science. No single company can withhold a potentially profitable innovation if there is the possibility that another may beat it to the market with a similar product.

Financial and built capital

Finally, financial and built capital includes debt capital, investment capital, tax revenue, savings, tax abatement, and grants — all involved in the development of biotechnology from the public and private sector. Does the public feel they are getting their money's worth from this? Is the worth of public money equal to an increase in value in biotechnology stock? Does this result in built capital that improves life and does not damage the environment? Does it result in appropriately diverse and healthy economies to reduce poverty, increase business efficiency, increase business diversity, and increase community resident assets? All of these questions need to be viewed in which biotechnology inputs and uses are compared with those from traditional approaches.

Concern about impacts on multiple community capitals underlines the importance of monitoring multiple impacts. Monitoring, conducted by a wide range of groups from the market, the state, and civil society, and sharing results allows for quick response to unanticipated consequences; thus, the need to monitor all the forms of capital. It involves multiple stakeholders and negotiations that lead to determination of indicators. This also helps to determine the parameters under which biotechnology innovation occurs. It provides feedback to scientists. It provides feedback to the market. It provides feedback to citizens groups.

For agricultural biotechnology to be beneficial to both producers and consumers, it is critical that there be greater communication with all links in the value chain regarding basic values and characteristics desired from food. These characteristics go beyond taste, price and nutritional value to a healthy

ecosystem and even a just society. Processes need to be developed by a partnership of institutions and groups from the market, state, and civil society to build trust and public identification with decision-making processes. A more socially responsible, responsive, and accountable model for the application of food biotechnology is possible (Barling, et al. 1999) This includes consideration of a broader set of links in the value chain when developing agricultural biotechnologies, providing choices of GMO and non-GMO products (this worked well with GMO tomato paste in Europe), certification of non-GMO crops, segregation throughout the value chain, and labeling. All of this provides transparency throughout the value chain. As Barling, et al. (1999) point out, "This degree of transparency would allow consumers to make a more fully informed choice of foodstuffs, in line with their deeply felt values on such issues, and would provide for a more democratic and participatory basis for transparency."

I want to end with a caution. Privileging any form of capital over another can defeat all forms of capital in the long run. The current adoption of biotechnology, using the producer, short-term goals of the ease of pest management allowing one individual to farm more land may have long-term negative consequences, including losing a powerful biological control and further decimating biological diversity, particularly among a specific variety of insects and other invertebrates (Huang, et al. 1999)

It is not in our best interests to unilaterally reject or accept any new technology. It is very important that monitoring take place and transparent feedback mechanisms be developed in regard to technologies that are complex and multidimensional.

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Figure 1. The Producer and Biotechnology: Relevant Social Control

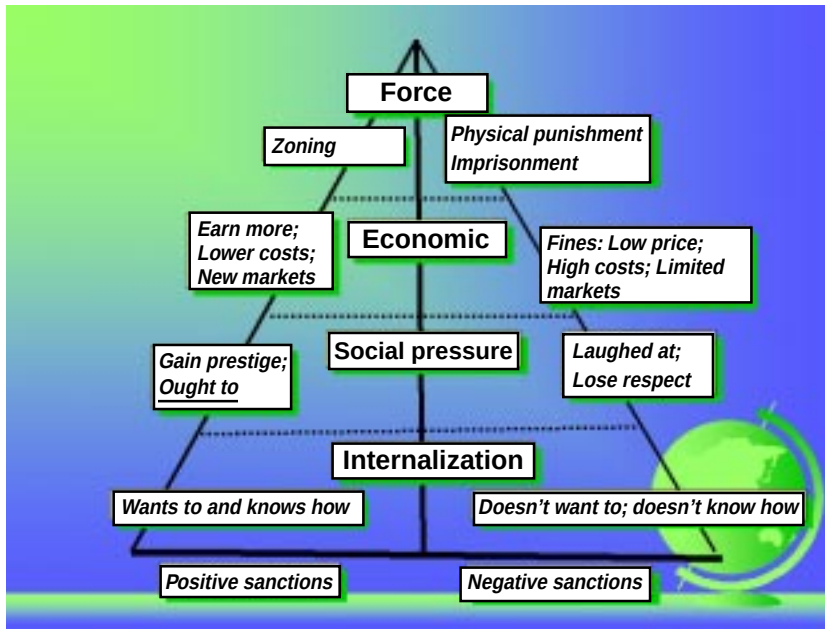

Figure 2. The Consumer, Agricultural Biotechnology, and Social Control