



*Agriculture and Human Values* 20: 125–141, 2003.

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## **The effects of the industrialization of US livestock agriculture on promoting sustainable production practices**

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Accepted in revised form September 15, 2002

**Abstract.** US livestock agriculture has developed and intensified according to a strict productionist model that emphasizes industrial efficiency. Sustainability problems associated with this model have become increasingly evident and more contested. Traditional approaches to promoting sustainable agriculture have emphasized education and outreach to encourage on-farm adoption of alternative production systems. Such efforts build on an underlying assumption that farmers are empowered to make decisions regarding the organization and management of their operations. However, as vertical coordination in agriculture continues, especially in the animal agriculture sectors, this assumption becomes less valid. This paper examines how the changing industrial structure in four US livestock sectors (poultry, hogs, beef, and dairy) affects possibilities in each for promoting more sustainable production practices. Comparisons between the sectors are based on the relative ability to employ an intensive pasture or alternative (deep-bedded) housing system, which are widely seen as sustainable livestock alternatives. While the highly integrated poultry sector appears impregnable to traditional sustainable agriculture approaches, the cow-calf sub-sector of the beef industry, non-feedlot dairy operations, and small parts of the hog industry, especially in the Midwest, still retain some potential for effectively targeting the farmer. Building on the presentation of barriers and opportunities in the four livestock sectors, the paper concludes by evaluating several structurally-oriented approaches to promoting a more sustainable livestock agriculture that should complement more traditional approaches. They include developing alternative coordinated networks in livestock agriculture, pressing integrators to permit more sustainable production practices, and working for legislation that shifts more decision-making within integrated systems towards growers.

**Key words:** Beef, Coordination, Dairy, Hogs, Industrialization, Poultry, Sustainable agriculture, US livestock agriculture, Vertical integration

**Abbreviation:** SARE – Sustainable Agriculture Research and Education Program (US Department of Agriculture)

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### **Introduction**

Like other sectors of agriculture, contemporary livestock agriculture has undergone structural changes

that have led to persistent criticisms. Many contend that much livestock agriculture in the US today poses substantial environmental risks, and is associated with growing economic and social inequities

throughout the food system (see, e.g., Schlosser, 2001). Like agriculture more generally, livestock agriculture has developed and intensified according to a strict productionist model that primarily emphasizes efficiency, with less attention to how intersecting cultural, social, economic, and environmental functions constitute dynamic agricultural systems. As a result, livestock agriculture poses sustainability problems that are challenging to resolve, particularly given distinct patterns of industrialization in different animal sectors.

Agricultural industrialization involves various structural changes, such as increasing scale and capital intensiveness of the farm operation, farm-level adoption of chemically intensive approaches to soil fertility and pest management, dramatic reductions in the numbers of farms and farmers, movement from family-based labor toward hired labor, and increasing vertical coordination (as well as explicit integration) between off-farm firms, such as food manufacturers and input suppliers, and production operations. Specific changes reflective of industrialization may occur individually or in combination (Welsh, 1996). In this paper, we highlight, in particular, the significance of vertical coordination in the industrialization of livestock agriculture.

Sustainable agriculture offers an encompassing banner under which groups and individuals have gathered to address the environmental, social, and economic equity problems they associate with conventional, industrial agriculture (Buttel and Shulman, 1997; Mooney et al., 1996; Pfeffer, 1992). A number of collective efforts constitute the sustainable agriculture movement. These include education to support legislative and regulatory reforms to control agricultural pollution more effectively; shifts in federal and state agriculture research funding toward sustainable agriculture priorities; and education and outreach to convince farmers to adopt practices under the sustainable agriculture rubric (see National Campaign for Sustainable Agriculture [<http://www.sustainableagriculture.net/>]). The latter effort is the focus of this paper. Traditionally, such education and outreach work with farmers and other rural residents has involved activities such as establishing demonstration projects, holding field days, and disseminating research results through on-farm research, farm visits, newsletters, and websites.

Funding for the promotion of sustainable agriculture practices often originates at sympathetic foundations such as the Kellogg Foundation or from the US Department of Agriculture's Sustainable Agriculture Research and Education Program (SARE) (<http://www.sare.org>). Funding from SARE is available for research into sustainable agricultural prac-

tices, as well as for promoting practice adoption through the cooperative extension systems (SARE). Some of the technical practices and systems promoted by sustainable agriculturalists include reductions in synthetic chemical use through crop rotations, farm diversification through integrating crops and livestock, and intensive rotational grazing of livestock, as well as other more environmentally friendly, less capital intensive livestock production (see Beeman and Pritchard, 2001; Beus and Dunlap, 1990; Bird et al., 1995; SARE).

Sustainable agriculture has proven successful to some extent. For example, innovations such as Integrated Pest Management (Pedigo, 2002), biological control (Pickett and Bugg, 1998), and intensive rotational grazing (Jackson-Smith et al., 1996) have become fairly well accepted by a broad range of producers. However, the promotion of such practices and interventions has to date emphasized persuading farm-level operators and workers to change from conventional production practices to more sustainable approaches. Critically, this assumes that the individual on the farm has managerial autonomy and discretion over key organizational and operational aspects of the farm. Such an assumption may be less valid today than when sustainable agriculture first emerged in the US context.

In commodity systems, such as poultry, where production is coordinated or fully integrated with processing and/or input supply firms, targeting farm-level decision-makers to make changes intended to enhance sustainability has proven problematic. Poultry production is now more than 90% coordinated with processing; the majority of managerial control resides with the poultry companies, not the growers. Targeting the grower as a viable change agent for such agricultural systems is far less effective than in commodity systems where growers maintain a greater degree of autonomy and in which production has not become so highly concentrated and integrated with off-farm firms. Such integration can limit the menu of production alternatives available to poultry growers, since production practices can be highly prescribed by integrators. Substantial deviation from such prescriptions could lead to loss of access to the integrated market structure. Because a growing number of commodity systems appear to be changing to reflect, in certain respects, the structure of the poultry industry, sustainable agriculture advocates may need to alter their assumptions and strategies, or risk ineffectiveness or even irrelevance.

In this paper, we examine the changing structure of four major US commodity systems: the livestock sectors of poultry, hogs, beef, and dairy. Overall, these livestock sectors are shifting toward more concentrated

and coordinated structures, which pose obstacles for traditional educational and outreach approaches for promoting adoption of sustainable practices. However, differences within these sectors are also evident, suggesting distinct mixes of opportunities and barriers for sustainable agriculture within each sector. To make comparisons between the livestock sectors regarding the efficacy of targeting farm level decision makers to adopt sustainable practices, we consider the relative ability within each sector to employ an intensive pasture system or alternative housing system in place of or in addition to a confinement system.<sup>1</sup> We use intensive pasture system (e.g., rotational grazing) adoption as a basis for comparison because such systems have been developed for all major livestock sectors and have been widely promoted as a sustainable approach to livestock production (see, e.g., SARE). We also consider alternative-housing systems (e.g., hoop houses) for hogs because they address some of the concerns of those promoting sustainable agriculture and have now been adopted by a small, but steadily growing number of Midwest hog producers (Honeyman, 1996a).

The use of relative ability to adopt a pasture-intensive or hoop house system as our basis for comparing the four livestock sectors is not an assertion that such systems are the only approaches or complete answers to sustainable livestock farming.<sup>2</sup> Rather, we emphasize the feasibility of targeting the farm-level operator in order to increase use of technologies and systems that are increasingly associated with sustainable livestock agriculture. Following our discussion of the four livestock sectors, we conclude by proposing several structurally informed recommendations that those seeking to promote more sustainable livestock agriculture might consider as strategic complements to more traditional education and outreach approaches with farmers.

### Coordination in agriculture

Through the 1970s and 1980s, the sociology of agriculture focused considerable theoretical attention on the “persistence” of household-based production in agriculture (Buttel et al., 1990; Buttel, 2001). Different camps struggled with how to interpret the “agrarian question” of why household-based production has persisted in modern agriculture when in every other economic sector it has been replaced by larger-scale corporate bureaucracies. Winson (1990: 376) argues that this preoccupation with the “agrarian question” prevented many sociologists from recognizing the significance of the “. . . real changes taking place in the agrarian structure of advanced capitalist countries.”

Winson’s (1990: 377) argument proceeds from an analysis of structural change in North American agriculture, especially the increasing importance of industrial production that was “. . . produced through some form of contracting arrangement or on the corporate farms that input manufacturers and food processors operated themselves.” Taking a critical perspective, Winson (1990) focuses on the shift in managerial functions and ownership of production inputs from farm-level operators to off-farm firms that characterizes many coordinated arrangements. He also suggests that “degenerated petty commodity production” better describes household-based agricultural production that has entered into such contract arrangements (Winson, 1990: 378).

Less critical perspectives on vertical coordination in agriculture often focus more on firm and consumer benefits. They point to positive outcomes, such as the sharing of risk between production stages, increased throughput efficiency, and better information exchange through the food system so as to improve quality and enhance responsiveness to end-consumers (Martinez, 1999; Smith, 2001; Tweeten and Flora, 2001). They tend to minimize or overlook possible imbalances of power and control among the various coordinated entities.

A commonly offered explanation for increasing industrialization, and especially vertical coordination, in animal agriculture sees these trends as consumer driven (Smith, 2001). Food consumers have developed more specific, discriminating tastes and preferences; to respond effectively, the food industry requires tighter, more coordinated linkages between system components from production through marketing and distribution. Coordinated structures permit information to flow more easily and accurately and enable food manufacturers to meet more fractionalized consumer demand (Barkema, 1993; Welsh, 1996). However, this explanation has been criticized. For example, economist V. James Rhodes (1993) argues that the rise of the discriminating consumer happened well after significant industrialization had begun in the poultry and fed cattle sectors.

In addition, sociologists of agriculture have argued that global agro-food system restructuring is driving the industrial reorganization of large parts of the livestock industry. Such restructuring entails the global integration of the input, production, and marketing sectors such that transnational agro-food firms can globally source production inputs to enable industrialized production of livestock (Constance and Heffernan, 1991; Friedmann, 1994; Heffernan and Constance, 1994). Integration of this type takes place through such firms either owning their own feed grain and animal feeding operations or by forming stra-

tegic alliances and joint ventures (Friedmann, 1994; McMichael, 1994, 2000). Here flows of transnational capital are arguably more influential than the preferences of consumers.

While the reasons for greater coordination in an industrializing agriculture can be debated, Welsh (1997a, b) argues that one definite outcome is an increase in more direct farmer-to-consumer marketing arrangements over the past two decades. Dissatisfied with the industrial food system, an increasing number of producers and consumers are developing and participating in separate, "alternative" food streams that incorporate attention variously to environmental protection, animal welfare, social equity (including protecting the "family farm"), rural community vitality, and the desire for more personal relationships and less anonymity within the food system (Hinrichs, 2000). However, such alternative food streams can themselves represent a form of coordination, albeit different than the formally administered coordination of production contracts or integrated ownership. In what Marsden et al. (2000) have termed "short food supply chains," producers and consumers are forming quality-focused food networks, based variously on face-to-face relations, spatially proximate marketing, or more spatially extended marketing. Sometimes incorporating processors, retailers or restaurants, such alternative food supply chains vary in their degree of formal organization and illustrate how coordination is being adapted and employed throughout the food system. In fact, alternative coordination has emerged in some fashion in each of the four livestock sectors analyzed in this paper. In the next four sections, we trace patterns of industrial development in the poultry, hog, beef, and dairy industries. While vertical coordination is a crucial feature of industrialization in these livestock features, we also explore the rise of alternative coordination arrangements that may be more conducive to sustainable agriculture.

### The poultry paradigm

For several decades, the poultry industry has been held up as a model – both positive and negative – for other agricultural sectors. Those who look favorably on the poultry industry view its vertically integrated structure as a model of production and processing efficiency, as well as responsiveness to changes in consumer demands (Bjerklie, 1995). Those who view the industry more critically see it as an overly concentrated, coordinated monolith, offering largely negative consequences for producers, workers, rural communities, the environment, and consumers (Kim and Curry, 1993).

The poultry industry has several characteristics that make it unique and also a flashpoint for current controversies over structural change in agriculture.

1. The industry exhibits high levels of integrated ownership and the widespread use of highly prescriptive production contracts.
2. Poultry production is geographically concentrated in the average number of animals per farm and in the relatively few counties in which the vast majority of birds are produced.
3. The poultry companies, i.e., integrators, have designed the production, processing, and marketing system, whereby they control the production process to produce a uniform product that they differentiate for marketing purposes through processing. The companies also brand the final product that consumers purchase.

The changes toward an industrialized structure in the broiler poultry industry began after World War II. Before that time the industry was much more decentralized and loosely organized, often a household-based subsistence or income augmentation activity run by women (Fink, 1986). In addition, broiler production was a residual activity of egg production.

After World War II, the location of broiler production shifted, contract and integrated production rose rapidly, and firm concentration steadily increased. For example, in 1954, there were *no* broiler poultry farms with at least 100,000 birds. In 1974, there were 9,314 (30% of all poultry farms) with at least 100,000 or more birds (Reimund et al., 1981). By the middle of the 1990s, almost 100% of broiler poultry production was accounted for by farms with 100,000 or more birds (Welsh, 1996). In addition, by 1960, 90% of broiler production was accounted for by production contracts (Welsh, 1997a). Firm concentration has increased dramatically. Whereas the top 19 broiler processing firms accounted for 30% of production in 1960, by 1975, the top 8 broiler processing firms controlled 30% of production (Reimund et al., 1981). More strikingly, by 1998, the top four broiler processing firms controlled approximately half of total production (Heffernan, 1999).

The change toward an industrial poultry broiler structure was made possible by developments that included advances in equipment and building design, making it possible to clean houses mechanically and automate feed handling and watering of animals. In processing, mechanized killing and processing lines were developed and implemented, so that all processing functions could now be integrated in single plants. Furthermore, breeding changes made fast growing strains of chickens the new norm. With antibiotic feed additives, poultry scientists sought control



of poultry diseases. These scientific and technological developments made it possible to grow chickens faster and in larger numbers (Reimund et al., 1981), and thereby significantly reduced prior business risks in poultry production.

But beyond engineering and genetic changes, organizational changes fostering vertical coordination helped to industrialize the broiler poultry industry. Specifically, the production contract provided the vehicle to integrate all the changes in the various parts of the broiler production and processing industry. Reimund and colleagues (1981: 8) argue that "... without production contracts, and the opportunities they afforded for coordinating the several stages of the sub-sector, it is doubtful that new entrants, primarily feed manufacturers and dealers, would have considered broiler production very attractive." As Heffernan (1984) notes, the terms of such production contracts dramatically tipped the balance of power away from growers towards the integrating firms.

As the broiler poultry industry industrialized, there were significant shifts in regional distribution. Before 1950, most broiler production was located in the Delmarva states, New England, Arkansas, East Texas, and California (Martin and Zering, 1997). By 1971, the South Central and South Atlantic states were home to almost 90% of broiler output (Reimund et al., 1981). This shift has been attributed, in part to boll weevil outbreaks in cotton producing regions and major apple crop failures in Arkansas, which weakened the position of other agricultural production systems. In addition, land was cheap, other employment opportunities were limited, and to local people, contract production looked similar to sharecropping, and hence familiar enough to try (Martin and Zering, 1997; Skully, 1998).

Reimund and colleagues (1981) argue that the development of the South as a new poultry production region favored an industrialization approach. That is, there were fewer barriers to overcome regarding existing investments, production methods, and bureaucratic institutions governing production relations. This argument may help explain why industrialized hog production also rose more quickly in the South, a non-traditional hog production region, than in the Midwest (Page, 1997). In areas where a production sector has been historically based, making it a significant part of the regional and/or national economy, it can be more difficult to reorganize production. Martin and Zering (1997) found that in North Carolina a direct effort was made to develop a nationally competitive hog industry where one did not exist previously. They argue that the region was not blocked by the existence of the type of barriers listed by Reimund and colleagues (1981).

Since the rapid and dramatic shifts in economic and geographic concentration and coordination in the

broiler industry in the 1950s and the 1960s, the rate of change in these areas has slowed. Rather, as the demand for poultry products continues to increase (up more than 100% since 1969 [McBride, 1997]), production remains geographically stable, characterized by fairly consistent organizational relationships.

Because virtually all broilers are raised under contract, broiler production has become more oriented toward labor markets than product markets. That is, a poultry operator does not sell chickens in a market; instead, the operator sells his or her labor to an integrator to feed chickens (Skully, 1998). Lack of adequate price information, combined with the high and growing concentration in the processing sector has resulted in a poultry industry where the producer holds a weak bargaining position relative to the integrating firm. This has meant that poultry producers, on average, earn very little from their operations and often bear responsibility for environmental management of their operations (e.g., poultry litter and dead bird disposal), although they have few resources and little control over production decisions (USDA, 1998).

Such problems facing growers in the poultry industry have generated a movement to form grower bargaining units through the National Contract Poultry Growers Association (NCPGA). This organization has sponsored legislation at the state and federal level that would allow voluntary cooperative associations of agricultural producers to organize to bargain collectively with integrators. Legislation of this type has been introduced in the US House of Representatives (Skully, 1998).

Overall, the historical development and current structure of the poultry industry make it largely impregnable to efforts to convince producers to adopt a sustainable practice such as intensive grazing. The tremendous concentration of production coupled with intensive managerial control by the poultry companies make targeting the poultry grower as a viable change agent unrealistic. Efforts to move poultry production towards more sustainable outcomes have therefore primarily focused on regulating the companies and growers, developing alternative litter and dead bird management technologies for growers to integrate into their current systems, and developing a wholly alternative production, processing, and marketing system. These efforts each have inherent shortcomings. For example, environmental regulations to force companies to become more responsible for environmental outcomes may have unintended effects. The companies are powerful and have historically attempted to shift any environmental mandates toward the grower, who is the least able to afford new manure management technologies (Morrison, 1998).

The development of pastured poultry systems appears to offer an economically viable production alternative for some growers (Salatin, 1993; SARE). However, because of the structure of the poultry industry, with its extreme concentration and vertical integration, it is currently unrealistic to expect widespread adoption of these systems by growers. Instead, this approach has relied on on-farm or smaller scale processing for slaughter, and direct marketing to bring the birds to market (Salatin, 1993; SARE). But such an approach, particularly on an individual farm basis, raises the cost of the broiler product and reduces consumer access. Therefore for the most part, pastured poultry growers have catered to more elite, niche markets (DeLind, 1993). It is currently unlikely that "alternative" poultry production of this sort will account for more than a very small percentage of total poultry production in the US.<sup>3</sup> Therefore, promoting adoption of sustainable practices such as intensive pasture production to the vast majority of poultry growers is unrealistic. Instead, efforts are split into two largely separate endeavors: (1) working for federal, state, and local government regulations to entice or require integrating companies to reduce nutrient surpluses in areas with intensive production; and (2) establishing niche markets for the small number of producers who have opted for the pasture-based approach. We turn now to discussing the degree to which the hog, beef, and dairy industries adhere, or do not adhere, to the poultry paradigm; how this relative level of adherence has emerged and changed over time; and the implications for the promotion of on-farm adoption of sustainable agricultural production practices.

### Hogs

Starting later than the poultry industry, the US hog industry has undergone its own process of dramatic industrialization and restructuring during the past two decades (Furuseth, 1997; Page, 1997; Rhodes, 1995; Thu and Durrenberger, 1998). Overall, the hog industry is moving toward a more concentrated and coordinated structure. According to the Packers and Stockyards Administration, in 1980, the largest four firms controlled 34% of the hog slaughter. By 1999, the figure had increased to 56%. Furthermore, independent production (where the producer owns the animal) is rapidly being displaced by production under contract (where a producer feeds animals owned by another grower or an integrator) or integrated production (where an off-farm firm, such as a processing firm, owns production) (Heffernan, 1999).

Historically, the structure of US hog production was characterized by small to moderate-sized independent producers raising hogs from "farrow-to-finish" (i.e., birth until ready for slaughter). Many hog producers raised their animals as part of an integrated crop-livestock system. Farmers traditionally viewed their hogs as an on-farm investment and value-added activity providing additional income toward farm household goals, such as paying off debt. In the 1970s, with the advent of confinement technologies making large scale production more feasible, some producers turned to production contracts to increase their output further (Rhodes, 1995). As recently as 1993, the overwhelming majority of contract hog production was horizontal (between producer and grower) rather than vertical (between integrated firm and grower) (Rhodes, 1995). With the growing concentration in meatpacking and associated control of production, the relative proportions of horizontal vs. vertical contracting may be changing. Current estimates find that more than 80% of hog production now passes through some type of coordinated supply chain (Federal Reserve Bank of Kansas City, 2001).

As food manufacturers gain greater control of the production process through integration and contracting, the structure of hog production has changed. Hog producers under contract are less likely to raise hogs from farrow-to-finish. Increasingly, producers raise hogs from only one life stage to another: farrow-to-feeder pig and feeder pig-to-finish (McBride, 1997), or farrow-to-early wean, early wean-to-feeder, and then feeder pig-to-finish (Harris, 2000). Under a contract arrangement, the producer no longer owns the hogs; instead, the integrator owns them. The integrator typically supplies the producer with key production inputs. Contracts generally specify that the grower supplies the land, waste handling and disposal facilities, repairs, fuel, electricity, buildings, and labor, while the integrator provides the animals, feed, medicine and veterinary services, marketing and transport services, and supervisory labor (Jackson-Smith and Buttel, 1998). While Midwestern growers have typically produced hogs independently before becoming contract growers focused on one stage of production, contract hog growers in other regions have often had little or no prior experience with hog farming (Rhodes, 1995).

As production relations have changed, so too have the relative sizes of hog production operations changed. Hog operations under contract arrangements tend to be much more homogeneous in size than independents. Welsh and Hubbell (1999) found that 90% of contract producers surveyed maintained at least 240,000 animal pounds on their farms (240,000 pounds is equivalent to about 1,000 finished hogs).

Only 57% of independents had that many animal units. As hog production under contract becomes more prevalent, hog farms will tend to be larger and of similar size. Thus, there will be less diversity in the structure of hog production. McBride (1997) found that from 1969 to 1992, the number of farms with hogs declined by around 70% to around 200,000 operations. Total hog sales meanwhile increased by 20%. In 1997, the USDA Census of Agriculture estimated about 139,000 hog operations nationwide.

As contract production overall becomes more common, hog production also tends to become more geographically concentrated. That is, large numbers of animals are now being raised in relatively limited geographic areas. Hubbell and Welsh (1998) demonstrated that areas dominated by the industrial style of hog production described here contain many more hogs in smaller geographic areas. For example, two adjacent counties in North Carolina—Duplin and Sampson—have each witnessed the addition of over one million hogs since 1990 and have a combined total of more than 3.9 million hogs. The combined area of the 2 counties is 1785 square miles, which means that there are on average 2185 hogs per square mile in those two counties (Hubbell and Welsh, 1998).

Such rapid changes in the hog industry have heightened social tensions, leading to conflict between rural residents and hog producers (Constance and Bonnano, 1999; Furuseth, 1997; DeLind, 1998). Environmental and rural advocacy groups have also taken notice of developments in the hog industry (Cochrane et al., 2000; Frey et al., 2000; Halverson, 2000). Negative issues linked with the industrializing hog industry include displacement of large numbers of family-based hog producers, agricultural pollution from manure spills and leaks from huge manure lagoons (some many acres in size), air pollution from gases released from hog manure, and socio-economic impacts on rural communities (Jackson et al., 2000; Kellogg et al., 2000; Nowlin, 1997; Thu and Durrenberger, 1998).

Much of the evidence above indicates that the hog industry is moving toward the poultry paradigm. Particularly as vertical coordination becomes more widespread, traditional sustainable agriculture strategies become less appropriate. Assuming a diversified, flexible structure of agriculture based on large numbers of independent, small-to-moderate sized farms becomes increasingly problematic. Furthermore, convincing producers to adopt intensive pasture systems becomes at least more complex under contract arrangements than under spot market arrangements. For example, Welsh and Hubbell (1999) found that contract hog producers in the Southern states were unlikely to utilize pasture-based systems. Independent

hog producers employed pasture systems at higher rates. In Iowa, where packers are more numerous and spot markets still exist, pasturing of hogs is more common and can still be done without having to develop direct links to consumers (Honeyman, 1996b).

Industrialization accelerates the trend toward a highly concentrated structure dominated by off-farm firms and reducing managerial control and decision-making of farm-level workers. In this situation, targeting farm-level workers to make changes in their operations that incorporate sustainable practices is less effective. Therefore, emphasis has shifted toward petitioning the state for command and control environmental regulations, which the industry opposes (Cochran et al., 2000; Halverson, 2000) or seeks to pre-empt through environmental self-regulation initiatives (National Pork Producers Council, 1997). Under these circumstances, sustainable agriculture advocates have begun promoting alternative hog production, processing and marketing systems. This “alternative coordination” often centers on a carefully articulated form of sustainable “branding.” For example, a group of Iowa hog farmers have formed an alliance to provide sustainably produced pork, according to stringent specifications, for California-based Niman Ranch, which markets to high-end restaurants, and through select retailers and an on-line store (Fitzgerald, 2000). The alliance imposes Niman Ranch’s rigorous production guidelines (emphasizing pasture and deep-bedded systems) and also process verification requirements. Approximately 200 farmers, mostly in Iowa, raise hogs for Niman Ranch now, receiving a substantial premium over conventional pork prices (L. Cleverly, personal communication [May 28, 2002]).

While commendable, this approach, like pastured poultry, remains problematic in its dependence on comparatively small niche markets, mostly targeted to elites. However, the conventional hog industry may differ from the poultry industry in its receptivity to alternative production practices. For instance, some hog integrators in Iowa have recently begun accepting hogs from operations using deep-bedded housing systems, such as “hoop houses,” a low cost, flexible alternative to confinement buildings and to traditional open lots; Iowa Extension specialists estimate 40% of producers using hoop houses are feeding those pigs on contracts of some sort (M. S. Honeyman, personal communication [October 15, 2001]). In this system, pigs are housed in groups of 150–200 animals on straw bedding and the structure is naturally ventilated. Animal mobility and opportunities for play reduce animal stress and enhance overall welfare (Lay and Haussmann, 2000). Furthermore, manure management with hoop structures may offer some environmental advantages. Mixed with bedding and composted, hoop



structure manure is solid rather than liquid, high in organic matter, and relatively stable, reducing the risk of air or water pollution through leaching, volatilization, or accidental spills (Richard and Choi, 1999). Integrators in Iowa have been sufficiently impressed by the positive press accorded to deep-bedded swine systems that they have begun company research programs on these systems (M. S. Honeyman, personal communication [October 15, 2001]). However, deep-bedded systems still account for a very small proportion of contracted hogs in Iowa. Furthermore, integrators have expressed reservations about the difficulty of strictly standardizing process and product in deep-bedded systems (M. S. Honeyman, personal communication [October 15, 2001]).

Another aspect of the developing hog structure that differentiates it from the poultry paradigm is the emergence of producer-controlled networks and alliances attempting to work in conventional markets. The organization and operation of networks varies, but decision-making is often shared among a group of producers. The networks have been formed to enable producers to exploit economies of size, while remaining collectively independent from the increasingly dominant corporate supply chains. Such networks have functioned to engage in group marketing and purchases and information sharing (Zeigenhorn, 1998). In the networks, producers concentrate on a single stage of production, but coordinate their efforts to produce a single product at the end of the networked chain (Welsh, 1997b; Zeigenhorn, 1998). Adherence to sustainable practices is not necessarily the organizational focus of some networks.

At this point, it is difficult to discern if such networks are temporary institutions that will eventually give way to the tightly organized top-down supply chain structure of the poultry industry. In addition, since decision-making is shared among producers within a network (Skully, 1998), it may be that traditional approaches to promoting adoption of sustainable methods would be more problematic than approaching individual independent producers. The networks generally form in an effort to match the ability of vertically coordinated systems to produce a uniform product in large enough numbers to be attractive to meatpacking firms (Zeigenhorn, 1998). Furthermore, it is unclear the degree of autonomy that producers retain with such networks (Skully, 1998). This probably varies between networks, the members' requirements and needs, their orientation toward sustainable production, and the markets for which they produce (Zeigenhorn, 1998).

## Beef

The beef industry has several sub-sectors that reveal different patterns in terms of correspondence to the poultry paradigm. Beef cattle production is comprised of a fed cattle market and the cow and bull market. The fed cattle market consists of steers and heifers fed concentrated feed to accelerate weight gain and to make the meat tender and better tasting. Fed cattle products include steaks, roasts, etc. An increasingly important subset of the fed cattle market is the boxed beef market. "Boxed beef" is partially processed into cuts and boxed before it is shipped to retailers. Boxed beef is an innovation pioneered by IBP. It allowed retailers to move more product because it eliminated the need for more highly skilled butchers. The resulting increase in demand for beef provided incentives to IBP to invest in larger, and more economically attractive, slaughter-capacity plants that were located near High Plains beef feedlots (Broadway, 1995).

The cow and bull market consists of animals culled from beef and dairy herds. This is the primary source of hamburger and other processed meat products. In contrast to the fed cattle sector, the cow and bull market is not concentrated. Many smaller packers forced out of the fed cattle market as it consolidated entered the cow and bull market (WORC, 1991). The fed cattle market involves several sub-sectors based on the growth, development, and utilization of the beef cow. These are cow-calf (birth to weaning or about 400 pounds), stocker (weaning to approximately 600–800 pounds), feedlot (confinement feeding of high-energy grain and other ingredients to reach final weight of between 1000 to 1500 pounds), slaughter and processing (manufacturing), and wholesale and retail (Krause, 1991). However, the concentrated structure of the overall fed cattle industry contrasts with the structure of the cow-calf sub-sector. Many cow-calf farmers who send animals into the fed cattle pipeline are small-scale, independent operators. This is especially true in the northeastern US (Krause, 1992; GAO, 1995; USDA, 1998). In the Great Plains and the West, the herd size is much larger than in other parts of the US (Krause, 1992). In addition, compared to the fed cattle sector (and the broiler and increasingly the hog sector), the cow-calf sub-sector is relatively dispersed geographically (McBride, 1997). Many farmers having some land unsuited for crop production find they can graze a few cattle.

Prior to 1960, cattle feeding was dominated by small farmer-feeders mainly located in the Corn Belt. However, by the mid-1970s, the cattle feeding industry had shifted to the Southern Plains and Western States and to large-commercial feedlots. Through the 1980s and 1990s, the fed cattle sector continued to consoli-



date with the largest operations accounting for an increasing share of total sales (GAO, 1995). In addition, the fed cattle slaughter sub-sector consolidated. For example, from 1980 to 1999, the largest 4 firms increased their control of the steer and heifer market from 36 to 81% (Packers and Stockyards Administration).

Several technological and policy factors influenced these geographical and organizational shifts. The development of mechanized systems for feed handling and manure management created barriers to entry through increased capital requirements. Discoveries related to animal nutrition (feed additives, growth stimulants, liquid protein feeds) and development of health regimes (pest and disease control) facilitated production based on sustained close confinement of large numbers of animals (Reimund et al., 1981; Krause, 1991). A sorghum-based feed grain sector also emerged in the Southern Plains, due largely to USDA commodity programs. The passing of anti-corporate farming laws in the Northern Plains and Corn Belt states shifted corporate production elsewhere (Krause, 1991). Growing concentration in the industry facilitated equity investments that reinforced such concentration (Reimund et al., 1981). That is, investors became interested in cattle feeding when the industry consolidated into larger units. At the same time there was a rapid increase in consumer demand for beef (Reimund et al., 1981). Finally, more stringent federal standards for meat inspection systems hastened the demise of smaller local packers, who tended to process beef for smaller, independent producers (Krause, 1991).

Besides the matter of scale, an important difference between the farmer-feeder operations and the commercial feedlots was the degree and type of vertical integration. Farmer-feeders essentially harvested their grain through their animals. This meant feeding took place on a seasonal basis, with feed and livestock production geographically coterminous. Commercial feedlots are often integrated with feed companies or grain elevators, but the production of grains is physically separated from cattle feeding. This change in integration structure enabled further consolidation of production by removing seasonality as a constraint to growth. As this consolidation occurred, former farmer-feeders began moving their cattle into large-scale feedlots through custom-feeding contracts. Under such contracts, the farmer owns the cattle and investors own the feedlot. This arrangement attracted even more outside investment, contributing further to the rapid concentration of the fed cattle industry. The custom feeding contract is important because it transfers the financial risk to the client and away from the feedlot. During the 1970s, the fed cattle industry ran into diffi-

culties as the prices for feeder cattle dropped, leading to a drop in supply. This drove investors from the industry. The industry adjusted to this increased risk by increasing vertical integration and concentration. Large grain firms purchased large feedlots (Reimund et al., 1981).

A major issue in the beef industry is the use of captive supplies. Captive supplies refer to livestock that are committed to a buyer at least two weeks before slaughter. Ward (1999) describes the three most common captive supply methods: packer feeding, basis forward contracting, and marketing or purchasing agreements. Packer feeding refers to packers purchasing feeder cattle and placing them in packer-owned or commercial feedlots. Basis forward contracting refers to an agreement between a packer and a feeder in which a price is agreed upon based on the month the cattle are expected to reach slaughter weight. And, marketing or purchasing agreements are supply contracts in which the cattle feeder agrees to market fed cattle to a given buyer for some specified time period. Price is based on a prearranged formula consisting of a base price plus premiums or less discounts depending on cattle quality. Captive supplies are held to ensure an adequate supply of cattle, and gain control over the timing of deliveries (WORC, 1991), and clearly contribute to the industrialization of the beef sector.

However, although such captive supply mechanisms are now regularly employed in the beef industry (Ward, 1999), to this point, the kinds of integrated ownership and contract arrangements dominating poultry, and gaining ground in hogs, are not common in beef (Krause, 1991; Ward, 1997). There are several reasons that the beef industry thus far lacks the integrated ownership and contract arrangements dominating the poultry industry. First, there is as yet no significant differentiated (brand) market for beef products to induce integration and coordination (Ward, 1997). Also, the longer (three stage for beef versus two for poultry (hatching and growing) and, until recently, hogs) life cycle of the beef cow, *coupled* with the fact that cows give birth to one calf per year, presents an inherent biological barrier to increased integration and coordination (Ward, 1997). That is, the life stages of beef each present different resource and management needs, thereby making it difficult and expensive to integrate across stages; and the longer life and limited calf numbers of the beef cow make it more difficult to observe the effect of changes in the breeding process on the eating quality of the carcass (Krause, 1991; Ward, 1997).

Despite these inherent encumbrances, the firms and organizations within the beef industry are attempting to vertically coordinate production with processing

and even branding at the retail level (Smith, 1998a, b; 2000). Coordinated networks that tie the various stages of production, processing, and retail together are emerging that are based on management and access to markets rather than ownership. In these new beef systems, cow-calf producers have particular protocols to follow regarding aspects of their operations, such as inputs and management and even pasture densities (Smith, 2000). The new generation cooperative US Premium Beef represents a producer alliance, developing coordinated relationships to market a branded beef product (Novack, 2001).

Currently, the beef industry contains elements of the poultry paradigm, but is not yet undergoing radical restructuring toward a fully integrated structure. Even if managerial integration is successful, it is not likely that the beef industry will closely mimic the poultry industry through all stages of the beef cow's life cycle. The cow-calf part of the beef life cycle retains many elements that make it a suitable target for the traditional sustainable agriculture approach. In fact, alternative systems such as intensive rotational grazing are being developed for cow-calf operations (SARE). Operators can adopt the alternative systems and still sell into mainstream processing and distribution channels. In the latter parts of the beef cow's life cycle, especially at the feedlot stage, the industry structure more closely resembles the poultry industry. The feedlots are more likely to be directly integrated into off-farm firms with more managerial control shifted away from the point of production. Feedlots also tend to be very concentrated geographically with the same types of pollution problems common to intensive poultry and hog production.

## Dairy

The dairy industry reflects some, although not all of the changes outlined for the beef, hog, and poultry industries. Dairy has experienced profound structural changes over the last 50 years. Average herd size has increased dramatically, production per cow has also risen, and the number of dairy operations has declined by more than 70% since 1969 (McBride, 1997). In the last 20 years, new, non-traditional, production areas have emerged (California and other Western States) with industrial-sized operations, geographic concentration of dairy cow inventory has risen over time, and contracts have played, and continue to play, an important role in coordinating production (DuPuis, 2000; McBride, 1997). Furthermore, the dairy feedlot model is heading east, as states like Indiana now see this kind of growth in the dairy sector (Bailey, 2000). At the same time, dairy processing facilities

have grown in size and dropped in number, and both production and processing have become more capital intensive (Manchester and Blayney, 1997). Historically, the processing sector in dairy has not been concentrated, but it is rapidly consolidating (Bailey, 2000).

However, although average herd size has increased and industrial-sized dairy farms have emerged, the average herd size in dairy is only about 80 cows. Industrial-sized dairies are usually said to be those with more than 500 (or even 1000) cows (Jackson-Smith and Buttel, 1998). In addition, although contracts are important in the dairy industry, with 95% of fluid milk production under contract, the contracts are overwhelmingly marketing contracts in which the producer maintains ownership of the cows and controls the vast majority of production decisions on the farm (Martinez and Reed, 1996). Also, many of these marketing contracts are between farmers and their farmer-owned cooperatives, institutions pre-dating more recent structural trends outlined in this paper (Jackson-Smith and Buttel, 1998). Even with rapid consolidation in production and processing, it is expected that small dairy farms that can keep costs low will survive (Bailey, 2000; Jackson-Smith and Buttel, 1998).

Beyond this, it is often said that milk is milk. In this sense, milk is considered the prototypical undifferentiated product. Food manufacturers may not attempt to fully integrate dairy until there is an advantage to ensuring milk has particular characteristics critical in the manufacturing process or in marketing (Dupuis, 2000; Manchester and Blayney, 1997). At this point, milk from operations of varying structures and management regimes does not significantly differ with respect to the qualities that food manufacturers currently value. Finally, the fact that the historical development of the US dairy industry occurred, in large part, through cooperative structures could also hobble industrialization. As long as producer member-owners control the decision-making of the cooperatives, the strategies followed by food manufacturers in other animal sectors may not be adopted (Dupuis, 2000; Jackson-Smith and Buttel, 1998).

In the Midwest and Eastern states, the traditional dairy farm is still predominant, although larger confinement dairies exist. In these areas the farmer owns the animals and maintains managerial and decision-making control. Thus, farm-level decision-makers can still be targeted for conversion to alternative production practices. This may explain why efforts to convince farmers to adopt the less capital intensive rotational grazing feeding system have been so successful in dairy (Jackson-Smith et al., 1996). Dairy farmers can adopt the intensive grazing system

and continue selling to their traditional milk buyer. Thus, using an intensive grazing system in dairy does not require developing an alternative processing, distribution, and marketing system. In contrast, if a poultry producer were to adopt an intensive grazing (pasture) system, the poultry company would very likely cancel the grower's contract. Because they retain access to mainstream markets, smaller, low cost dairies can often remain competitive. And while this is the case, sustainable agriculturalists can target small-to-moderate-sized dairy operations for conversion to sustainable techniques such as intensive grazing.

Table 1 summarizes the life cycle stages we have discussed for each animal sector and shows how these relate to the potential success of traditional approaches for promoting on-farm adoption of sustainable livestock production systems. The poultry sector provides the example of a commodity system now largely impregnable to appeals to farm-level producers. Hogs are ranked as low to medium potential because of the presence of hoop houses within coordinated systems and the emergence and persistence of some producer networks and alliances. The cow-calf portion of the beef system has high potential, as managerial control largely remains on-farm. But the potential drops as the beef cow life-cycle progresses. Dairy is ranked as high potential throughout the life cycle in spite of substantial changes in the structure of the dairy industry and the move toward highly concentrated production. This is because most dairy producers could switch to alternative production systems without endangering their markets. Overall, the table should be treated as an ideal-typical approach to comparing the animal sectors. It is a heuristic device and not an attempt to make detailed and complete measurements.

### Whither livestock agriculture?

As the feedlot model becomes more prominent, efforts at promoting sustainable agriculture through the on-farm adoption of practices become less effective. This occurs as the window of opportunity for convincing farmers to adopt more sustainable practices such as intensive pasture systems narrows. As larger numbers of producers and stages of production within a commodity system become industrialized, the relevance of a pasture-based system diminishes and/or the producer loses the ability to choose an alternative production system and still retain access to conventional agricultural markets.

As a result, efforts to establish a more sustainable agriculture increasingly rely on regulating industrialized systems and on developing niche, generally high-end markets for animal products produced through

pasture-based or alternative housing systems. We have demonstrated that the industrialization process is uneven and probably will not result in all livestock sectors becoming completely unsuitable for targeting the farm-level producer to adopt alternative livestock production practices. However, the efficacy of such efforts will be confined to the cow-calf sector of the beef commodity system, dairy producers not amenable to the feedlot model, small parts of the hog industry, and niche market livestock producers.

To respond to the structural changes we describe, advocates of sustainable agriculture must address the managerial control over production decisions increasingly wielded by livestock integrators through their supply chains. This approach can include several complementary efforts:

- Sustainable agriculture advocates could work to expand the niche production and marketing systems to reach beyond high-end markets. Part of this effort might entail working more with sympathetic consumer organizations.
- Sustainable agriculture advocates could follow the model employed by environmental groups in other industries and press for agreements with the integrators to allow growers to adopt alternative production systems.
- Sustainable agriculture advocates could invest time and resources toward encouraging the adoption of legislation that focuses on shifting more decision-making control, within coordinated systems, to the farm level with the goal of providing more opportunities for targeting farm-level decision-makers to adopt alternative practices.

Current efforts to develop fully alternative livestock systems based on direct marketing and other quality-oriented "short food supply chains" (Marsden et al., 2000) that bypass the industrial structure altogether could intensify. The growth of such alternative networks potentially represents more wholistic and systematic attention to environmental and social problems in agriculture than "end-of-the-pipe" technological fixes for industrial agricultural systems. Legitimizing a more ground-up, comprehensive approach is important, particularly in light of sustainable or organic "reductionism," which emphasizes implementation of select sustainable or organic agriculture production practices, with little or no incorporation of broader societal criteria for sustainability (Goodman, 2000; Buck et al., 1997).

However, it therefore becomes even more important that alternative networks expand beyond elite driven markets. Different levels and combinations of sustainable practices may be more workable in



**Table 1.** Life stages and potential for success of traditional approach to sustainable agriculture by livestock commodity system.

	Poultry	Hogs	Beef (fed cattle)	Dairy
<i>Life stage 1</i>	Hatching	Farrow to early wean	Cow-calf	Calf
Potential for traditional approach to sustainable agriculture	Low	Low to medium	High	High
<i>Life stage 2</i>	Growing	Early wean to feeder	Stocker/background	Bred heifer
Potential for traditional approach to sustainable agriculture	Low	Low to medium	Low to high	High
<i>Life stage 3</i>	NA	Feeder to finish	Feeding	Milking
Potential for traditional approach to sustainable agriculture	NA	Low to medium	Low	High

NA – not applicable.

different production and marketing systems (Power, 1999). Some may be appropriate in select areas of livestock agriculture, such as some remaining independent producers in hogs, hog producer networks, and certain smaller dairy and beef producers. In this way, it might be possible to connect sustainable production practices to parts of the more traditional livestock commodity sectors, technically and organizationally, if not ideologically. Rather than pursuing highly specified (and high price) niches such as certified organic meats or dairy, such producers might market on the basis of these selected sustainable production practices and systems of process verification. This would entail establishing, acquiring, or at least maintaining access to large numbers of small to moderate-sized processing plants and recruiting conventional retail outlets to carry products produced through this system. It would require creative exploration of alternative approaches to coordination. As the long-established French Label Rouge poultry system demonstrates, complex supply chains can successfully deliver sustainably produced, quality meats to mass markets (Westgren, 1999). Alternative supply chains can pose a middle ground between elite local direct markets and mass industrialized markets, but both private and public commitment to such infrastructures are necessary to their success. In the US context, such efforts should be complemented by other efforts to increase sustainable production practices within the conventional system.

Some environmental groups have been successful at reducing harmful environmental impacts of large-scale firms, by pressuring these firms to change their production practices in environmentally beneficial ways (Stafford and Hartman, 1996). Such NGO-business “alliances” can be either formal or informal, but the intention of environmental groups is to shift major industrial actors in more sustainable directions, through collaboration rather than confrontation (Constance and Bonanno, 2000; Hemphill, 1994). A much publicized example of this strategy

is the ongoing alliance between Environmental Defense (formerly the Environmental Defense Fund) and McDonald’s, begun in 1989. Initially focused on packaging and waste reduction, Environmental Defense convinced McDonalds to replace its Styro-foam clamshell packaging with a biodegradable paper container. Environmental Defense is now working with McDonald’s on energy efficiency initiatives. Outside its alliance with Environmental Defense, McDonald’s has made other recent “green changes,” including ceasing use of genetically modified potatoes and ordering its egg suppliers to house hens in larger cages (Anonymous, 2000). McDonald’s claims it would not make any of these changes were they not cost-neutral, but it also recognizes the added public relations benefit of a greener image (Anonymous, 2000; Zwerdling, 2002). Rather than dwelling on the integrity of corporate motivations for change, collaborating environmentalists emphasize the pragmatic outcomes in working with industry to promote environmental reforms of conventional business practices.

Sustainable agriculture advocates could develop a similar strategy and pressure integrating companies to allow, or encourage, growers to adopt sustainable systems. This would require making the current role and practices of integrating companies more visible to an increasingly concerned public, since there is not a direct consumer-retailer encounter as with McDonald’s. The growing clout of consumer and citizen activist groups focusing on the food system could reinforce these efforts. In hogs, sustainable agriculture advocates could build on the hoop house finishing contracts model. Perhaps these contracts could be liberalized to permit intensive pasture production. Integrators could perhaps also be convinced to develop integrated systems that are more geographically dispersed and that allow for less capital-intensive production. Such changes may not appear economically rational at first glance, but may become more compelling, particularly as consumer scru-

tiny of the livestock industry continues to grow. In poultry, companies could be encouraged to allow more dispersed and pasture intensive production. Such production could be processed and marketed through traditional channels, or the companies could develop a separate label. These efforts would be combined with efforts to allow growers to realize a greater portion of the final price of the finished product.

The burgeoning organic industry worldwide may well be a forerunner of such a systemic compromise. Analysts have pointed out that some organic food sectors, such as milk, are already more concentrated and coordinated than their conventional counterparts (Dupuis, 2000). Indeed, organic agriculture more generally is increasingly characterized by the involvement of large-scale corporations and consolidation (Halweil, 2001). Therefore, to the extent that the organic industry is developing as a "green" counterpart to conventional agriculture, it provides some evidence that more environmentally friendly approaches to production can be integrated into the top down supply chain approach.<sup>4</sup> Indeed, such approaches will be initiated by more corporations as they recognize the potential market advantages with discerning consumers. The drawback in attempting to make large integrated corporations support sustainable production practices is the possibility that environmental problems associated with agricultural practices will be addressed mostly in isolation from other perceived problems. Many see industrialized agriculture as fundamentally problematic regarding equity among participants and impacts on rural social cohesion and community (Welsh, 1996). Convincing integrators to allow adoption of grazing systems and promote more geographically dispersed production may not greatly advance other social goals of sustainable agriculture. A compromise focused on technical production practices alone could be seriously deficient in the eyes of some (although perhaps not all) sustainable agriculture advocates.

Ultimately, concentration in the food-manufacturing sector and the power differential between the individual grower and the food-manufacturing firm are driving the many problems attributed to industrial agriculture. Anti-concentration interventions by the federal government could help alleviate some of these problems by providing greater options for growers. With more options, growers and their allies in the sustainable agriculture community have a greater chance of finding sympathetic or vulnerable companies with which to deal in attempting to promote more sustainable production practices. Growers could bargain for greater managerial control of their operations if there were more companies to which they might sell. Companies might be smaller, and thus

less likely to command the resources needed to gain substantial market control or to fully integrate the production, processing, and marketing systems. Such efforts can be very capital intensive and require sophisticated capital raising strategies, the province of larger firms (Marsden and Whatmore, 1994).

Likewise, if growers could collectively bargain more effectively, a relative shift in power from integrator to grower might be effected. This might enable growers to maintain a greater degree of managerial and decision-making control over their farm structure and practices that would, in turn, potentially provide more opportunities for considering and implementing sustainable production practices. Collective bargaining would also provide a vehicle for addressing some of the equity issues often raised in discussions about concentrated and coordinated commodity systems (Levins, 2001).

Some anti-trust and collective bargaining efforts have been underway concerning agriculture and the food industry. However, to a large degree the individuals and groups working on anti-concentration or collective bargaining measures may not have considered the link between on-farm decision-making control and efforts to promote sustainable production practices. Collective bargaining arrangements, bans on packer feeding of livestock or anti-corporate farming laws could be amended to explicitly cement the requisite decision-making control on the farm such that farmers have the choice of adopting pasture-based or hoop systems or other types of sustainable approaches to livestock agriculture.

## Conclusions

The sustainable agriculture movement has a broad and diversifying agenda, but historically, its efforts have emphasized the design and promotion of practices and systems that are productive, but also protect the environment, and to varying degrees, enhance the ability of farm-level workers to substitute managerial and on-farm inputs for externally produced and purchased inputs (Pfeffer, 1992). Education and outreach to farm producers have been the traditional means of promoting sustainable agriculture. But currently in livestock agriculture, the degree to which a commodity system is vertically coordinated and geographically concentrated limits the effectiveness and relevance of the traditional approach to promoting sustainable production practices. As a result, new approaches must be considered – approaches that attempt both to enhance the possibilities within existing highly coordinated systems (because they account for so much of the market) and to build

new “alternative” coordinated systems (because they can incorporate more comprehensive sustainability criteria from the outset). However, all of these “non-traditional” approaches will likely require different individual competencies and organizational capacities than traditional sustainable agriculture education and outreach.

Given trends in the historical development of livestock agriculture, a more *structurally informed* approach to promoting sustainable production practices is necessary. But it need not devolve into gloomy materialist teleological predictions. Rather, it is important to recognize historical contingencies and the ability of social agents to make decisions and changes within a fluid and dynamic structural framework. Part of this process involves recognizing structural patterns and areas where collective efforts and strategies can have the most impact. With regard to the emerging global economy and society, Giddens (2000) writes that pointing out future possibilities or risks is actually part of determining eventual outcomes. However, he views this as potentially paradoxical. If groups or individuals analyze current conditions and foresee them leading to particular outcomes, simply voicing such an analysis may induce social action that shifts those possible outcomes in new potential directions. In response, other parties may conclude that the original analysis was overly deterministic, wrong, or simply so much fear-mongering. Thus, a structural analysis (such as this one) can hold within it useful resources. With any luck, we may at some future moment of reckoning be able to say that our analysis ultimately missed the mark.

### Acknowledgments

Both authors contributed equally to the writing of this paper. This paper has benefited from comments, criticisms, and gentle disagreements provided by Fred Kirschenmann, Tom Lyson, and seven anonymous reviewers. Remaining errors or omissions are our responsibility alone

### Notes

1. Although we focus on technical systems, we recognize that implementation of sustainable technologies is necessary, but not sufficient for sustainable agriculture outcomes; producers employing sustainable technologies also need access to profitable markets.
2. Indeed, as one reviewer usefully reminded us, intensive pasture systems for ruminant animals (e.g., cattle) may be more clearly sustainable in terms of natural resources

and the environment than intensive pasture systems for monogastric animals (e.g., poultry, swine), for whom grass and legumes can provide only a small amount of the feed requirements.

3. The Label Rouge poultry system, operating for more than 35 years in France and commanding more than a third of the chicken market, demonstrates the possibility of more sustainable poultry production through larger coordinated supply chains. But as Westgren (1999) observes, the Label Rouge system has emerged in part due to a culture and practice of governmental regulation and oversight in France that is arguably less evident in the US context.
4. In a related, but non-organic example, in 1998, Unilever began its Sustainable Agriculture Initiative, which has sought to pilot and assess indicators of sustainability for its corporate and contract operations growing palm oil, peas, spinach, tomatoes, and black tea (<http://www.unilever.com/susag>).

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