Globalization and Changing Relations among Market, State and Civil Society: A Comparative Analysis of Patagonia and Iowa*

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Neo-liberal government policies created in the mid-1980s reduced barriers to the international flow of capital, goods and services worldwide. Value-chain coordination and integration increased (Hendrickson and Heffernan, 2002; Tweeten and Flora, 2001; Cavalcanti, 1999). Distribution gained importance over production in the process of accumulation and increasingly controlled the food value chain (Busch and Bain, 2004; Reardon and Berdegue, 2002; Ponte and Gibbon, 2005). In order to increase capital accumulation, firms negotiated, tested, redesigned, renegotiated, retested and implemented different mechanisms for control of value chains. The new patterns of accumulation disadvantage producers of raw commodities, particularly in the food-based value chains. In the process of becoming more demand oriented, the conventions around certain commodities changed from the market convention to the industrial convention. The inability of the producers' organizations to institute a civic convention for coordination of the value chains, despite mobilization of civil society in response to consolidation of production, further disadvantaged them in setting the norms, regulations, and enforcement that might have enabled them to offer another demand-driven convention, the civic convention.

The response of civil society in two very different settings triggered our interest in this unusual comparison of hogs and fruit. Sitting together in a farm kitchen in Río Negro, in the Argentine Patagonia, with a group of farm women gathered together to protest what was happening to their prices and their control over production reminded us of similar meetings in farm kitchens in Iowa. Middle class families, who were the heart and soul of their communities, were experiencing serious cultural and economic shocks and displacement. Their commonality is that prior to the 1990s the value chains used the market convention and family managed farms provided agricultural products to regional, national and international markets. Both provided economic stability in their regions. And both were now forced to provide hogs or fruits with much more specific qualities that responded to industrial convention demands for specific qualities at designated prices. Differences between the two production systems were enormous in terms of the exigencies of production

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(such as degree of seasonality) and the socio-political regime in which they were located (a rich Northern state dominating the world system versus a Southern state in fiscal crisis). We wanted to learn how market, state and civil society negotiate to enhance accumulation in the shift to the industrial convention and how power is wielded in those negotiations. We picked these two cases because of our familiarity with them, although we originally thought there would be little in common between animal agriculture in the heart of the U.S. and fruit production in a relatively peripheral region in Argentina. We looked for common elements in the responses of state, market and civil society actors, as well as the differences, explained corporate strategies that bridged continents, cultures and crops.

Conventions theory

Conventions theory was developed by French economists in order to better understand coordination in economic, political and social life through chains and networks (Thèvenot, 1995, 2002; Morgan, et al. 2006; Boltanski and Thèvenot, 1991; Thèvenot, et al. 2000). Conventions are shared norms and values, standards of uniformity, and the rules and institutions to apply and enforce those standards. Most of the research around conventions theory in agriculture has been around the formation of alternative value chains, built on either the civic convention (particularly looking at organic agriculture and fair trade (Raynolds, 2000, 2002, 2004)) and the domestic convention (*terroir* and eat local campaigns (Barham, 2003; 2002) or, as Kerwin (2006) refers to it, the regard convention).

For much of agriculture, the shift from the market convention, where the value the lowest price per unit, and producers were rewarded for volume with minimum quality standards, to the industrial convention, where multiple values related to specific end users, had dramatic impacts in terms of loss of control of the production process. Incorporation in the new, more integrated value chains based on product characteristics required producers to adopt new mechanisms of production, including more sophisticated record keeping and attention to a multiple quality standards in order to participate in the market. While the state may determine and enforce the minimum quality standards around food safety, the environment, and labor, market actors set and enforce the quality standards concerning characteristics of the production process and the product in the industrial convention (Henson and Reardon, 2005).

We compare changes in the behavior of market, state and civil society actors in the rapid movement from family managed farm production (utilizing the market convention) to vertical coordination (using the industrial convention) in two conventional production systems: hogs in Iowa, USA and fruit in southern Argentina. This comparison provides insight into the similarities and difference between the structures of capital accumulation in a core and a peripheral country. Dixon (1999) argues that the relations between consumption and production are becoming much tighter, shifting power in commodity and food systems. Reardon and Berdegue (2002) and Reardon, et al. (2002; 2004) demonstrate the power of supermarket chains on fresh fruits and vegetables and dairy in Latin America, while Hendrickson and Heffernan argue, “In the global food system, power rests with those who can structure this system by spanning distance and decreasing time between production and consumption” (2002:349). Control of the distribution system by setting and enforcing product standards drives value chains. And further, transnational private regulation

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by market actors responds demands by retail chains for what they calculate can sell most profitably while maintaining market share (Bartley, 2007).

As a result, medium-scale producers in the United States and Argentina face similar issues in terms of the exploitation of propertied labor through the contract farming process (Davis, 1980). Non-market civic conventions prevalent for in each country (concern for labor versus concern for the environment) triggered the pressures that made contracting less risky than owning for the integrated firms. Other market, state, and civil society actors influence the pattern of accumulation by creating alternative value chains and passing and enforcing laws and regulations related to labor, the environment, and commerce.

The current climate of neo-Liberalism encourages free trade while deregulating land, labor and capital. The market has been the driver, and the state the facilitator. Civil society is often the intermediary, determining how conventions are established and enforced. The struggle is around who sets what standards for which agricultural products and which externalities of the agricultural production process.

We describe the shift in the conventions governing the hogs and the fruit value chains from market to industrial, building on those laid out by Thèvenot, et al. 2000. We analyze how governments and firms negotiated over rules and regulation that are driven by conventions outside of the qualities of the products, and how civil society attempted to influence how standards are set and enforced. Finally, we compare the forms the value chains have taken in light of both the internal logic of the market driven shift in conventions and the external pressures civil society in response to the violation of other conventions.

The settlement period and the rise of the market convention

In the nationalist era of settlement in both regions, the federal expansion project was congruent with the spread of family managed farms as the best way to draw labor to "wilderness" areas (Pfeffer, 1983; Gasteyer and Flora, 2000). Small-scale production units and the political legitimacy they enjoyed justified extensive capital investments by the state as well as private capital to open new lands in both the state of Iowa and the provinces of Río Negro and Neuquén.

Iowa

Farmer colonization in Iowa was complete by the 1880s, when land that was initially wetlands was drained in order to produce crops fed to livestock. European settlers in the Midwest operationalized their vision for the prairies as farmland was exploited for maximum agricultural production through technology and capital. The capital, while primarily domestic, came from out of state, and farm products (crops and animals) were primarily exported to the rest of the country.

The state was a critical actor in providing both capital and technology. These two driving forces changed the Midwest's landscape and were historically critical to the colonization project. State policies provided generous incentives to built the railroad and drain the wetlands. Both required substantial subsidies to the private sector. Railroads provided Iowa the means to import the equipment necessary to drain the swampy prairie and to convert it to farmland, which settlers were paid to do by the U.S. government (Schwieder, 1996; Bogue, 1994). Capital and technology were configured based on the perceived need for state intervention to control land and nature that was part of the colonial settlement process. Those state-subsidized tools tamed and changed Iowa's landscape to meet the interests of the market. Since the goal of the market was "more" to feed a growing industrial labor force, the market convention prevailed.

The process of land accumulation and reduction in the number of production units began almost immediately after colonization. Railroad conglomerates sold speculators the land titled to them by the U.S. government in exchange for railroad construction. The speculators in turn sold it to settlers. Additionally, the Homestead Act of 1862 provided settlers government land at low costs, although that land, too, was quickly consolidated into larger units. Farm families grew the grains that fed the hogs, and the manure went back into the fields, often distributed by the hogs themselves. Hogs were marketed locally in sale barns and slaughtered either in small local meat plants or in large, unionized packing plants in urban areas.

Many farmers had farrow-to-finish operations well into the 1990s. They kept sows and sought appropriate boars for semen to inseminate the sows for desired characteristics, most recently leanness, and litter size. Some farmers also fed out the weanlings from the farrowing operations, and some farrowing operations fed out their hogs to market-size and sold other hogs to neighboring farmers to feed to slaughter weight.

Since hog prices tended to be counter-cyclical to grain prices, hog production was widely dispersed, with many farms throughout Iowa having a small number of hogs on farms. Many of these farms came to be "century farms," meaning that either the husband or wife was a descendent of the individual who owned the farm at the time of the settlement period. Hogs were a commodity product of these farms, and they served to stabilize diversified agricultural production.

Patagonia

The fruit growing valleys in North Patagonia were settled by migrants from Spain, Chile and northern Argentina who came in the wake of the "Conquest of the Desert" (1875-1879). The vast area of Patagonia was opened for new settlers and immigrants, as the native inhabitants were defeated. Ex-soldiers were given small plots of land and organized into battalions to dig the first irrigation canal. Once settled, the new migrants served as justification for massive state investment in irrigation and transportation infrastructure. The Argentine army cleared the land of the "savage" people, while British capital modernized the land by financing dams and irrigation projects. Fruit production was destined for urban markets, first to Buenos Aires, then to international ones (De Santillán, 1965; McLynn, 1980).

Families settled on land with irrigation grew trees for windbreaks and planted vegetables and orchards. Irrigation along the Río Negro produced "wonderfully rich fruit and wine…" (White, 1942:6). Farmer colonization was complete in the 1930s. The fields, now protected from the constant wind and overcoming the arid climate through irrigation systems, produced a wide variety of fresh fruits and vegetables that was sometimes processed into dried fruit and juices. Often these value-added enterprises were developed as much to absorb family labor as to retain value. However, seasonal labor was needed for a variety of tasks, from planting to pruning to harvest, and many migrants came from Chile to work. *Mapuches*, an indigenous people whose ancestral lands are in the Andes and foothills separating Argentina from Chile, picked the fruit and packed it for export. Their Andean origins allowed them to escape the genocide experienced by their desert-dwelling indigenous contemporaries.

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Yet because of their ethnicity, they were often denied the labor rights available to other citizens of both Chile and Argentina.

Petty commodity production of hogs in the Midwest and fruit in southern Argentina continued long after multinationals dominated other parts of the food industry. This was in contrast to chicken production, which was quickly industrialized and vertically integrated (Fink, 1986; Dixon, 2002; Fulcher, 1992; Stiffler, 2005).

The role of the state in the establishment of transnational private regulation of the food chain

Opening markets and decreasing regulation and oversight greatly increase the ability of transnational firms to maintain internal control and increase external freedom as they seek to maximize firm profits and net firm worth, the two sterling indicators of market success in an international capitalist economy. These policies, in turn, allows the processes and supermarkets to establish the standards for the industrial convention (Bartley, 2007)

The impact of neo-liberal state policies

Rules set to open the economy have particularly affected fruit producers in Argentina. The repeal of laws against direct foreign investment greatly increased the control of fruit processing by transnational firms. New flexible labor legislation promotes low wages and unstable and unprotected work, challenging the established division between formal-regulated vs. informal-unregulated labor (Olmedo and Murray, 2002). This legislation provided a definite advantage to highly vertically integrated firms by reducing the costs of labor.

In the U.S., decline in the power of organized labor, which began under Ronald Regan in the 1980s, and increased freedom of industrial consolidation through relaxation of anti-trust laws increased the consolidation of meat processors, and with fewer buyers, gave substantial transaction cost advantages to integrated hog production. Weakening of the labor laws made it easier to keep wages low. In the case of hogs, the labor for CAFOs increasing came from new immigrants, particularly from Latin America.

Initial attempts at complete vertical integration

In the U.S. and in Patagonia, early efforts to master the efficiencies of vertical integration led transnational companies buying the land and investing in the infrastructure to produce the product it then processed and distributed. In the Midwest, Seaboard Farms invested in a completely integrated operation next to its processing plant in Guymon, Oklahoma. Not only was there a considerable capital outlay that reduced their corporate flexibility despite the incentives and tax relief offered by the state of Oklahoma, the county and the city, but there was considerable pressure on them concerning the workers employed and the environmental problems generated (NCRCRD, 1999; Mayda, 2001). The transnational corporation picked Guymon precisely because it was NOT a hog-producing area, but a cattle town. Further, the impacts in Guymon fueled protests in other Kansas and Missouri, which cost the corporation time and money in expanding. A similarly integrated plant in northern Missouri felt similar pressure (Constance, et al. 2003).

In Río Negro and Neuquén, an Italian-based firm exporting fruit gained access to land and establish technology-intensive production units in order to be more responsive to shifts in market demand. However, this visibility increased the surveillance as to their environmental and labor practices. They soon shifted to contracting land and labor from particularly medium producers, but providing everything else centrally (Gutman and Lavarello, 2002).

The shifting role of the family farmer from independent entrepreneur to a dependent link in the transnational value chain has played out differently in both countries, with some strikingly similar results in terms of centralized accumulation and decentralized risk.

Labor as a factor in maintaining family-managed farms in the market convention

In both settlement situations, state investments in infrastructure – directly through the construction of irrigation systems in Patagonia and railroads in Iowa and indirectly through payments to farmers to tile and drain fields in Iowa – was the basis for the family farm settlement pattern. The fact that the land went to yeoman farmers, who were often veterans of wars to maintain or expand national boundaries, helped justify the public investments.

Transient labor was used in both early systems for harvest, although grain harvests in Iowa were mechanized by 1940, ending the need for threshing crews (Rikoon, 1988). When hogs were raised in relatively small numbers (up to about 50 sows or 200 feeder pigs), family labor was sufficient. As hog production became industrialized, more labor was hired. Tasks became differentiated, with the less skilled tasks going to more marginalized workers – the rural poor or migrant laborers.

Labor in fruit packing plants became less seasonal in order to reduce inefficiencies due to low worker continuity, inadequate worker qualifications, and lack of multiple skills possessed by an individual worker. Improved genetics increased productivity and length of season for the pit fruits, allowing staggering harvests, which provided more working months per year. In packing and refrigeration, there was an increase in continuity and decrease in seasonality, but with a lower skill level required. These technical changes required greater formal knowledge, and technical and managerial positions previously by family members, whether or not they had formal training to undertake those tasks, were now filled based on expertise. Even within family farms, ownership and management became increasingly separate. We found fruit producing families deliberately channeling each child into a different specialty in order to keep the operation in the family.

In both commodity systems, hogs and fruit, much value is added after harvest. Meatpacking plants slaughter and disassemble the carcasses. And as the value chains became more industrialized, post harvest processing became more differentiated, just as the genetics of the hogs and fruit became more specified by the retail chains.

Workers in fruit packinghouses clean, grade and treat fruit according to its destination. Meatpacking is extremely labor intensive compared to other steps in the value chain. However, the labor demand is year round, now that refrigeration keeps meat fresh despite hot summers. In the U.S., workers in meatpacking plants organized early and militantly, as did the butchers who prepared the meat for sale in retail markets. For fruit, packing is as labor intensive as fieldwork at harvest. Labor demand is seasonal, lending itself to either seasonal migration or long periods of unemployment. While unionization is difficult to maintain under circumstances of high labor turnover, strong urban unions in Argentina pushed through legislation which gave workers a great deal of protection -- when the laws were enforced.

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In order to evade labor laws, transnational firms helped workers organize into work cooperatives (Tskoumagkos and Bendini, 2000). Thus the workers were self-employed, removing the responsibility for labor welfare from the firm to the worker (Gallegos and Bendini, 2002; Steimberger and Bendini, 2003).

Who hires the labor? Ownership versus contracting

To increase accumulation, both meat and fruit packers sought to avoid organized labor and government enforcement of labor laws; contracting with family growers was one strategy. Family businesses can be less costly because their workers are not paid a formal sector wage, do not have taxes withheld, and receive no benefits, resulting in lower overhead for their employers (Reardon and Berdegue, 2002).

As labor law enforcement declined, even larger family farms were less likely to be regulated than were transnational corporate orchards (Bendini, 1999). Thus, despite attempts of several large fruit integrators to set up orchards, it became more cost and risk effective to contact out the fruit. But that left control of the production process in the hands of producers with varying degrees of skill and different germ plasm which led to heightened variations in quality. Transnational corporations who wished to maintain control of production but escape responsibility for labor extended the probationary period, which allowed them to lay off workers before they were eligible for benefits, a tactic also used in the U.S. by meatpacking plants (Grey, 1995; Gouveia and Justa, 2002; Gray, 1995). Because of the need for continuity in the work force, that was not enough. Transnational companies with Argentine interests encouraged (and sometimes organized) "labor cooperatives," and as cooperatives of workers, they did not have to pay benefits. The cooperative "members" were thus "liberated," from social security and health benefits that were otherwise available to workers who were hired directly by transnational companies. In the U.S., as meat packing moved from urban to rural areas, the more militant unions were driven out by management (often under bankruptcy reorganization), and new unions were formed with a more management friendly approach (Fink, 1998; Gouveia and Justa, 2002).

Agriculture production enterprises are exempt from many labor laws in the U.S. Further, hog production has grown the most in "right to work" states, where labor unions are by law much weaker than in states where such legislation has not been passed. Thus the power of labor to enforce wage or working conditions is quite low in hog production regardless of the size or corporate structure of the enterprise. In contrast, in Argentina, up until the recent past, large corporate enterprises have been more subject to labor law enforcement than the independent fruit growers.

The Industrial Convention: Specifying qualities

Commodity hog production has moved to leaner, more homogeneous animals, but homogeneity is paramount, including strict control of genetics. Fruit, on the other hand, has responded to differentiated markets. There is increasing demand for multiple characteristics from expanded varieties of fruit. Thus fruit growers are under pressure to constantly respond with new popular varieties in homogenous sizes and colors. Similarly, as competing countries such as Brazil, devalue their currency in January, 1999, pressures to reduce production costs further increased.

The industrial convention is enforced through new procurement practices that include:

- consolidating purchases in distribution centers and sourcing networks,

- increasing chain coordination through contracts with wholesalers and growers,
- requiring private standards and certifications in addition
- constant new investments in production technology and equipment (trucks, cooling sheds and cold chains), in packing, in management and coordination to ensure quality as defined by the retailers,
- increased consistency and timing, and
- larger volumes supplied to consolidated buying points,

in order to keep costs down(Reardon and Berdeque, 2002, 381-382). Growers incur significant costs to ensure product homogeneity, co-ordination of harvest, centralized grading, sorting, packaging and delivery, and administration (Steimberger, 2001). Larger volume means spreading the costs over more production units. Thus the imposition of the industrial convention in the contract agreements favored larger operators.

Specialized fresh fruit and vegetable wholesalers control access to supermarkets (Reardon, et al. 2002). These wholesalers are increasingly vertically coordinated with the fruit packers, and who respond to the multiple demands of distinct end users in their sorting and packing processes (waxed, not waxed, same size, etc.).

As vertical integration increased during the 1990s, a number of transnational firms sought total vertical integration by buying land and hiring operators to produce hogs in the U.S. and fruit in Patagonia. Murphy-Brown still owns over 200 hog farms in North Carolina. However, state laws against corporate ownership of land in Iowa, coupled with the emergent problems of such integrated operations as Seabrook Farms in Oklahoma (NCRCRD, 1999), has lead to increased contracting out of the production function, while retaining control of the animals and tress and the production. These newly-differentiated property rights that favor the transnational corporations makes it almost impossible for independent producers to survive unless they are very well organized and establish alternative value chains through linkages with civil society and alternative market organizations. One of the ways to do that it to definite alternative product characteristics than that provided in the industrial value chain.

The move to the industrial convention has made market access increasingly difficult for independent produces. The terms of contracts become increasingly more specific, to the point that the *chacarero*, the family farmer, provides land to grow the fruit and contracts labor managed by the technicians hired by the transnational fruit corporations. This arrangement leaves the *chacarero* with the responsibility for following labor and environmental laws, but few resources to do so.

Producer Response to the Industrial Convention

Argentina

Chacareros, the traditional Patagonia fruit producers, responded individually by renting out their land to other producers, selling fruit for industrial processing, contracting their product, taking governmental credits instead of selling their production, and selling goods directly at farmers' markets. While contracting allows them to keep their land so that the transnational firms can finesse labor laws, farm income declines and the alternative strategies do not return them to their previous middle class status and role in the area.

In Argentina, there are two main fruit grower organizations, one for the large producers, known as *fruticultores*, and the smaller, family managed growers, the *chacareros*. They had two very different organizations. CAFI, the Argentine Bureau of Integrated Fruit Growers, represented the larger growers in the north central part of Argentina. Local Producer Bureaus (Camaras de Productores) brought together small and medium sized producers, and the local entities make up the Federation of Fruit Producers of Río Negro and Neuquén, composed of independent producers and non-exporting integrated producers. The organization also included very small producers, known as *pobladores*, people who lived near the orchards and primarily provided their labor to the land owners.

The Federation consistently made demand on the state in order to maintain prices through a variety of state investments in price supports and infrastructure since the 1970s (Bendini and Palomares, 1993). Under the market convention, they sought a variety of mechanisms to increase their comparative advantage in producing lots of fruit, including protection from imports from neighboring countries, a threat that increased in 1991 with the passing of the convertibility law that put the Argentine currency on par with the U.S. dollar in order to control hyperinflation and spur economic growth. During the 1990s, the U.S. dollar strengthened against other currencies. This made imports of fruit from competitors, such as Chile and Brazil, less expensive, driving down fruit prices for the producers. to confront the worsening economic situation.. The situation became even worse when Brazil floated its currency in 1999 , greatly decreasing its value and reducing further any price advantage Argentine fruit might have.

In 2000, the Fruit Growers Federation produced a document called “Bases and Conditions for a Fruit Program” (Federación, 2000). The document concentrated on solving the problem of taxes and financial liabilities of the producers, as the Federation considered that the existing program of refinancing debt by the National Argentine Bank insufficient. They also made demands to increase state investment in infrastructure to support fruit production, alternatives for transition, conversion, or relocation of small and medium producers, and horizontal coordination among producers by the state to increase their bargaining power. They proposed a Fruit Restructuring Program adapted to the regional economy, to be developed through a bargaining table (Mesa de Concertación) to be convened by the governors of Río Negro and Neuquén. The federal government authorized he mesas de concertación in 1989. The goal was to increase the transparency of market, state and civil society actors and to reach consensus on collective action

In June of 2001, as part of general anti-recession measures, the governors of Río Negro, Neuquén and Mendoza (a much older fruit growing area that specializes in wine) convened a broad-based “Table of Pre-competitive Agreement of the Chain of Apples and Pears” as part of their antirecession efforts in order to increase competitiveness and increase employment. Participants included not only the local bureaus of the Federation, but also representatives from the federal and state governments of the economy, interior, work and agriculture, organizations of the integrated fruit growers and fruit distributors. They came up with proposals for interjurisdictional and intersectoral collaboration, including a branding agreement and complementary agreements between the various levels of government and the producers and distributors (Bendini, 2002; Bendini and Taskoumagkos, 2002). They also declared a public emergency, as demonstrations and road blockages were being carried out by the local chapters of the Federation, including *Mujeres en Lucha*

(Women in Struggle), an organization of women in fruit producing families from around the nation. Using the farm tractors to block the road, the women pulled trailers behind the tractors with fruit to give to those inconvenienced by their action.

While market convention competitiveness in terms of exchange increased with the exit from convertibility in 2001, the members of the Federation had little negotiating power in the restructuring of internal prices and wages, the consequences of pesticide use, and the conditions of export of fruit. In response, the Federation reoriented its demands toward increased transparency in sales contracts. However, the solutions that they sought were again based on the market convention and price per unit, rather than differentiation either to make the industrial convention more favorable or to institute a civic or domestic convention.

Iowa

While populist groups early noted the increasing concentration in the pork industry and its implications for family farmers (Strange and Hassebrook, 1981), the impact on Iowa, with its highly dispersed hog production system, took more time (Flora, et al. 2007). Fewer farms produced more hogs. For Iowa producers increasing integration of the pork value chain let to control of hog genetics by just a few companies, driving out producers of "seed pigs" or individually owned breeders of sows and boars. Decreases in the price of hogs, even when grain prices were high which reversed their countercyclical advantage, put huge pressure on hog producers. Further, consolidation in the meat processing industry restricted the number of buyers (MacDonald, et al. 2000; Zering, 1998). Some pork producers put in their own integrated operations, contracting fattening weaned shoats to neighboring farms with fewer resources. Other hog farmers went deeply into debt to construct the hog "hotels" and manure lagoons required by the companies that contracted them to raise hogs (Banker and Perry, 1999). Indeed banks strongly supported these investments linked to contracts, as they saw such loans a wonderful new source of revenue (Brunoeler, 1998; Walster, 1998). The differentiation among producers created a split in the Iowa Hog Producers – and similar organizations in other states – between big pigs and little pigs (Page, 1997).

The small pig faction of the Pork Producers in several Midwestern states Iowa, Illinois, Missouri and Minnesota) became part of the Coalition for Family Farms. The CFF is a coalition of farm and rural groups in four states that fought factory farms and corporate concentration in agriculture since 1995. Since 1999, these groups have sought, unsuccessfully, to end the mandatory pork check off, which they view as a tax on every hog sold in the U.S. that is being used to promote corporate concentration in the pork industry. In that effort, they joined with the National Family Farm Coalition (NFFC), a coalition of 30 farm and rural groups that work on federal farm policy issues. Despite their numerical success in referendums of pork producers based on numbers, the United States Department of Agriculture, which oversees the check off program, has invalidated the results and the check off continues, promoting "the other white meat" and funding ways to make hog manure less odiferous.

However, by drawing on research conducted by Iowa State University on alternative ways to produce hogs more humanely in hoop houses, using non-industrial genetics that allowed for more intramuscular fat that gave more taste and better cooking characteristics, some Iowa hog producers stayed in business using the resulting civic convention. Linking to California-based Niman Ranch, where Bill Niman "raised his animals using traditional, humane husbandry methods and

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wholesome natural feeds." (The Niman Ranch Story, 2007). He developed a high end market, with steadily increasing demand. In 19995, at the very time that many hog farmers felt compelled to move to contract growing to the major pork integrators, Paul Willis, owner of Willis Free Range Pig Farm in Thornton, Iowa began working with Bill, producing tender, well-marbled pork that gathered a national following. Willis then recruited other hog farmers to use implement a civic convention in producing hogs with decidedly non-industrial convention characteristics, which, while contract driven, provided a premium price and much more farmer control of the more artisanal production process. The Niman Ranch website states, "All of us at Niman Ranch are committed to fulfilling the vision upon which the company was founded - to bring the finest tasting meat possible to customers while practicing the highest standards of animal husbandry and environmental stewardship." This use of the civic convention allows farmers and consumers to understand the characteristics in terms of both process and product. The civic convention was totally controlled by the market sector, linked to an important and growing niche demand. Farmers must follow a strict production protocol, with more record keeping and careful tracing of all inputs used. But, like organic agriculture, the records allow the documentation of the civic convention which provides the key characteristics of the pork produced.

Local negotiation of sectoral state policies was attempted by producers in Iowa. In Iowa, those policies revolve around the environment with demands for local control over the establishment and expansion of confined animal feeding operations (CAFOs). The producers called upon a value important under the civic convention – environmental quality – in order to stop factory farms. However, that still left them within the market convention in terms of the hog value chain.

The sectoral policies addressed in Argentina revolved around prices and labor costs, based on the market convention – price per unit – and required a greater role of the national and provincial state in guaranteeing prices. The globalization of consumption was the driver of the move to the industrial convention in the Patagonian fruit industry (Bendini 1999, 2002). Bendini found increasing integration of agriculture, industry and marketing in the fruit industry. International capital is linked with local integrated firms; joint ventures are a mechanism for further concentration of marketing.

Civil Society

While workers' organizations have been greatly weakened in both countries in terms of production and processing, producer organizations are much stronger. The Pork Producers have both state and national organizations in the U.S., as do fruit growers in Argentina. In the U.S., civil society has organized in response to the environmental hazards, which are part of the industrialization of hog production, providing a counterweight to expansion.

In Argentina, civil society in general was supportive of grower claims, as direct state indirect interventions to make the market convention profitable are more accepted than in the U.S., where cheap grain that hog farmers use in hog production is subsidized by commodity payments, countercyclical payments, and deficiency payments, among others.

The Federation is now located with the Secretary of Fruit Production in the province of Río Negro, although it covers its local Bureaus in both Río Negro and Neuquén. It works to provide a variety of legal representation and technical assistance to small and medium fruit grower based on the market convention. They argue that smaller scale production allows them to produce a higher quality fruit at a lower cost, due to the personal attention the producers can give to their fruit trees. The Federation's goal is to represent small and medium fruit producers when decisions are made regarding labor legislation, new laws, phytosanitary regulations, opening new markets, control of monopolies and oligopolies, good agricultural practices, traceability, export assistance, marketing projects, media campaigns, weather forecasts, and other information to help producers be profitable and minimize their environmental impact (Federación, 2007).

Iowa

As in many states, Iowa's laws against corporate farms made it difficult for pork processors to own the farms that produced the pigs (Hamilton and Andrews, 1993), and the strong public outcry, particularly around environmental issues, in states where corporate farming was permitted, such as Missouri (Constance, et al. 2003), Oklahoma (NCRCRD, 1999; Mayda, 2001) and Texas (Constance and Bonanno, 1999), document wide-spread civil society mobilization against fully integrated hog production when it was allowed. The concern of community residents about the potential disruptions in the social structure and environmental quality of the move to confined animal operations stirred a number of grass roots oppositional movements (DeLind, 1998, 1995; Durrenberger and Thu, 1996; Thu and Durrenberger, 1998).

In The Midwest of the United States has a history of populist movements where grassroots groups resisted market and state efforts to limit the options of small producers. As a part of the Chicago-based National People's Action, Iowa Citizens for Community Improvement was founded in 1975, primarily around urban issues of low-income housing issues, neighborhood preservation, and community reinvestment by financial institutions. They achieved a number of legislative and administrative victories, particularly on issues of tenant – landlord relations. With the U.S. farm crisis of the late 1970s and early 1980s, ICCI moved into rural areas, the only affiliate of National People's Action to do so.

The ICCI began organizing farmers and rural residents in 1982 to "fight for fair farm prices and address problems associated with high interest rates and rapidly increasing farm foreclosures. Since then, they have focused on a variety of economic and environmental issues, including sustainable agriculture, credit and lending policies, conservation and corporate concentration in agriculture. When there was a split in the Iowa Pork Producers on the issue of vertical integration of hog production, beginning in 1995, many of those opposed to it joined with ICCI. ICCI's current rural organizing is focused on factory farms and livestock concentration linked to environmental protection, food from family farms federal farm policy. They seek to:

- Stop the spread of large-scale factory farms (hogs, chickens, dairy) and corporate concentration in agriculture at the local, state and federal level.
- Promote responsible economic development that respects the environment, local communities, the rights and dignity of workers, and Iowa's tradition of family farms.
- Assist family farmers in marketing their meat and produce directly to consumers in order to receive a fair price and provide a safe, affordable, locally-grown product.
- Protect Iowa's rivers, streams, air and land from pollution caused by

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industrial methods of agricultural production.

- Promote a federal farm policy that would allow farmers to receive a fair price for their product, establish a farmer-owned grain reserve, and provides for land stewardship grants and incentives.

ICCI uses community-organizing strategies and techniques that encourage citizen participation, hold institutions accountable to grassroots people, and emphasize issue and leadership development. In response to the factory farm issue, they held public meetings, organized and implemented direct action protests and rallies, sent out well-timed press releases, and conducted leadership training sessions to encourage action against corporate hogs and factory farms. They favor local control of the licensing of hog lots, in face of the failure of the state to set limits.

In order to make their action cumulative on a regional and national level, Iowa CCI works very closely with other state-based groups. ICCI is a member of the Campaign for Family Farms, as well as the National Family Farm Coalition (NFFC).

However, ICCI and environmental groups have not been able to rescind the state prohibition on local regulation of CAFOs, as the agricultural committees of state legislatures are dominated by commodity groups, particularly the big pig faction of the Iowa Pork Producers.

Environmental Laws and Corporate Structure

Hog production and pork processing produces lots of vile-smelling waste through manure and the processing itself, which makes its environmental impacts more visible to the middle class likely to mobilize politically. It also threatens water quality when carried out in large confinement operations (Flora, et al. 2007). In such facilities, manure, which has been diluted by a great deal of water used to clear out the stalls (substituting water for labor), is stored in huge constructed lagoons. Even in operations, such as those promoted by Murphy-Brown LLC (one of the largest pork producers in the world and part of Smithfield Foods, largest vertically integrated producer and marketer of fresh pork and processed meats in the United States), where manure is stored in huge steel tanks rather than lagoons, the manure must be transferred and when that transfer occurs, and manure spillage – and water contamination – can occur as pipes get disconnected or leak. Air and water contamination, and the concomitant health risks to communities that are downstream or downwind, present a major place-based risk.

Local and state governments are increasingly seeking to regulate the outputs of confinement animal feeding operations (CAFOs), and the Federal government is also placing environmental regulations on CAFOs (Jackson, et al. 2000). These regulations apply to operations above a certain size, and generally hold the CAFO operator responsible for environmental damage. Sanctions for pollution include heavy fines and the risk of being closed down. However, these are not often enforced.
Fruit production in the Rio Negro watershed is dependent on high uses of pesticides. The resulting pollution of air and water directly affects the field workers and the low income households that live on the edges of the orchards and use the water from the irrigation ditches, becoming a labor problem as well as an environmental problem. There is little or no legal protection for these workers, who are often foreign nationals or ethnic minorities. Further, the lack of active civil society environmental groups does not provide the push back that the threats to water and air quality do in Iowa. (It should be noted that Iowa environmental groups are relative silent about the impacts

of pesticides on human health, similar to the Argentinean situation.) However, the producers do feel the demand to reduce pesticides from demand for low pesticide residues that are part of the industrial convention imposed by the exporters, keenly aware of northern hemisphere ecological demands.

In Patagonia, in contrast, labor laws made it more troublesome for the totally vertically integrated transnational systems (Cavalcanti and Bendinia, 2001). With an even greater concern for quality control than in pork, technicians from the distributing transnational corporations make regular visits to each contractor, supplying the inputs, including the germ plasm (fruit trees), all inputs, and orchard management. However, just as the Iowa land owner bears legal responsibility for the environmental externalities, the Patagonia land owners bears legal responsibility for labor well-being. In both cases, smaller producers are less likely to be held accountable by weakened enforcement structures, and when they are, the transnational corporations can explain how such illegal activities are against their corporate policies.

Neo-liberal policies have successfully shrunk all levels of the state and reduced state income in both the U.S. and Argentina. Massive budget cuts to departments of labor, agriculture, and natural resources make it impossible to enforce existing laws and regulations. Nevertheless, given the highly organized nature of civil society and the visibility of transnational firms, they are more likely than family-based hog operations they contract with to face fines or law suits.

Contracting as the Accumulation Strategy: Reducing Transnational Risk

Thus the strategy for major processor-distributors, such as Smithfield, IBP, Conagra, and others has been to vertically integrate by owning the hogs, but not owning the land and buildings where they are raised. Thus contracting the raising of the hogs to independent producers frees them from environmental liability, but leaves them with control of the operation. The farm operator, who invests in and maintains the buildings, the land, and the manure distribution system, is held liable for environmental damage. Contracting, in which decisions surrounding production lie with the transnational corporation but responsibility for externalities lies with the contractor, forces more risk on the producers, who have less control over reducing them.

Contracting previously independent *chacareros* to lend their land and labor, but not their expertise, to fruit production maximizes the flexibility of the transnational firms, making it easier to move from country to country as exchange rates change. It increases the vulnerability of the fruit producers, who, despite retain land rights (although these remain precarious because of debt issues surrounding the devaluation of the peso), have not only lost income but lost decision making status within the value chain. Meanwhile, like the hog grower in Iowa, the small and medium producers retain the responsibility and liability for labor and the environment.

Conclusions

Integrating hog and fruit value chains using industrial conventions increases the control of grocery chains on setting the product characteristics desired, determining the processes necessary to produce those characteristics, and making sure that those processes are followed. While the North American pork market demands a uniformly lean, uniformly sized, and safe product, the global fruit market presents constantly changing characteristics in terms of type and qualities of fruit. In both situations, those characteristics are insured by provision of germplasm by the transnational firm.

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For hogs the germplasm is in the form of sows and boars from a very narrow genetic pool to produce shoats to be raised at a completely different place to decrease the disease inherent when animals are raised in close proximity. The disarticulation of production further removes control from farm households.

In fruit, the genetic stock for grafting on existing root stock is provided by the transnational firm, carefully monitoring and creating consumer demand in the North. Company technicians provide the management, even directing the workers that the owner of the orchard has hired.

In Iowa, some hog farms have drawn on the civic convention to maintain a more integrated and satisfying value chain. Alternatives do exist for Iowa farmers, although the market convention is no longer functional for them. In Argentina, on the other hand, the small and medium fruit producers have increased their linkages to the state in order to give them some advantage under the market convention. Increasing attention to environmental quality has led to some small and medium producers moving into ecological fruit, although without a strong organizational base. But the option of a civic convention is beginning to open for them, as it has in Brazil (Marsden et al. 1996). However, as Freidberg (2003) points out, colonial constructs remain, even in Southern countries as modern as Argentina.

Conventions theory allows us to compare two different situations of globalization in terms of both buyer and producer strategies. While the advantage is definitely with the buying end of the value chain, when producers identify consumers who want civically appropriate characteristics, the possibility of profitable and satisfying alternative

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THE EMERGING NANO-CORPORATE PARADIGM: NANOTECHNOLOGY AND THE TRANSFORMATION OF NATURE, FOOD AND AGRI-FOOD SYSTEMS*

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Introduction

Nanotechnology is emerging as the technological platform for the next wave of development and transformation of agri-food systems. Nanotechnology is attracting large-scale investment from global food corporations, is backed by academic science, and has captured financial and ideological support from many governments around the world (see for example Roco, 2005; Sandler and Kay, 2006). As a result, nanotechnology is rapidly moving from the laboratory and onto the farm, supermarket shelves and the kitchen table. For example, a new range of 'smart' agricultural inputs and products are being developed, such as nano-seed varieties with in-built pesticides that will release under certain environmental conditions; nano-encapsulation techniques may make it possible to alter the nutritional composition, flavour and other attributes of food to match consumers' personal tastes and physiological requirements; and 'smart' food packaging able to detect the presence of pathogens. These and other applications of nanotechnology across the agri-food system are emerging from a growing alliance between the corporate food sector and scientific communities (see for example Helmut Keiser, 2004; Joseph and Morrison, 2006). This industrial and scientific collaboration strategically place the corporate sector to shape the research trajectory and commercial applications of nanotechnology, and the future of agri-food systems.

This paper provides an overview of some of the growing number of nano-applications being researched and commercialised across the agriculture and food sectors. This includes considering the ways in which the techniques and products of nanotechnology may extend, entrench and exacerbate, but also reconstitute or transform the social and ecological relations that they mediate. We will refer to the emergence of a 'nano-corporate food paradigm' as a way of identifying some of the technical, ecological, and socio-economic characteristics associated with the incorporation of the techniques and products of nanotechnology across the food system. For example, in terms of ecological relations, nanotechnology represents the most powerful set of techniques yet developed to take apart and reconstitute nature at the atomic level. In terms of economic relations, nanotechnology provides new opportunities for the extension and further integration of corporate ownership and control within and between sectors of the agri-food system. We will also reflect on the relationship between this nano-corporate paradigm and other recent techno-economic paradigms of agri-food production and consumption.

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Nanotechnology Defined: Techniques, Risks and Regulation

Nanotechnology commonly refers to any engineered materials, structures and systems that operate at a scale of 100 nanometres or less (one nanometre is one billionth of a metre) (Moraru et al., 2003). Nanotechnology is essentially a set of techniques that enable the direct manipulation and reconstruction of the world at the level of atoms and molecules. Nanotechnology introduces the most powerful set of tools to date which enable scientists to deconstitute or decompose nature into its constituent components — atoms, molecules and super-molecular structures — and to reconstitute and recombine these components into new forms (Scrinis, 2006a).

There are a diverse range of existing and promised techniques, devices and applications that come under the broad banner of nanotechnology. Nanotechnology is not so much a separate and distinct technological field, but rather a new techno-scientific platform, whereby a range of existing techno-scientific disciplines — such as chemistry, physics, biology, biotechnology, neurology, information technology and engineering — are able to shift down to the molecular level (ETC Group, 2003; Hunt and Mehta, 2006). Nanotechnology will facilitate the accelerated development of these various techno-sciences, including the development of nano-chemical technologies, nano-biotechnologies and nano-information technologies (Shand and Wetter, 2006). Nanotechnology will also enable a greater degree of integration and convergence across the various techno-scientific disciplines, technologies, and technological products. A number of types of nano-techniques and applications can be distinguished, including the manufacture of nanoparticles, nanofabrication techniques, and the field of nano-biotechnology (ETC Group, 2003).

Nanoparticle production includes the breaking down of larger-scale chemical compounds and materials into nano-scale particles — referred to as the ‘top-down’ approach to nanotechnology — as well as the manufacture of distinctly new materials, such as carbon nanotubes, buckyballs and quantum dots. Simply dealing with materials at the nanoscale can change their properties in comparison with the same materials at a larger scale. This is in part because smaller particle sizes increase the surface area of molecules. The nanoscale material could be more reactive, have different optical, magnetic and electric properties, and may be stronger or more toxic (Royal Society and Royal Academy of Engineering, 2004).

In addition to the manufacture of nanoparticles, there are also nanotechnologies being developed for assembling materials and products at the atomic and molecular level from the ‘bottom-up’, atom-by-atom or molecule-by-molecule (Royal Society and Royal Academy of Engineering, 2004). The approaches to bottom-up manufacturing include chemical synthesis, self-assembly and positional assembly techniques. For example, molecular self-assembly involves the use of supramolecular chemistry to cause molecules to self-assemble into a particular configuration. DNA nanotechnology refers to techniques for constructing molecular structures out of DNA (Patrick McCray, 2005; ETC Group 2003).

Nanoparticles, nano-devides and other nano-systems may be used to produce cheaper, more durable, or greater quantities of existing commercial products. They can also be used to manufacture products with new or enhanced qualities, such as ‘smart’ surfaces and materials, faster computer chips, pharmaceuticals able to target particular organs in the body, and ultra-small sensors and monitoring devices that can be utilised across a range of industries (ETC Group, 2003).

Nano-biotechnology refers to the use of nanotechnology to manipulate living organisms, as well as to enable the merging of biological and non-biological materials. This includes the use of nanotechnology to facilitate genetic engineering breeding programs, the incorporation of synthetic materials into biological organisms, and ultimately the creation of new life forms. The ETC Group refer to the creation of new life forms through the development of ‘synthetic biology’ as one of the ultimate goals of nano-biotechnology research (ETC Group, 2007). Synthetic biology entails going beyond merely cutting and pasting existing gene sequences between organisms — and the current imprecision, randomness and other limitations of these techniques — and instead involves constructing DNA itself out of atomic building blocks, with the aim of creating novel organisms that are able to be ‘programmed’ to more precise specifications. Rodney Brooks from the Massachussetts Institute of Technology puts forward this vision of a nano-biotech future: “Much of what we manufacture now will be grown in the future, through the use of genetically engineered organisms that carry out molecular manipulation under our digital control. Our bodies and the material in our factories will be the same…we will begin to see ourselves as simply a part of the infrastructure of industry” (ETC Group, 2005b: 13).

In these ways, atomic elements and molecular structures become the Lego-style building blocks for producing a wide range of materials and products across all industrial sectors. Nanotechnology extends the *reconstitutive rationality* that has characterised the contemporary techno-sciences, and which can be defined as where the objects of nature are not merely used and exploited in their received form, but increasingly encountered as malleable and available for reconstruction from the ground up — or in this case, from the atom up.[1] Nanotechnology can also be understood as constituting a materially *more abstract* level, or mode, of engagement with nature — a way of taking hold of and transforming nature that is further abstracted from the objects of everyday sensible and practical experience (Sharp, 1992).

Nanotechnology research and development is being undertaken by most of the world’s largest corporations, as well as by university research centres and smaller start-up companies. The intensive patenting of nano-scale techniques and materials is a key feature of the nanotech industry, with many competing and overlapping claims threatening to lead to costly legal disputes (ETC Group, 2005b; Shand and Wetter, 2006). Given the materially fundamental nature of these patents and their widespread applicability across applications and industries, the control of these broad nano-patents may be a strategy for corporate concentration both within and across industrial sectors.

The novel characteristics of nanoparticles and other nanomaterials that offer new and desirable traits for a range of industrial applications may also be the source of new forms of hazards to environments and people, such as new forms of toxicity and new forms of pollution (Colvin, 2003; Tolstoshev, 2006; ETC Group, 2004; Scrinis, 2006a). There is little known about the health affects of eating foods that contain nano-particles, or of workers handling nano-materials. A report by the British Royal Society has warned of the serious risks of nano-toxicity (Royal Society and Royal Academy of Engineering, 2004). The International Union of Food, Farm and Hotel Workers (IUF) have called for a moratorium on nanotechnology until the effects of exposure to nano-materials is more thoroughly understood (International Union of Food, Farm and Hotel Workers, 2007). A key concern regarding human exposure to nano-scale particles is that they have many pathways for entering the body, such as through inhalation, digestion and through the skin. From there they may be able to pass into the bloodstream, penetrate cells, by-pass immune responses, lodge in the lungs, and cross the blood-brain barrier (Friends of the Earth, 2006; Royal Society and Royal Academy of Engineering, 2004; Scrinis 2006b). The similarity in size of some nanoparticles

[1] This ‘reconstitutive’ form of rationality can be understood as over-laying and framing the formerly dominant ‘instrumental’ form of rationality, the latter characterised by the use and exploitation of nature or natural objects in their received form.

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with asbestos has often been noted (see for example Swiss Re, 2004). Many commentators have also drawn parallels between genetically modified foods and nano-foods in terms of the types of risks they introduce, as well as in terms of the inadequacy of the testing and regulatory frameworks governing these technologies (see for example Bowman and Hodge, 2006: Bowman and Fitzharris, 2007).

Civil society groups and non-government organizations — notably the ETC Group and Friends of the Earth Australia — have been calling for a moratorium on the release of any products of nanotechnology until adequate regulatory frameworks are in place; until the public are democratically involved in decision making over the applications and broad societal consequences of these technological innovations; and until such products are shown to be safe (Bowman and Hodge, 2006; ETC Group, 2005c; Friends of the Earth, 2007). To date, there have been very limited opportunities for public engagement in nanotechnology debates (Bowman and Hodge, 2006; 2007). Yet a recent report by the Woodrow Wilson Center for International Scholars' Project on Emerging Nanotechnologies concluded; "involvement of members of the general public is crucial for dealing with nanotechnology's adverse effects . . . the public needs to be involved in assessing nanotechnology's risks, as well as in defining the measures to be taken to deal with the risks" (Davies, 2006: 29).

Despite these risks, and the current limits of public engagement in debates about nanotechnology, nanotech materials and products are being researched and commercialised by scientists and companies across all sectors of the agri-food system. Applications include farming technologies and inputs, food processing, food packaging and retailing. Reflecting the extent of nano research, development and commercialisation, by 2004 the market for nanotech food and food processing was estimated to be worth US$2 billion. This figure is set to expand to US$20 billion by 2010 if current trends continue (Kuzma and VerHage, 2006).

Proponents of nano-food applications argue that they offer the capacity to bring on-going improvements to agriculture and food systems: they argue it will improve the productivity and efficiency of crop and livestock production, as well as increasing the safety, nutritional value, and shelf-life of food, and helping to increase food production to meet future population growth trends (Joseph and Morrison, 2006; Rutzke, 2003). This paper will now identify and evaluate some of the specific applications and implications of nanotechnology within the various sectors of the agri-food system.

Nano-Agricultural Applications

In the agricultural sector, nanotech research and development is likely to facilitate and frame the next stage of development of genetically modified crops, animal production inputs, chemical pesticides and precision farming techniques. While nano-chemical pesticides are already in use, other applications are still in their early stages, and it may be many years before they are commercialised. These applications are largely intended to address some of the limitations and challenges facing large-scale, chemical and capital intensive farming systems. This includes the fine-tuning and more precise micro-management of soils; the more efficient and targeted use of inputs; new toxin formulations for pest control; new crop and animal traits; and the diversification and differentiation of farming practices and products within the context of large-scale and highly uniform systems of production.

Through the convergence of nano and bio techniques, it may be possible to improve the precision of genetic engineering breeding programs, thereby ensuring greater control in delivering new character traits to plant and crop varieties (ETC Group, 2004). Researchers are attempting to use nanoparticles, nanofibres and nanocapsules to introduce foreign DNA and chemicals into cells (Friends of the Earth, 2008 forthcoming). For example, silica nanoparticles have been used to deliver DNA and chemicals into plant and animal cells and tissues (Torney, 2007). Researchers in this field have also already succeeded in “drilling” holes through the membrane of rice cells to enable the insertion of a nitrogen atom, to stimulate rearrangement of the rice DNA (ETC Group, 2004). This technique has been successful in altering the colour of rice, and researchers aim to use this technique to extend the growing season for rice, enabling year round production. There is, however, little evidence of any commercial applications of such nano-genetic engineering research at this stage.

The perhaps more distant prospect of not merely re-engineering existing plants, but of creating novel plant varieties from scratch using synthetic biology would enable significantly greater control over crop traits (ETC Group, 2007). While such developments may be a number of years away, Drew Endy, an engineer and promoter of synthetic biology has claimed: “There is no technical barrier to synthesizing plants and animals, it will happen as soon as anyone pays for it” (ETC Group, 2007: 23).

Techniques at the nano-scale are also being applied in an attempt to enable the targeted delivery or increased toxicity of pesticide applications (ETC Group, 2004; Kuzma and VerHage, 2006). This includes the insertion of nano-scale active ingredients into pesticides. The specific properties of these nano-scale materials, such as their ability to dissolve in water or their increased stability, are designed to maximise the effectiveness of these pesticides. Leading agri-chemical companies including BASF, Bayer Crop Science, Monsanto and Syngenta are engaged in nanotech research in these areas. In terms of commercial applications of this technology, Syngenta, the world’s largest agrochemical company, currently retail a number of chemicals with emulsions that contain nanoparticles. Agrochemicals include ‘Primo MAXX Plant Growth Regulator’, ‘Banner MAXX Fungicide’, ‘ApronMaxx RFC seed treatment’ and ‘Cruise Maxx Beans’ (ETC Group, 2004; Friends of the Earth, 2008 forthcoming). To date, none of these agrochemicals are currently labelled as containing nanoparticles.

Pesticides may also be encapsulated via nano-encapsulation techniques. These encapsulation techniques enable greater control over the circumstances in which encapsulated pesticides will be released. For example, pesticides could be released quickly or slowly – depending on need – and under specific conditions, such as moisture and heat levels (see for example Syngenta, 2007; Zhang et al., 2006). Syngenta have obtained a patent for a ‘gutbuster’ microcapsule containing pesticides that will break open in alkaline environments, including the stomach of certain insects (ETC Group, 2004). Such nano-encapsulation techniques not only provide in-built pesticides for crops – in some ways similar to genetically modified *Bt* insecticidal crops – but also in-built switches to control the release and subsequent availability of pesticides.

One of the rationales for these nano-particle pesticide applications lies in their improved capacity for absorption into plants compared to larger particles. As such, they may not be washed off as readily, thereby increasing their effectiveness, but also posing a new order of risks to consumers of these products (see for example Belfield, 2005). Farm workers and rural residents are also being exposed to these nano-pesticides, in the absence of any required safety testing or regulation of nano-scale formulations of already approved chemical pesticides (Lyons and Scrinis, 2008 forthcoming). The size and dissolvability of nanoparticle pesticides may also mean they contaminate soils, waterways and foodchains across a wider geographical area, while nano-encapsulated pesticides may release their toxins in other environments or in the stomachs of other living organisms.

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Nano-pesticide research and development is concentrated within a small number of large agri-chemical companies that already dominate the agri-chemical and seed market, and these corporate actors are likely to further extend their control of these markets, and therefore over farmers (Lyons, 2006; Friends of the Earth, 2008 forthcoming). Proponents argue that pesticidal applications of nanotechnology promise to reduce pesticide use, due to their more precise and targeted nature. As such, nanotechnology is frequently portrayed as introducing environmental benefits (see for example Dept of Environment, Food and Rural Affairs, 2007). However, as in the case of GM crops, these efficiency gains may also provide ideological legitimation for, and thereby further entrench, chemically-intensive farming systems. The reformulation of the active ingredients of patented pesticides into nano-scale formulations may also be used as a strategy for agri-chemical corporations to apply for an extension of their patent rights after the initial patent period has expired (Friends of the Earth, 2008 forthcoming).

Nanosensors — or nano-scale, wireless sensors — represent the intersection of nanotechnologies and information technologies. Alongside geographical positioning systems and other information technologies, nanosensors could be scattered across farmers' fields to enable the 'real time' monitoring of crops and soils, and the early detection of potential problems, such as pest attacks and declining soil nutrient levels (ETC Group, 2004). Nanosensors have the capacity to extend the logic of precision farming in new and novel ways – to both identify and rectify agronomic problems in a very short time frame. The US Department of Agriculture, for example, is reported to be developing a "Smart Field System" that "automatically detects, locates, reports and applies water, fertilisers and pesticides — going beyond sensing to automatic application" (ETC Group, 2004: 17). Nanosensors may thereby introduce greater efficiencies within — and thereby facilitate the expansion of — large scale farming operations.

Nanotechnology also has the potential to displace traditional food and non-food farm commodities through the development of artificial nanomaterials in factories (ETC Group, 2004; 2005a). It is the farming communities and countries of the South that produce some of these commodities, such as cotton and rubber, which would be most severely affected by these crop substitutions. For example, the global cotton market and cotton prices could be further undermined by the development of synthetic fibres such as Nano-Tex, which is reported to be a much stronger material than cotton but with a similar texture. Similarly, nanoparticle alternatives to rubber are already in production, such as silica carbine nanoparticles and carbon nanotubes for use in car tyres. Another more distant possibility is that crops could be engineered to themselves produce nanoparticles, referred to by the ETC Group as "particle farming", whereby plants are used to extract particular minerals from the soil for harvesting (ETC Group, 2004: 27).

Nanotechnology also has a range of potential applications for animal production systems, including new tools to aid animal breeding, targeted disease treatment delivery systems, new materials for pathogen detection, and identity preservation systems (Scott, 2007; Ajmone Marsan et. al., 2007; ETC Group, 2004). Examples include the use of micro and nanofluidics systems for the mass production of embryos for breeding; drug delivery systems able to penetrate previously inaccessible parts of the body; more biologically active drug compounds; and sensors for monitoring livestock locations. For fish farming operations, nano-applications include nano-scale water cleaning products, and nanocapsule vaccines released into fishponds which are absorbed into the cells of the fish and then activated using ultrasound (ETC Group, 2004). These nanotech animal and fish production technologies are essentially ways of creating efficiencies and productivity gains within capital and input intensive industrial production operations, including close confinement factory production.

They largely involve re-engineering and further adapting animals to the requirements of this mode of animal production. As the ETC Group put it, "retrofitting farm animals with sensors, drug chips and nano-capsules will further extend the vision of animals as industrial production units" (ETC Group, 2004: 34).

The economic impacts of nanotech developments are likely to affect farmers differentially, depending on the size and capital-intensity of the production unit. As with earlier technological innovations, it is larger-scale, capital-intensive farming operations that will be more able to reap any early economic advantages from adopting nano-applications. Farming communities in the South, particularly smaller-scale and local market and subsistence oriented farmers, as well as agricultural labourers, may be adversely affected in a number of ways. This includes the continuation of commodity price depression through any productivity increases and dumping of produce in the South; the displacement or undermining of traditional agricultural commodities through the development of nanotechnological industrial alternatives; and the reduction in farm labour through the increased efficiency, mechanisation or automation of farming practices (ETC Group, 2004; 2005b.

Nano-Processed Foods

Nanotechnology is also being applied to the production of processed foods and drinks, and a number of foods containing nanoparticles and nanocapsules are currently available for purchase, though without being required to indicate the presence of these nano-materials on their packaging. These nano-processed foods have entered the food supply largely in the absence of public awareness, nano-specific labelling requirements, or nano-specific food safety regulations. Most major food companies, including HJ Heinz, Nestle, Hershey Foods and Unilever, have invested heavily in nanotech research and development in these areas. Kraft's global 'Nanotek Research Consortium' of 15 universities and national research laboratories, for example, reflects a corporate strategy to lead developments for a nano food future (Kuzma and VerHage, 2006).

As Peerak Sanguansri and Mary Ann Augustin describe this shift in scale in food science and technology research; "The next wave of food innovation will…require a shift of focus from macroscopic properties to those on the meso- and nano-scales, as these subsequently control the hierarchical structures in food and food functionality" (Sanguarnsri and Augustin, 2006: 547). A range of nano techniques and materials are being developed in an attempt to assert greater control over food character traits, and to enhance processing functionalities, such as flavour, texture, speed of processing, heat tolerance, shelf life, and the bioavailability of nutrients (Gardener, 2002). As with all food processing research and development, one of the aims is to achieve these ends in a cost effective way, and to continue producing cheap convenience foods with consumer appeal. But a major growth area has also been in the development of so-called 'functional foods' — nutritionally engineered foods that are marketed with nutrient or health claims (Scrinis, 2008b forthcoming) — and nanotechnology provides a range of approaches to the cost effective production of foods with modified nutrient profiles and novel traits .

Nanotechnology applications include a range of nano-scale materials added to foods and nano-encapsulation techniques as delivery systems for other food components (Nichols, 2007). Nanoparticle-sized ingredients may increase the functionality or bioavailability of ingredients and nutrients, and thereby minimise the concentrations needed in the food product (Weiss et al., 2006). Food companies are currently producing nanoparticles in emulsions in an attempt to control the material properties of foodstuffs, such as in the manufacture of ice cream to increase texture uniformity (Rowan, 2004). Encapsulation techniques are also being

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applied as part of a strategy to harness the controlled delivery of nutrients and other components in processed foods. For example, many of the Omega 3 additives commonly found in food are of both nano and micro-encapsulated size.

Food industries argue the addition of micro and nanocapsules to processed foods will improve both the availability and delivery of nutrients, thereby enhancing a food's nutritional status (Kuzma and VerHage, 2006). For example, a recent study claimed that the encapsulation in nanoemulsions of curcumin — the phytochemical found in tumeric and claimed to have antitumor and anticarcinogenic properties — increased the bioavailability of this compound (Wang, 2007). Nanotechnology also holds out the promise of 'interactive' foods able to change their nutritional profile in response to an individual's allergies, dietary needs or food preferences (FOE, 2008 forthcoming). This promise of "personalised nutrition" — based on the development of targeted delivery systems — is described in the food industry journal *Food Technology* by Chen *et al*:

> …advances in nanotechnology may lead to multifunctional nanoscale nutraceutical delivery systems that can simultaneously detect and recognise the appropriate location, analyze the local and global needs, decide whether or how much of the payload should be released, and monitor the response for feedback" (Chen et al., 2006: 36).

The proliferation of such nutritionally-engineered foods — along with some novel nutrient traits and interactive functions — will further promote and accentuate the nutritionally reductive approach to food that now dominates public discourses on the relationship between food and bodily health. This ideology or paradigm of "nutritionism" is associated with an increasingly "functional approach to food and the body", whereby foods are conceived in terms of their functional components and their impacts on specific bodily processes (Scrinis, 2002; 2008a forthcoming). This way of understanding and engaging with food renders consumers ever more susceptible to the nutrient-content claims and health claims used to promote processed foods, and also facilitates the further commodification of food knowledge and preparation skills and their embedding in value-added products.

The introduction of nano-scale components in foods also raises novel health concerns. For example, as Arpad Pustzai and Susan Bardocz note in their review of the health risks of nanoscale food components, nanoparticle versions of the food additives titanium oxide and silicon dioxide are already being used in foods, and have been approved as GRAS (generally recognised as safe) by the US Food and Drug Administration. Yet they argue that there is already sufficient scientific evidence that these nanoparticles are cytotoxic (i.e. toxic to cells), and that they have been incorporated into foods without appropriate safety testing (Pustzai and Bardocz, 2006).

Nano-Food Packaging and Other Applications

To date, the nano food packaging sector has experienced some of the most significant developments in terms of commercialisation (see for example Helmut Keiser, 2004; Joseph and Morrison, 2006). Manufacturers are applying nano techniques with the aim of improving the quality, durability and shelf life of packaged foods. At the same time, they may provide food industries with a new platform to define and regulate the terms of food safety. Nano packaging applications are anticipated to grow from a $66 million business in 2003, to over $360 million by 2008 (Brody, 2006). These various packaging applications may facilitate an expansion in the type of foods packaged, their durability, and the distances they may be transported, thereby facilitating an expansion in the national and global distribution of foods. While promising to deliver 'safer', pathogen-free food, the production of 'smart' packaging may also undermine individuals' knowledge and skills in determining the freshness and safety of food (Friends of the Earth, 2008 forthcoming).

A new range of so-called 'smart packaging' is being developed through the application of nano-sensors able to detect the release of particular chemicals. The packaging may be engineered to change colour to warn the consumer if a food is beginning to spoil, or has been contaminated by pathogens. To do this, electronic 'noses' and 'tongues' will be designed to mimic human sensory capacities, enabling them to 'taste' or 'smell' scents and flavours (ETC Group, 2004).

Nano techniques are also being applied to improve food quality attributes, including the shelf life and freshness of food. For example, nano-composite barrier technology is being used to strengthen a range of packaging materials. The aim is to strengthen the barrier between carbon dioxide and oxygen, thereby keeping food fresher longer — or at least slowing down the rotting process — while at the same time blocking packaging materials from absorbing flavour or vitamin content (Rowan, 2004). Nanocor is a leading manufacturer of nano-composite plastics, and currently hold more than 40 patents for these nano techniques. Miller Brewing has also used nano-composite barrier technology to create plastic beer bottles they claim are stronger than their glass counterparts, while nano-particles provide a strong barrier to increase the shelf life of the beer (ETC Group, 2004).

Nanotechniques are also being used to develop food identifiers that may be able to detect contaminants in food and animal feed. The aim is to increase the security of manufacturing, processing, and the shipment of food, by enabling early detection of contaminants, and the removal of infected products from the food chain. In this vein, bioMerieux have developed a multi-detection test – FoodExpertID. This test enables detection of vertebrates in animal feed, and thus represents a nano surveillance response to food scares, including outbreaks of Mad Cow Disease (CJD) arising from the contamination of animal feed with animal products (bioMerieux, 2004).

A new range of nano-barcodes and monitoring devices are also being developed. This includes nano-scale radio frequency identification tags (RFid) able to track containers or individual food items. These RFid tags could also transmit information after a product leaves the supermarket, unless the tags are disabled at the check-out register (ETC Group, 2004). The nanotech company pSiNutria are also developing nano-based tracking technologies, including an ingestible BioSilicon which could be placed in foods for monitoring purposes, but could also be eaten by consumers (Friends of the Earth, 2008 forthcoming). Supermarkets would use nanosensors to monitor product sales and expiry dates, enabling them to reduce their response time for product re-ordering (Kuzma and VerHage, 2006). Nano-sensors may thereby further increase the efficiency of management and buying arrangements for the large-scale retailers able to absorb the costs of these nano-monitoring and identification techniques.

For home kitchens, a number of companies – including LG Electricals, Samsung and Daewoo – have designed 'smart fridges'. The so-called 'intelligence' of these fridges is attributed to the addition of silver nanoparticles, which are intended to inhibit bacterial growth and eliminate odours in fridges. While nano-silver fridges are marketed as a technology to improve food safety, civil society groups and others have drawn attention to the potential toxicity of nano-silver materials in their products (Foladori and Invernizzi, 2007; Royal Society and Royal Academy of Engineering, 2004).

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The Nano-Corporate Food Paradigm

This array of nano-applications – from the farm to the kitchen – demonstrate the extent to which nanotechnology is already being integrated throughout agri-food systems. The scale of corporate investment in nanotechnology suggests that it is likely we will see significant and on-going expansion in nanotechnologies across agri-food systems. In this light, nanotechnology is set to become the dominant techno-scientific form that will frame the next stage of development and transformation of the agri-food system. We will refer to the 'nano-corporate food paradigm' as a way of broadly defining and grouping together some of the likely common features and characteristics of the application of nanotechnology across the agri-food system, and more generally for identifying a distinct techno-economic paradigm of agri-food production, distribution and consumption. While the range of applications of nanotechnology within and between different sectors of the agri-food system will be very diverse, we argue that the nano-corporate food paradigm will be characterised by the continuation, extension, exacerbation as well as transformation of some of the dominant technological, ecological and socio-economic relations within and across the various sectors of the food system.

Technical Characteristics

There are a number of technical characteristics that are likely to frame the development and application of nanotechnologies across the agri-food system. First, the reconstitutive logic of nanotechnology will enable the re-engineering of crops, animals and other living organisms at the genetic and cellular levels, the reconstitution of agricultural inputs, and new techniques for producing a range of 'processed-reconstituted' foods. Atomic and molecular structures, rather than whole organisms and wholefoods, will increasingly become the building blocks and primary inputs in agricultural production and final-food preparation systems (Weiss et al., 2006).

Second, nanotechnology enables the development of more precise, efficient, 'smart' and self-regulating production technologies and inputs. Nanotechnology will enhance the ability to engineer products, tools and systems that are delivered relatively more precisely, or with new, more precisely tailored traits; new production efficiencies designed to reduce inputs and waste; interactive or cybernetic technologies designed to respond to particular conditions or triggers; and the ability to 'stack' a number of traits and features into foods, seeds and other inputs (see for example Savage and Diallo, 2005; Ross et al., 2004).

Third, nanotechnology enables the development of tools and systems for the identification, tracking, monitoring and surveillance of inputs, products and systems, for the purposes of identity preservation, reporting, quality control, and the policing of patent compliance (Hu et al., 2007).

Fourth, the ability to manufacture new types of materials and to modify the traits of crops and food products may mean that both the inputs and end-products of agricultural and food processing systems may be rendered increasingly interchangeable. This includes the ability to develop 'artificial' alternatives to food crops for the food processing industry, or to modify the traits of particular crops to broaden their functional properties. This interchangebility of inputs and outputs would thereby facilitate the extension of existing 'appropriationist' and 'substitutionist' strategies across the food system (Goodman et al., 1987, Goodman & Wilkinson, 1990).

Finally, nanotechnology is a technological platform that provides the technological basis both for the further development of existing techno-scientific forms, and — importantly — for the projected convergence and integration of these technologies. There is also the potential to apply the techniques, materials and products of nanotechnology across a range of applications and sectors of the agri-food system, in much the same way that the new biotechnologies have facilitated the integration of the seed and chemical sectors, and the convergence of the agri-food and pharmaceutical industries though the emergence of 'life science' corporations (Goodman and Wilkinson, 1990; Kloppenburg, 2004). Nano-encapsulation techniques, for example, could be applied both in the encapsulation of pesticides for farm use and the encapsulation of nutrients for processed foods (Friends of the Earth, 2008 forthcoming). In these ways, nanotechnology may give greater unity to otherwise distinct technological trajectories in the contemporary era.

Ecological Relations

These techno-scientific characteristics will in turn constitute or enable the extension and continued transformation of the ecological relations of the contemporary food system. Nanotechnology greatly extends the ability to engage with, transform and reconstitute nature at the atomic and molecular levels, including the engineering of thoroughly novel organisms, materials and final food products. While this level of engagement with nature is not in itself new, its reach and the ability to apply it in a wider range of situations is being radically enhanced. This mode of engagement involves encountering nature — ie. plants, animals, microorganisms, wholefoods — as being constructed from a set of standardised and increasingly interchangeable nano-molecular components (Scrinis, 2006a). There is little respect here for the integrity of the objects of nature in their received form, for all are encountered as plastic and malleable, a standing-reserve of raw material (Heidegger, 1977) ready to provide useful components, to be re-engineered from the atom up, or whose self-assembling properties at the molecular level are to be harnessed, in order to meet the requirements of — and to be smoothly integrated into — the dominant agri-food system (Dupuy, 2007). This more abstract mode of encountering nature will increasingly define the character of food production practices and products as it works its way through the system, including plant and animal breeding and production practices, food processing techniques and products, and consumption practices.

Within the terms of this form of ecological relations, nanotechnology may enable the more *efficient* use of natural resources for many applications and situations. This efficiency may take the form of the reduction in pesticide or fertiliser use, or the development of biodegradable packaging. This technological efficiency has come to define the character of the dominant sustainability discourses within and outside of the agri-food system (Beder, 1997; Lockie, 2001). Genetically modified crops have similarly been promoted on the basis of this more efficient use of agri-inputs, with the aim of legitimating chemical-intensive farming practices (Scrinis, 2007; Buttel, 2007).

This enhanced capacity to reconstitute nature at the nano-scale also introduces novel kinds of hazards and new orders of risk. There may be an inherent unpredictability and unmanageability associated with atomic and molecular level manipulations of nature (Dupuy and Grinbaum, 2006). Despite the enhanced level of precision associated with the nanotechnological manipulation of nature at the atomic and molecular level, there is nevertheless still a considerable lack of precision in understanding and being able to control the consequences of these nano-atomic level manipulations – both in terms of the ways in which the materials, devices and organisms may themselves be transformed, and with respect to how these transformed materials, devices and organisms interact with their wider environments. The 'ideology of nano-atomic precision' refers to the tendency within scientific and popular discourses to exaggerate the level of precision of understanding and control of nature at the nano-level, as well as the tendency to conceal or not recognise the

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new forms of uncertainty and unpredictability associated with this level of engagement with nature (Scrinis, 2006b).[2]

Nanoparticles are already recognised as a potentially very serious toxic hazard to human health and the environment (Belfield, 2005). Nanoparticles in foods in particular — whether in the form of food additives or nanochemical pesticides — “raise legitimate nutritional and health concerns and safety problems” (Pusztai and Bardocz, 2006: 167). The release of nano-engineered living organisms that are capable of reproducing also potentially creates novel hazards reminiscent of the new order of risks associated with the release of genetically engineered organisms (Crook, 2001). The release of these new organisms and materials into the environment and into the food chain heralds the emergence of a new form of ecological pollution, or what can be referred to as nano-pollution (Scrinis, 2006a). There is currently limited understanding of the distance nanoparticles may travel through agricultural environments, or their likely health and environmental impacts. Nor do we understand the health impacts of exposure to nano-particles in the workplace, or the ingestion of nano-particles in food. These potential hazards are exacerbated by a lack of regulation and labelling requirements (Institute for Food and Agricultural Standards, 2007), and by the current limits in public understanding, and public education, related to nanotechnology (Stilgoe, 2007).

Forms of Production and Consumption

In terms of the material practices and forms of production and consumption, nanotechnology is likely to be used to facilitate both the expansion and fine-tuning of large-scale, standardised, mechanised, integrated and capital-intensive production, distribution and retailing systems, as well as to meet the growing demand for more differentiated, tailored, quality or value-added end products (Friends of the Earth, 2008 forthcoming).

In the agricultural sector, for example, nanotechnology is being used to enhance the efficiency and productivity of large-scale chemical-industrial and genetic-corporate farming systems. The ‘efficiencies’ and productivity gains of remote sensor farming, for example, may only be realised on large-sized, capital-intensive farms. In the food processing sector, nanotechnology provides new techniques and materials for the cost-effective mass-production of cheap and standardised food products. Nano-packaging will meet the increasing demand for the long distance transportation and long shelf-life of fresh foods and ready-to-eat meals (ETC Group, 2004; Friends of the Earth, 2008 forthcoming).

Within the context of these highly uniform industrial production systems and their standardised products, nanotechnology also introduces new possibilities for the differentiation of production systems and final food products.[3] This differentiation includes the development of micro-managed large-scale farms that allow the differentiation of specific fields; the development of food crops with modified nutrient and functional traits; the manufacture of processed foods with a wider variety of features and functionalities; and packaging to enable the improved transportation, shelf-life and year-round availability of quality foods such as fresh foods and ready meals (Moraru, 2003). Nanotechnology will also facilitate the growing demand for the identification or identity preservation of products across the food system, for the purposes of food safety, quality control, segmented supply chain logistics, consumer data gathering, and patent surveillance (Mannino, 2007; ETC Group,

[2] The ideology of nano-atomic precision is similar to the ‘ideology of genetic precision’ that has characterised the dominant discourses surrounding the introduction of genetic engineering, particularly with respect to genetically modified organisms and crops (Scrinis, 2000; 2006b).

[3] On the logic of differentiation, see Allaire and Wolf, 2004.

2004). Once again, these applications are likely to favour the larger agri-food and retailing corporations.

In terms of food consumption practices, the use of nanotechnology to manufacture processed foods with enhanced processing, health and packaging functionalities — flavour, texture, shelf-life, transportability, reduced costs and nutritional traits — will facilitate the expansion of the range, quality and quantity of processed foods, and to thereby meet the contemporary demands for both 'health' and 'convenience' (Dixon and Banwell, 2006). The new possibilities for producing so-called 'functional foods' with modified nutrient profiles will also accentuate the growth in demand for these foods, and further promote a nutritionally reductive approach to food and bodily health (Scrinis, 2008a forthcoming). The prospect of 'smart' nutrient delivery systems and 'smart' food packaging for pathogen detection are also distinctly novel applications, and may contribute to the transformation in our relationship to food, in the knowledge and skills of food preparation, and in ways of understanding and shaping the relationship between food and bodily health.

At the same time that nanotechnologies are likely to support the on-going expansion of the dominant or conventional agri-food sectors, it is not inconceivable that nanotechnologies might also be integrated within alternative agri-food practices and systems of production. The organic agriculture and food industries, for example, may support the application of nanotechnologies, especially those that have the potential to enhance sustainable farming practices – for example by reducing chemical and water use. At the same time, however, the organic sector is strategically positioned as a safe, healthy and environmentally friendly food alternative (Lyons, 2001). Nanotechnologies may jeopardise this reputation. The international organic community already appear wary of nanotechnology, and may well opt to exclude nanotechnologies from organic farming systems, in a similar way GMOs have been excluded (see Paull and Lyons, 2008 forthcoming).

Economic Relations

In terms of economic relations and structures, nanotechnology enables the further commodification of agri-food relations of production and consumption, and the extension of corporate concentration, control and integration of the agri-food system.

Firstly, nanotechnology will extend the processes of *techno-commodification* and techno-scientific dependency that have already penetrated deeply into relations of food production and consumption. The term 'techno-commodification' is here defined as where technologies directly mediate or enable the commodification of social relations, knowledge and material practices. Within the food system, the knowledge, skills and practices of farmers, processors and food consumers may be further appropriated, commodified and embedded within 'smart' and value-added inputs, technological packages and food products (Kloppenburg, 2004).

On the farm, this may include new techniques for integrating seeds and chemical inputs (such as chemically-triggered seeds traits); new tools for data gathering and evaluation (such as nano-sensors and other precision farming technologies for the micro-management of large-scale farms); new crop or animal traits that address emerging agronomic problems or consumer demands, and that thereby entice farmers to switch to patented seeds that are subject to 'technology fees' and binding contracts, as are many genetically modified crops; and the further undermining of subsistence practices, such as on-farm breeding (Friends of the Earth, 2008 forthcoming). The nanotechnological treadmill may join the existing chemical and genetic treadmills already confronting farmers, and create new forms of technological dependency, as well as financial and ecological risks for farmers (Scrinis,

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2007; Goodman and Redclift, 1991; Kloppenburg, 1992). Nanotechnology also threatens to intensify the reduction and displacement of farm labour, through the ability to expand the use of mechanical and chemical technologies, or to automate other skilled tasks or decision-making practices. This process of technological innovation – and the subsequent displacement of farm labour – has been characteristic of agricultural development across many parts of the world since the early 20th century. Goodman and Redclift (1991; 102) argue that this 'treadmill' of competitive innovation was – and continues to be – supported by agricultural research and development, as well as agricultural and technology policies. This trend has the dual effect of locking farmers into the on-going purchase of technological innovations (for example seeds and agri-chemical inputs), while at the same time extending the reach and authority of corporate agri-food industries (Goodman and Redclift, 1991).

For the food processing industry, techno-commodification may take the form of new proprietary techniques for modifying the nutrient profile of foods and introducing new packaging functionalities that provide new value-adding possibilities. For consumers, the knowledge and skills for understanding and preparing tasty and healthy foods and diets may be further appropriated where this knowledge and skills are embedded within modified and value-added foods and food packaging.

To refer to a 'nano-corporate' paradigm is to both emphasise the dominance of the corporate economic form *per se* in the contemporary period, as well as the close interconnection between these respective technological and economic forms (Scrinis, 2007). There is a very strong sense in which nanotechnology — and other recent techno-scientific forms, such as genetic engineering — are *corporate technologies*, both in the sense that it is corporations that predominantly own and control these technologies and their associated patents and products, as well as in the sense that corporations are using these technologies as one of their primary strategies for restructuring and extending their control of the agri-food system (see for example Boyd, 2003). Agri-food corporations are likely to determine the types of nanotechnological techniques, materials and products that are developed and commercialised. Nano-agricultural research and development, for example, is likely to be driven by large seed, biotech and chemical corporations, and to be underpinned by extensive patenting (ETC Group, 2005b; Friends of the Earth, 2008 forthcoming).

The dominant economic paradigm of the agri-food system has itself been in transformation over the past couple of decades. It has been characterised by corporate concentration, integration and co-ordination within and across sectors of the food system; the shift from competitive to oligopolised markets characterised by 'clusters' of corporations cooperating across food sectors; the shift from public to private research and development; and the increasing use of patents (Heffernan, 2000; McMichael, 2005). However this trend towards an increasingly vertically integrated and homogenous food system has also been challenged in some respects by the emergence of competing and segmented systems of production delivering a wider variety of quality, health-focused and niche products (Wilkinson, 2002a). The increasingly powerful retail sector has seen supermarkets wrest dominant control of the agri-food system from the agribusiness and manufacturing sectors, in part through their ability to meet these diversifying and quickly evolving consumer demands (Burch and Lawrence, 2007). From what looked like a single and increasingly unified system, there has perhaps emerged what is more like a system of interacting systems, with competing interests amongst the dominant players and between divergent demands, though with supermarkets firmly in control at present.

In this context, nanotechnology — a technology which itself increasingly encounters living organisms, and each of their component parts, as complex systems (Dupuy and

Grinbaum, 2006) — is perhaps ideally placed to serve these various interests and structural dynamics. Firstly, nanotechnology is able to facilitate the intensification of corporate concentration and integration of the agri-food system within and across food sectors. The ability to further technically integrate the various inputs, applications and sectors of the agri-food system, may facilitate the further vertical integration or coordination of corporate ownership and control. The corporate control of farmers, for example, may be enhanced via the more precise control and engineering of technologies and inputs, such as patented and chemically-triggered seeds, seed-chemical packages, and farmer surveillance technologies (ETC Group, 2004; 2001). At the same time, just as the new biotechnologies have enabled alliances and convergences across industrial sectors — such as between the food and pharmaceutical industries (Sanguansri and Augustin, 2006) — the cross-industry character of the nanotech platform is also likely to facilitate such cross-industry alliances and convergences. Secondly, through the ability to modify production systems and end products to precise specifications and to facilitate the distribution and identity preservation of these differentiated products, nanotechnology also enables these production and distribution systems to quickly adapt to changing and diverse consumer demands, as well as to emerging ecological pressures and crises.

While the emergence of the new biotechnologies in recent years may have primarily tended to favour the agricultural sector over the food processing sector (Wilkinson, 2002b), the significant level of investment in research by the large food manufacturing corporations may indicate that significantly more benefits may flow to the final foods industry in this next stage of technological development, particularly due to the enhanced ability to create value-added and differentiated food products. At the same time, the dominant position of supermarkets may be further strengthened through nano-applications which deliver product differentiation, identity preservation and monitoring, and more flexible and enhanced product packaging and distribution possibilities.

Paradigm Shifts

Technological innovation has played an important role in shaping the development and characteristics of the agri-food system over the past century and more (Goodman et al., 1987). The emergence of the new biotechnologies of food production since the 1980s — such as genetic engineering, tissue culture and other cellular and genetic level techniques — have been identified as the basis of a new technological paradigm, and as framing the restructuring of contemporary agri-food systems. In the agricultural sector in particular, this has variously been referred to as a new ‘bioindustrial paradigm’ (Goodman and Wilkinson, 1990; Wilkinson, 2002b), a ‘genetic-corporate paradigm’ (Scrinis, 1995; 2007), or more generally in terms of a shift from a Green Revolution to a Gene Revolution form of agricultural production.

The nano-corporate food paradigm does not represent a major break with other recent technological or economic paradigms within the agri-food system, such as the biotech paradigm in agricultural production. In the case of agricultural biotechnologies, for example, there are strong similarities and continuities between genetic engineering and nanotechnology in regard to the types of agricultural practices, farming styles, patenting regimes, and corporate structures these technologies are being used to support and transform. Nanotechnology will in fact serve as an enabling technology for genetic and cellular technologies, as well as for the information technologies which have played an increasingly important role across food sectors for managing and coordinating production and distribution systems.

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Nevertheless, nanotechnology is set to become the dominant technological form of the early twenty-first century, in the sense that it is the technological platform that will frame the further development — as well as the further integration and convergence — of these other contemporary techno-sciences. The scope of this technological platform — in terms of its range of applications and products — is also much broader than, say, genetic engineering, and the characteristics of the nano-corporate paradigm we have identified are to some extent common across agri-food sectors. The nano-corporate paradigm can be understood as consolidating — and enabling the further extension and convergence — of these existing technological and economic paradigms across the food system. In the agricultural sector, for example, the nano-corporate paradigm will effectively incorporate the genetic-corporate form of agricultural production.[4]

The characteristics of the nano-corporate paradigm are also broadly consistent with what Tim Lang and Michael Heasman (2004) have referred to as the emerging "Life Sciences Integrated paradigm". They argue that the life sciences integrated paradigm is one of two general responses that have emerged as a result of the limitations and crises confronting the dominant 'Productionist paradigm' towards the end of the twentieth century, with the other alternative response being the 'Ecologically Integrated paradigm'. Lang and Heasman emphasise the role of the new biotechnologies of food production for the development of genetically engineered crops, nutrigenomics, and functional foods. They acknowledge that the life sciences integrated paradigm in many respects "relies on a simple re-interpretation of the existing Productionist paradigm but claims to remedy a number of its limitations: from lessening environmental impacts, through improving human health from greater food production, to creating new products with enhanced, yet often contested, health benefits" (Lang and Heasman, 2004: 22). While Lang and Heasman do not refer to the new nanotechnologies, these technologies will certainly facilitate many of the applications and structural tendencies associated with the life sciences integrated paradigm that they identify.

As the new techno-sciences have come to play an increasingly important role across the agri-food system, they have in recent times also become the focus of civil society and social movement contestation. The strong opposition to genetically modified crops has arisen on the basis of a number of concerns, ranging from "the defence of peasant and small farmer interests, to bio-diversity, environment, animal welfare, ethics and consumer health issues" (Wilkinson, 2002a: 4). The range of issues raised reflects a growing recognition of the power of these new techno-sciences to not only introduce new health and ecological hazards, but also to increase the power of agri-food corporations over farmers and citizens' interests. This opposition has so far restricted the development and commercialisation of genetically modified crops, and has raised concerns about the emergence of a similar level of public resistance to nano-foods (Feffer, 2005; Renton, 2006). This has led to repeated calls for the nanotechnology and food industries to "learn the lessons" of biotechnology and GM foods (Grove-White *et al*, 2004). If a significant level of public and consumer resistance to the introduction of nano-foods does emerge, an important issue will be whether the now dominant retail sector will take a position of responding to consumer concerns — as supermarket chains in some countries have to GM foods, thus pitting themselves against the interests of corporations at the other end of the food chain — or whether the broad scope of nano-food applications, and supermarkets' own adoption of nano-applications, compromises their ability to respond in similar ways.

[4] A way of categorising agricultural paradigms with reference to their dominant technological and economic forms respectively, is in terms of a progressive shift from organic-subsistence, to chemical-industrial, to genetic-corporate and nano-corporate modes of agricultural production (Scrinis, 2007; 1995).

As we are still in the relatively early stages of research and commercialisation of nanotechnology, there is considerable potential for civil society groups, workers' unions, farmer and producer organizations, environmental and consumer groups, to challenge and shape the development and implementation of this technology, and to thereby support alternative applications, regulatory regimes, and techno-economic paradigms of development.

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BOOK REVIEW:

NUTRITION POLICY IN CANADA, 1870-1939. *PUBLISHED IN 2006 BY UBC PRESS, ISBN 978-0-7748-1328-0 (PAPERBACK). 136 PAGES*

E. Melanie DuPuis
UC Santa Cruz

In an era when it sometimes seems that too many people are publishing too many books about the same thing, it's such a relief to find a book that covers a topic no one has come even close to covering. There are, as we know, mountains of books about nutrition, but there are very few books about nutrition policy and almost none about nutrition policy history, in fact, hardly any books that claim to be doing "policy history" in general. Ostry's book is therefore a very welcome piece of work. It is well researched, setting a methodological standard for what a nutrition history should entail, with significant attention to archival materials and early surveys, statistics and texts. My main problem with it is, in fact, my problem, not his: I wish the book were not about Canada.

I realize that this is the usual boorish, US-o-centric response that Canadians are quite used to by now. I also realize that this is an *International* journal, and that I should be happy that the Canadians have their own nutritional policy history when nothing similar exists for the US. But I am, honestly, jealous. I can't help reading the book wondering what the US history would look like.

Because of this jealousy, my response to the book is quite skewed. Like most US Americans, my experience of Canada is of a place strangely familiar and strangely different at the same time. Reading Canadian history makes me feel like I'm in "Bizzaro World." Running out of plot ideas, DC comics created this somewhat different world in which the usual life and people in Superman comics had unusual variations (some good guys were bad guys and vice versa, for example).

Canada is in no way "Bizzaro World." As a matter of fact, if you believe Michael Moore, the US may be the more bizarre country. However, reading as a US researcher who knows a bit about US nutrition policy history, *Nutrition Policy in Canada* is a bit like visiting a world which is so much like your own you are lulled by the sameness, until you realize that everyone has slightly purple eyes. As I read his history, I would find myself looking up US statistics just to make sure things weren't exactly the same. For example, the responsibility for inspecting food for adulteration in Canada moved from the Department of Agriculture to the Department of Health in 1919. When did FDA move to HEW? 1953. Infant mortality rates decline sharply during the Depression. Is this true in the US? Less so, but overall rates had declined the decade before while Canadian rates made a similar decline in the 1930s. Why? Ostry attributes the decline to increased food availability, despite the Depression, due to lowering of food prices. An interesting argument, but why did mortality rates decline so significantly during rising food prices in the US the decade before? Well, I'm not sure I have found the answer to that question, yet.

I'm also not sure why there are such strong differences in epidemiological statistics on nutrition diseases between the US and Canada. Harvey Levenstein's histories of food consumption in America are not strictly histories of nutrition, but they are the closest we have. Levenstein argues that a lot of the "nutrition surveys" in the US overstated malnutrition. There's some indication this was true as well in Canada, for similar reasons: to give ammunition to those who were lobbying for greater government relief payments. However, once again, I was driven to take a quick look at US statistics on nutritional diseases like rickets, and the story is not exactly the same, although it would take me days to figure out comparable statistics to those in Canada, given the differences in reporting.

In other words, I ended up reading this book with the internet by my side, trying, often unsuccessfully, to come up with the comparable statistics and institutional histories in my own country. It was a fascinating, if somewhat frustrating exercise. Of course, Ostry's response to my frustration should be: "Go and write your own nutrition history!" This book is Canadian grown and written for that audience. The US version is a book waiting to happen.

Which brings me to my another question about this fascinating account: to what extent are the differences between the story told about Canadian nutrition policy history and US nutrition policy history differences in fact or in the eye of the storyteller? For example, when looking at the development of dietary standards in the US, I tend to argue that it began with work in the nineteenth century measuring the amount of calories needed to do work, and that this research was part of a larger professional middle-class agenda in opposition to the need for higher wages, despite workers' organized efforts in this area. Ostry argues that, in Canada, national dietary standards emerge decades later from a need to set relief rates during the Depression. Is there no parallel set of nineteenth century middle-class nutrition professionals responding to workers' movements in Canada? Of course, I can't ask Ostry to talk about what isn't there.

Ostry's work on Canadian milk policy also has some specific parallels to my own milk history work. Here again, are his conclusions due to different facts or different interpretations of the facts? For example, using health surveys from the time periods, I argue that breastfeeding declines primarily among middle class women in the United States in the nineteenth century and that it is only in the twentieth century that poor women abandon breastfeeding (DuPuis, 2002)[1]. Ostry claims that many poor women in Canada abandoned breastfeeding much earlier. This may be a difference in culture: Ostry notes that many of the poor urban women who did not breastfeed in Canada were French-Canadian. Even in the US, breastfeeding statistics show that French-Canadians were less likely to breastfeed than other mothers. This tendency not to breastfeed is also evident in French statistics from the time. French-Canadian women were also more likely to be poor. In French culture, women were more likely to work full-time outside the house, even in the nineteenth century, than other European cultures. On the other hand, what percentage of total mothers breastfeeding represents a significant drop in breastfeeding? Ostry doesn't give us actual rates of breastfeeding for the periods he discusses, so it is difficult to compare with US breastfeeding rates for that period.

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Some differences are in fact differences and are not variations in interpretation. One very interesting difference was the existence in Canada of a national guide to children's nutrition called the *Canadian Mothers' Book*. No equivalent book existed in the US. Why this difference? Only a comparative history could tell.

So, as you can see, this reader kept looking for a comparative history of US and Canadian nutrition she had no right to demand from this author. What Ostry does give us, however, is a wonderful place to start thinking about these comparisons. He gives us an example of how one country went about creating a nutrition policy and how it did and did not work. He also gives us an example of nutrition history as a genre and as method. No matter where you come from, this book will give you ideas about how to think about your own nutrition policy history in your own country.

Work cited:

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BOOK REVIEW:

GOING ORGANIC: MOBILIZING NETWORKS FOR ENVIRONMENTALLY RESPONSIBLE FOOD PRODUCTION. BY STEWART LOCKIE, KRISTEN LYONS, GEOFFREY LAWRENCE AND DARREN HALPIN. PUBLISHED IN 2006 BY CABI PUBLISHING WALLINGFORD, UK. ISBN: 9781845931322 (HARDBACK) 208PAGES

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The book, *Going Organic*, records a broad based and detailed examination of organic agricultural from a notably Australasian perspective. As such, it provides a refreshing – and potentially revitalising – assessment of a sector that has emerged as a pariah in other contexts (most notably in the popular press, Michael Pollan's condemnation of corporate organic). In fact, the authors position the objective of the book – telling "a more complex story about organic food and agriculture" (p. 2) – as directly opposed to the burgeoning literature that suggests the organic sector is becoming more difficult to distinguish as an alternative form of agricultural production (i.e. the increasing prevalence of the conventionalisation thesis). Thus, their narrative also carries the ambition "to use the experiences of the organic sector to transform more radically the ways in which we produce, distribute and consume on a global scale" (p. 2). In effect, the authors claim to be "putting the organic sector under the microscope" (p. 3) in order to assert its social and environmental benefits. This approach places the book squarely in line with the emerging academic debate around the potential of organic.

Organic agriculture is a topic that has captured the imagination of scientists examining social, agronomic and ecological aspects of agricultural production. As is indicated in *Going Organic*, it has likewise become a vibrant (if relatively insignificant) feature in the marketing and consumption of food and fibre throughout the global economy, often enticing the focus of a variety of media outlets. The attraction of organic agriculture, despite its marginal position in comparison to more 'conventional' agri-food production systems, lies largely in its claims to being an alternative. Not only are organic methods different from more chemically intensive practices, they also promise more positive relations between producers and both the environment and society. Thus, organic agriculture has become the sustainable production system *du jour* with which to challenge the existing values imbued within and assumed successes of more conventional agricultural practice. Early proponents and researchers of organic agriculture alike began to employ justifications of the practice based on the common good, constituted by collective solidarity developed around benefits for the health of the beings consuming its product and interacting with it. The contestation over the most appropriate means of production and its basis of justification exposed the practice of organic agriculture to public tests of these claims (see Rosin and Campbell 2006).

More recent assessments of organic agriculture have exposed some of the deficiencies of its practice within specified contexts. For example, assessments of the ecological

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awareness and social responsibility demonstrated by organic producers in California (see Buck, et al. 1997; Guthman 2004) showed that many failed to engage in the precepts of agro-ecological practice and that they increasingly employed exploitative labour practices similar to their conventional counterparts. Research in Canada has also suggested that, while women are more active in the decision making processes on alternative farms (including organic), traditional gendered roles are maintained (Hall and Mogyorody 2007). Furthermore, in Europe, the focus of critique is on the potential for organic agriculture to provide a viable alternative for small farmers. In this perspective, reliance on organic as a means of differentiating the product of small farmers is considered wanting as it is too readily routinised and incorporated within conventional marketing and retailing systems (see, Watts, et al. 2005). By contrast, *Going Organic* offers a uniquely Australasian perspective, following the approach of previous literature (see Campbell and Liepins 2001; Lockie and Halpin 2006; Lyons and Lawrence 2001) that is determined to maintain the distinctiveness of organic producers and their potential to usher in more socially and environmentally appropriate practice.

In *Going Organic*, the authors simultaneously develop a defence and a promotion of the organic sector as a positive alternative to an existing agri-food system fraught with environmental degradation and social exploitation. In the introduction, the objectives of the book are outlined with the presentation organised around the process of mobilisation – that is, a concerted focus on who is involved in organic agriculture and what may encourage a broader participation in the sector. The focus on mobilisation is readily evident in the structure and presentation of the chapters. The main body chapters each apply the authors' microscopes to specific 'links' in the organic food commodity chain and are sandwiched by a chapter "positioning organics" and one discussing "organic futures". In positioning organics, the authors review existing debates regarding the value and validity of the organic sector (its capacity to provide a socially and environmentally appropriate alternative) focusing, in particular, on the conventionalisation debate and associated concepts of bifurcation, institutionalisation and the potential erosion of standards. Conventionalisation is then discarded as an overly generalising concept that emphasises production while ignoring the complexities of consumption, regulation and promotion.

Following a commodity chain framework, the five central chapters of *Going Organic* examine the condition of organics with reference to: 1) media representations; 2) governance structures; 3) comparative impacts and output potential of production; 4) the tendency toward concentration of distribution and retail actors; and 5) the response of consumers. Each of these chapters discusses both the challenges to the claims to being a positive alternative forwarded by the organic sector and the extent to which these are based in either the misrepresentation or the lack of appropriate data. The balance of these discussions indicate the relative value of organic agriculture as both a practice and as the basis for a more egalitarian and environmentally responsible means of sourcing food for the global population. The state of the sector is represented as being vulnerable to the more powerful actors in the conventional sector, but also potentially resurgent by means of the mobilisation of it proponents. The greatest potential for realising such mobilisation is located in re-establishing the relationships and links between producers and consumers, a finding that leads to the chapter on organic futures.

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The future of organics is presented as a competition over claims to the 'green' market. The successful outcome for the sector is dependent on its capacity to project and substantiate its claims to social and environmental responsibility that involves the active participation of readers as interested consumers and academics. In the conclusion the challenges facing the organic sector are reiterated in the form of nine misconceptions, each of which is refuted on the basis of the data presented earlier. The question is then diverted from the relative value and validity of the organic sector as an alternative to the means by which support for the sector and its ideals can be mobilised. To this end, the authors provide five strategies which straddle the whole of the commodity chain (retail pricing, supply chain coordination, positioning and availability of organic foods, certification and labelling and promotion and education). In sum, the organic sector has the potential to thrive as long as a variety of participants are willing to act on its behalf. If any aspect of the book is to be found deficient, it is its lack of an overarching theoretical approach and explanation for the processes that have been so competently documented to construct a compelling narrative for mobilisation.

Overall, *Going Organic* provides an excellent review of the state of the organic food and fibre sector along the whole of the commodity chain. In essence, it holds true to the authors' intent to expose the sector to the microscope as promised in introduction. By presenting the current situation as a series of contested representations of organic and of food and fibre more generally, they establish solid credibility for arguing the necessity to mobilise support for organics. The substantial detail of analysis of respective links in the organic commodity chain also contributes to their claims that the sector is a positive alternative to existing conventional agriculture. As such, the book provides a good introduction to the sector and to the complexity of both the context within which it operates as well as the processes which either promote or constrain its growth. *Going Organic*, thus, is an excellent contribution to the literature on organic agriculture. It is an especially good resource for those beginning their exploration of food and fibre production or as a text for undergraduate-level rural sociology or rural geography courses and its call for mobilisation positions it well for an audience among the general public. Finally, it provides a solid foundation for future examinations of the organic sector and of agri-food systems more generally, including a variety of innovative and incisive analyses and theoretical approaches.

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