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The Industrialization of Agriculture: Implications for Public Concern and Environmental Consequences of Intensive Livestock Operations

Charles W. Abdalla*

I. Introduction

The industrialization of the United States animal agriculture sector is bringing about significant change and giving rise to concerns about environmental degradation and other issues. The concentration of animals on fewer, larger farms and increased ownership, contracting, and joint ventures of adjacent food system functions or stages among agribusinesses are changing the structure of agriculture and the public perceptions about farming: Larger animal production units are increasingly leading to conflicts between producers and neighbors, and communities are faced with many actual and potential environmental and nuisance threats.¹

Current conflicts over Intensive Livestock Operations (ILOs)² can

* Charles W. Abdalla is an Associate Professor of Agricultural Economics in the Department of Agricultural Economics and Rural Sociology at Penn State University, University Park, Pennsylvania. His research and extension programs address public choices about natural resources and the environment. Dr. Abdalla received a Ph.D. and M.S. in Agricultural Economics and M.A. in Economics from Michigan State University and a B.S. in Environmental Resource Management from Penn State University. He is a recipient of Resources for the Future's Gilbert F. White Fellowship and the Soil and Water Conservation Society's Berg Fellowship. Dr. Abdalla received the Farm Foundation's Outstanding Public Issues Education Awards for extension programs on animal waste policies and land use conflicts in 2000 and 2001. He would like to thank Katie Bavoso, a Symposium Articles Editor, and Lauren Carothers, Editor-in-Chief, for editing his article.

1. M.C. Hallberg, C.W. Abdalla, & P.B. Thompson, *Performance in Animal Agriculture: A Framework for Multi-Disciplinary Analysis* 11-13 (Texas A&M Univ. Center for Biotechnology, Policy and Ethics, Working Paper No. 96-8, 1996).

2. The term Intensive Livestock Operation (ILO) is used here as a generic term referring to larger poultry and livestock operations. Some traits of ILOs would include increased scale and intensity at a given site, increased use of off-farm inputs, and in a few distinct cases of confinement of animals. There is no attempt made here to link the ILO term to the federally defined Concentrated Animal Feeding Operations (CAFO) or any

be better understood in the context of the history of the animal agricultural sector. Part of the controversy emanates from the expanded scale of animal production facilities, while other parts stem from the practice of animal agriculture at new locations. Thus, it is necessary to understand both the industrialization process and its indirect impact on the regional and national structure of the animal industries since World War II.

This paper provides historical background on the industrialization of animal agriculture that has led to current public concern and conflict over ILOs. Specifically, this paper addresses:

1. When and where did industrialized agriculture and ILOs come into being, and
2. What are the driving forces behind the agricultural industrialization process?

In the last section of the paper, the consequences of industrialization are considered from a broader institutional economics perspective. The discussion concludes that the choice of jurisdictional boundaries is a critical decision variable affecting resolution of conflicts arising from industrialization of animal agriculture. Specific jurisdictional decisions are identified that will affect the successful resolution of differences over ILOs.

II. Agricultural Industrialization and ILOs in the United States

The United States animal production and marketing system is undergoing significant structural change. Although this transformation has been underway for more than forty years, the pace of change has recently accelerated. Farm structure is generally evolving from a situation of many diversified crop-livestock farms that are spread out to a conglomeration of fewer specialized larger farms that are geographically concentrated. For example, poultry and livestock producers are more closely integrated into marketing functions and tend to be located in clusters near processing or infrastructure specialized to their needs.³ As the scale of operations has increased and production has become geographically concentrated, the potential burden placed on local environments by animal waste has increased. In some locations, this

other federal, state, or local definition.

3. A. P. Pagano & C. W. Abdalla, *Clustering in Animal Agriculture: Economic Trends and Policy*, in *BALANCING ANIMAL PRODUCTION AND THE ENVIRONMENT* 193 (Great Plains Animal Agriculture Task Force Conference, Oct. 19-21, 1994) (on file with author).

increased burden has led to neighbor and community concern over water and air noxious odors and insect infestation.⁴

A. Separation of Crop and Livestock Production

One of the more important developments related to animal agriculture is the trend toward increasing separation of crop and livestock production. This trend has affected the scale and intensity of production and the geographic location of agricultural production activities.⁵

Breimyer observed that in the early 1960s there were three distinct economies within the United States agricultural sector: crop, livestock, and marketing.⁶ He noted that the livestock economy then was at an intermediate stage between a traditional agrarian structure and a more industrialized model.⁷ Later in the same decade, Shaffer argued that a major transformation of the United States food system was under way in which specialized off-farm activities and products were being substituted for general farm work.⁸ Industrialization generally had the effect of decreasing agriculture's reliance on a fixed land resource and increasing the sector's dependence on manufactured off-farm resources.⁹ Breimyer further stated, "Livestock enterprises have been undergoing progressive organizational detachment from feed production Broiler production is not only semifactory style but seems to gravitate locationally to areas of the country where costs are lowest Feeder pig production now rings the Corn Belt as a halo."¹⁰

The relative emphasis of crop and animal agriculture within major United States production regions changed significantly as a result of industrialization. The upper Midwest shifted from animal to crop agriculture and the Northeast, Southeast, South Central, and Great Plains favored animal production over crop agriculture.¹¹ From 1930 to 1990,

4. M. C. Hallberg, C. W. Abdalla, & P. B. Thompson, *Performance in Animal Agriculture: A Framework for Multi-Disciplinary Analysis* 1 (Texas A&M Univ. Center for Biotechnology, Policy and Ethics, Working Paper No. 96-8, 1996).

5. H. F. Breimyer, *The Three Economies of Agriculture*, 64 J. FARM ECON. 679, 679-99. (Aug. 1962); M. C. Hallberg, POLICY FOR AMERICAN AGRICULTURE: CHOICES AND CONSEQUENCES, 62-63 (1992); L. E. Lanyon, *Does Nitrogen Cycle? Changes in the Spatial Dynamics of Nitrogen with Industrial Nitrogen Fixation*, 8 J. PROD. AGRIC. 70, 70-8 (1995).

6. H. F. Breimyer, *The Three Economies of Agriculture*, 64 J. FARM ECON. 679, 679-99 (Aug. 1962).

7. *See id.*

8. J. D. Shaffer, *The Scientific Industrialization of the U.S. Food and Fiber Sector: Background for Market Policy*, in AGRICULTURAL ORGANIZATION IN THE MODERN INDUSTRIAL ECONOMY 1-14 (P. Farris ed., NCR-20-68, Dept. of Agric. Econ., 1968).

9. *See id.*

10. H. F. Breimyer, *The Three Economies of Agriculture*, 64 J. FARM ECON. at 689.

11. L. E. Lanyon, *Does Nitrogen Cycle? Changes in the Spatial Dynamics of*

the increasing dependence on capital and the diminishing role of the inherent capacity of land as factors of production were reflected in the concentration of corn production and the associated use of nitrogen fertilizer.¹² That trend also illustrated the shift to purchased inputs for farm production from the 1950 to 1990 period.¹³

Industrialization forces, most particularly efficiencies gained from increases in operation size, have led to greater uses of technologies and practices, such as the proliferation of feedlots for cattle in the Midwest and Southwest in the 1960s. The United States Environmental Protection Agency (EPA) classified feedlots as point sources of water pollution in 1973 under its regulations to implement the Federal Clean Water Act of 1972.¹⁴ Therefore, National Pollution Discharge Elimination System (NPDES) permits were required for discharges from these Concentrated Animal Feeding Operations (CAFOs).¹⁵

B. Increased Integration of Production and Marketing/Geographical Concentration

An important development in the agricultural industrialization process was the use of production contracts and integration of vertically aligned input supply, production, and marketing stages. Such change had the impact of transferring the locus of decision-making for important production from the farm-level to elsewhere in the food processing and agri-business systems. Contracted producers typically owned land and buildings, supplied labor and electricity, and handled manure disposal and disposal of dead birds. The first major application of this integration in the animal industries occurred in the poultry (or broiler) industry in the

Nitrogen with Industrial Nitrogen Fixation, 8 J. PROD. AGRIC. 70, 70-8 (1995).

12. *Id.*

13. M. C. HALLBERG, POLICY FOR AMERICAN AGRICULTURE: CHOICES AND CONSEQUENCES 61 (1992).

14. See Clean Water Act, 33 U.S.C.A. §§ 1251-1387 (2002).

15. B. Eghball & J.F. Power, *Beef Feedlot Manure Management*, 49(2) J. SOIL & WATER CONSERV. 113, 113-22 (Mar.-Apr. 1994). A CAFO is defined as an operation that falls under the federal Animal Feeding Operation definition and has more than 1,000 animal units. National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations, 66 Fed. Reg. 2960, 2962 (proposed Jan. 12, 2001) (to be codified at 40 C.F.R. pts. 122 & 412). An Animal Feeding Operation is defined as a "lot or facility where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period; and where crops, vegetation, forage growth, or post-harvest residues are not sustained over any portion of the lot or facility in the normal growing season." National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations, 66 Fed. Reg. 2960, 2967 (proposed Jan. 12, 2001) (to be codified at 40 C.F.R. pts. 122 & 412).

1960s.

The need to achieve economies of scale in processing appears to have been the factor that drove vertical integration to its present level in the poultry industry in the 1950s and 1960s and in the swine industry in the late 1980s and 1990s.¹⁶ Today, economies from the industrialization process have affected the geography of production and have led to clustering where agglomeration economies exist.¹⁷

Examining the southern United States, Martin and Zearing described the process of change for the broiler industry as revolutionary.¹⁸ Prior to 1950, the broiler industry did not exist because chickens sold for meat were largely a by-product of laying flocks.¹⁹ The industry quickly emerged after World War II and rapidly evolved into a tightly coordinated and intensive industrial sector.²⁰ Technological advances in housing, breeding, and disease control were important factors affecting its explosive growth.²¹ Marketing innovations, such as contracts, emerged to address producer price risks for live broilers and to allow feed dealers a secured market for their products.²² These arrangements evolved into production contracts in which two parties jointly produce a product with each contributing inputs to the process.²³

Because live chickens could not be transported at great distances, growers had to be located close to the integrator or processing facilities. For example, in Delaware, Maryland, and Virginia, eight firms were documented in 1994 to have annually produced under contract over 500 million chickens, and about 6,000 chicken factories operated within a 16,000 square kilometer region.²⁴ Poultry contract producers were typically located within twenty-five miles of the integrator's processing facilities in the Delmarva Peninsula.²⁵

16. A. P. Pagano & C. W. Abdalla, Clustering in Animal Agriculture: Economic Trends and Policy, in *BALANCING ANIMAL PRODUCTION AND THE ENVIRONMENT* 193 (Great Plains Animal Agriculture Task Force Conference, Oct. 19-21, 1994) (on file with author).

17. *Id.* at 195.

18. L. L. Martin & K. D. Zearing, *Relationships Between Industrialized Agriculture and Environmental Consequence: The Case of Vertical Coordination in Broilers and Hogs*, 29(1) *J. AGRIC. & APPLIED ECON.* 45, 45-56 (July 1997).

19. *Id.* at 45.

20. *Id.*

21. *Id.*

22. *Id.*

23. Martin & Zearing, *Relationships Between Industrialized Agriculture and Environmental Consequence: The Case of Vertical Coordination in Broilers and Hogs*, 29(1) *J. AGRIC. & APPLIED ECON.* at 45-56.

24. C. Narrod et al., Potential Options for Poultry Waste Utilization: A Focus on the Delmarva Peninsula, 23 (1994) (unpublished manuscript, jointly sponsored by the Univ. of Pa., USDA, and EPA, Office of Pollution Prevention and Toxics, on file with author).

25. *Id.* at 14.

Since the 1900s, significant shifts in location of the broiler industry have occurred. Between the 1930s and 1940s, traditional production centered around the Delmarva region but after World War II, due to less expensive land, labor, and capital; attractive credit from feed dealers; and the willingness of southern farmers to accept broiler production contracts, processing shifted toward the southern region. In the mid-1990s, more than ninety percent of broilers were contracted and the sector was highly industrialized.²⁶ The major integrators consolidated with about twenty firms controlling eighty percent of production and four major firms dominating the market.²⁷

More recently, the swine industry began a similar but more gradual transformation toward greater integration of marketing and production through contracts, consolidation, concentration, and geographic shifts of production.²⁸ Hog production used to be a value-added activity to corn production and was historically concentrated in the mid-western Corn Belt. All of this has changed with the advent of new technologies and marketing practices. Improved housing, disease control, nutrition, and feeding are important technological changes that allowed specialization of production and increases in factory size and efficiency. Such hog production facilities, like those for broilers, needed to be located close to processing plants. New marketing arrangements include contract production, which is not yet used as extensively as it is for broilers. However, much more of North Carolina's significant swine production is contracted than in the traditional mid-western areas.²⁹

As the hog industry structure has been transformed, it also shifted in location from the historically strong Midwest to the South and more recently to the Great Plains and West.³⁰ Growth in production and processing has been especially strong in southern states and in North Carolina, the nation's second leading hog production state. One

26. Martin & Zearing, *Relationships Between Industrialized Agriculture and Environmental Consequence: The Case of Vertical Coordination in Broilers and Hogs*, 29(1) J. AGRIC. & APPLIED ECON. at 45.

27. *Id.*

28. C. Hurt, *Industrialization in the Pork Industry*, 9 CHOICES 9-13 (4th Quarter, 1994); M. Drabentstott, *This Little Piggy Went to Market: Will the New Pork Industry Call the Heartland Home?*, FED. RESERVE BANK KANSAS CITY ECON. REV. 79-97 (3rd Quarter, 1998), at <http://www.kc.frb.org/Publicat/econrev/pdf/3q98drab.pdf> (last visited May 31, 2002).

29. Martin & Zearing, *Relationships Between Industrialized Agriculture and Environmental Consequence: The Case of Vertical Coordination in Broilers and Hogs*, 29(1) J. AGRIC. & APPLIED ECON. at 45-56.

30. M. Drabentstott, *This Little Piggy Went to Market: Will the New Pork Industry Call the Heartland Home?*, FED. RESERVE BANK KANSAS CITY ECON. REV. 79-97 (3rd Quarter, 1998), at <http://www.kc.frb.org/Publicat/econrev/pdf/3q98drab.pdf> (last visited May 31, 2002).

implication of the shift of hog production to new areas is that production is increasingly occurring in areas not accustomed to hog farming, which in effect leads to a potential for misunderstanding and conflict.

Hog industry consolidation and geographical shifts in production have received much attention by researchers and policymakers. Researchers generally agree less about the key factors affecting swine industry developments in the last ten to fifteen years compared to the important factors surrounding the broiler industry in the 1950s and 60s. Some researchers emphasize market forces and consumer demand,³¹ but others point to entrepreneurial or policy factors affecting the consolidation production and geographical shifts.³²

At least two points raised in these discussions are worth noting. First, while there is considerable agreement that structural change is being driven to a large degree by technology and efforts to achieve economies of scale, there is some disagreement about the role of consumer demand and other factors. Barkema, Cook, Boehlje, and Schraeder emphasize an increase in consumer-driven forces and the benefits of greater vertical integration in terms of improved information flow and reduced transaction costs.³³ Rhodes, however, argues that growth in hogs is driven more by entrepreneurial producers who are expanding horizontally to control production costs and increase their returns.³⁴

Second, several factors have been suggested as being important in affecting these geographical shifts: a need for new farm enterprises, few barriers to adoption of new technology, a receptive political and social environment, and lack of barriers in the form of public policies (environmental, anti-corporate farming, and local zoning).³⁵

There is some disagreement about the relative importance of the factors causing geographical shifts in swine production. For example, different industry observers and researchers have offered different conclusions about the importance of environmental regulations. The evidence regarding these factors is largely anecdotal. Some industry

31. A. Barkema & M. L. Cook, *The Changing U.S. Pork Industry: A Dilemma for Public Policy*, 78 FED. RESERVE BANK KANSAS CITY ECON. REV., 49, 49-66 (2nd Quarter, 1993).

32. V. J. Rhodes, *The Industrialization of Hog Production*, 17 REV. AGRIC. ECON. 107, 107-08 (1995).

33. A. Barkema & M. L. Cook, 78 FED. RESERVE BANK KANSAS CITY ECON. REV. at 49-66; M. Boehlje & L. F. Schraeder, *The Industrialization of the Food System: Questions of Coordination* 32 (June 5, 1995) (unpublished manuscript, presented at conference on Vertical Coordination in the Food System, Washington, D.C., on file with author).

34. Rhodes, 17 REV. AGRIC. ECON. 107, 107-08.

35. Martin & Zearing, 29(1) J. AGRIC. & APPLIED ECON. 45-56.

observers believe that movement of the swine industry may be due to environmental constraints. For instance, Drabenstott said that the North Carolina legislature passed stronger water quality protection laws after large lagoon breaks caused extensive water pollution in the mid-1990s³⁶ and have since been a factor slowing the rapid growth of that industry.³⁷ Such policy developments, as well as evidence of danger of locating large animal facilities in flood plains as revealed by Hurricane Floyd in September 1999, has caused some researchers to predict that hog production will shift to areas with fewer environmental rules.³⁸ The little systematic research conducted on this issue shows that economic factors along with other factors may be relatively more important than state environmental policy in determining growth and expansion in swine production.³⁹

III. Drivers of Agricultural Industrialization

The process of structural change in agriculture is complex. Below, the author explains the importance that structural change in economies is given before addressing agricultural industrialization processes. A central theme of economics and the rationale for capitalism is the concept of economic transformation from less productive to more productive systems. This transformation is based upon advantages of specialization in human activity and trade. It is driven by competition leading to profits for the innovators and lower costs for the producers resulting in higher average real incomes. Industrialization is the organization of production to take advantage of the increased productivity that results from investing in capital goods. Scientific industrialization is based upon specialization in and investments in knowledge to be used to increase productivity. Differences in the capacity to develop and use knowledge are critical factors explaining differences in productivity among groups or countries. In many ways, the industrialization of livestock production rests on recently acquired and applied technical and organizational knowledge (*e.g.*, genetics and

36. R. Smothers, *Waste Spill Brings Legislative Attention*, N.Y. TIMES, June 30, 1995, at A-10.

37. M. Drabenstott, FED. RESERVE BANK KANSAS CITY ECON. REV 79-97 (3rd Quarter, 1998), at <http://www.kc.frb.org/Publicat/econrev/pdf/3q98drab.pdf> (last visited May 31, 2002).

38. J. Bernick, *A Farewell to Farms: Geographic Shift in Livestock Production is in the Wind*, FARM J. (Jan. 2000), at <http://www.farmjournal.com>.

39. Y. Mo & C. W. Abdalla, *An Analysis of Swine Industry Expansion in the US: The Effect of Environmental Regulation*, 39 (Dept. of Agric. Econ. & Rural Sociology staff paper no. 316, Mar. 1998); J. Sullivan, *Environmental Regulation and the Location of Hog Production*, 19-23 AGRIC. OUTLOOK (U.S. Dept. of Agric., Sept. 2000).

management practices).⁴⁰

A. *Stages of the Agricultural Industrialization Process*

United States Department of Agriculture (hereinafter USDA) researchers examined the industrialization process through case studies of the poultry sector and several other sectors.⁴¹ They identified three sets of external forces: new mechanical, biological, or organizational technology; shifting market forces and demand; and new government policies and programs that initiated the structural change process.⁴² *Technological* factors that were changing in the broiler industry in the 1950s and 1960s included mechanical and engineering advances in bird-housing, materials-handling and processing, and adaptable organizational technology such as contracting and vertical integration.⁴³ Important *market-related* factors were the existence of alternative production areas eager to accept new enterprises, potential for expanded consumption, high product-market risks with respect to both price and access, high input risk in the form of difficulty in accessing capital, and ease of entry into production.⁴⁴ *Policy* factors conditioning these market shifts included reduced feed grain costs due to the federal commodity programs, federal tax provisions favorable to agriculture, and antitrust rules that were not prohibitive of past industry activities.⁴⁵

B. *The Four Stages of Industrial Evolution*

Reimund, Martin, and Moore, USDA researchers, concluded that structural change is catalyzed by one or more external factors prompting an adjustment process that occurs in four stages:

- (1) *technological change*-innovators adopt new technology;
- (2) *locational shifts*-production of the commodity moves to areas more amenable to changed methods than to traditional ones;
- (3) *growth and development*-output rises as a result of newly gained efficiencies; and
- (4) *adjustment to risks*-new institutions for coordination emerge and relationships within the sector evolve to manage new risks. The shifts of

40. C. W. Abdalla & J. D. Shaffer, *Politics and Markets in the Articulation of Preferences for Attributes of the Rapidly Changing Food and Agricultural Sectors: Framing the Issues*, 29(1) J. AGRIC. & APPLIED ECON. 57, 57-71 (July 1997).

41. See D. A. Reimund et al., *Structural Change in Agriculture: The Experience for Broilers, Fed Cattle and Processing Vegetables*, USDA-ERS TECHNICAL BULLETIN NO. 1648, at 65 (1981).

42. See *id.*

43. See *id.*

44. See *id.*

45. See *id.*

the poultry industry out of New England and to the Delmarva Peninsula and other areas of the country can be explained by this progression.⁴⁶

While acknowledging that their model needed further validation, Reimund et al. identified a set of structural control variables for influencing the structural change process.⁴⁷ These policy “levers” included commodity programs, tax policy, reclamation policies in the West, consumer protection, antitrust policy, environmental policy, and public spending on research on new technologies.

The researchers cautioned that it would be difficult to control agricultural structure by manipulating existing policy variables, noting that “[t]he policy factors appeared to influence the structure of the three sub-sectors largely through their interaction with technological development and market forces.” In this respect, they were influential in attracting new entrants and equity capital to the sub sectors and in causing the geographic shifts in production regions.⁴⁸ An important conclusion of this study is that public policy change could indirectly provide a basis for influencing the structural change process through impacts on such structural dimensions as adoption of technology, producer risks, and geographic location.

IV. Why ILOs Have Become Controversial

Changes in animal agriculture have created third-party or external impacts for society at large.⁴⁹ Water and air quality degradation are frequently cited examples. The conflicts themselves can be very complex and may involve a broad set of concerns. During a recent study in Pennsylvania, researchers identified the following six general areas of public concern:

- Environmental Use,
- Health and Safety,
- The Role of Government Officials,
- Economic Impact,
- Community Conflicts About Farming and Our Food Supply, and
- Decision-making Processes About Intensive Livestock Operations.⁵⁰

46. See Reimund et al., USDA-ERS TECHNICAL BULLETIN NO. 1648, at 65.

47. See *id.*

48. See *id.*

49. Thomas N. Urban, *Agricultural Industrialization: It's Inevitable*, 6 CHOICES 4-6 (4th Quarter, 1991); D. E. Ervin & Katherine R. Smith, *Agricultural Industrialization and Environmental Quality*, 6 CHOICES 9 (4th Quarter, 1994).

50. C. W. Abdalla et al., *Alternative Conflict Resolution Strategies for Addressing Community Conflicts over Intensive Livestock Operations*, FINAL REPORT FOR PENNSYLVANIA DEPARTMENT OF AGRICULTURE CONTRACT ME 228432, at 12 (Sept. 2000).

Researchers developed these areas by analyzing data compiled from personal interviews with representatives of diverse stakeholder groups.⁵¹

The conflict resolution literature suggests there are at least three broad issues that people can disagree about concerning the creation of ILOs.⁵² First, a disagreement may be about the people, including their personalities, behaviors, or past relationships.⁵³ Second, a dispute may occur over processes or the informal or formal rules guiding patterns of interaction among parties and possibly patterns that escalated the conflict.⁵⁴ Third, a conflict may be about the problem or the substance of the issue causing a conflict.⁵⁵ This dimension of conflict is about the actual issues and interests that are the reason for the dispute.⁵⁶ The major emphasis here will be on the third dimension of the conflict, the *content* of problems that have been the consequences of the industrialization process that have led to the creation of ILOs.

A. *Adjusting to the Impacts of Industrialization*

Adjustment to industrialization is a dynamic and ongoing process. New interdependencies and third-party or external effects brought about by industrialization can create outcomes that are less desirable in addition to positive outcomes such as expanded employment or increased profits. Existing institutions and policies may become inadequate or obsolete as a result. New institutional arrangements may be needed to articulate consumer and citizen preferences and to coordinate economic activities to better meet societal goals.⁵⁷

In the case of animal agriculture, industrialization often changes relationships among the firms in the vertical chain and can lead to new or more extensive external effects from agricultural production. Nearby residents or farm-related businesses that perceive they will be harmed by these effects may attempt to protect themselves or take advantage of opportunities resulting from industrialization. The interaction of these actors in the political arena produces changes in policies and institutions that will determine the extent to which external effects of animal production are taken into account by farmers and input suppliers or processors and the distribution of benefits and costs to food and

51. *Id.*

52. J. E. BEER & E. STIEF, *THE MEDIATOR'S HANDBOOK* 12 (3rd ed. 1997).

53. *Id.*

54. *Id.*

55. *Id.*

56. *Id.*

57. J. D. Shaffer, *On Institutional Obsolescence and Innovation-Background for Professional Dialogue on Public Policy*, 51 *AM. J.AGRIC. ECON.* 245, 245-67 (May 1969).

agricultural firms, consumers, or nearby residents and communities.⁵⁸

At least part of the controversy over ILOs stems from the possibility that facilities may be located in areas that the animal species is not common or in areas that the production or marketing (and implicitly ownership and decision-making) practice is not familiar to the residents. The recent advances of technologies and practices and the uncertainty about the environmental impact of ILOs may play a role in the willingness of neighbors or community members to accept facilities in their area. For example, in the case of marketing arrangements, a neighbor may prefer a local farmer's manure management practices over an integrated or contracted facility's manure management where more decision control rests outside the community.

B. The Public Policy Response

Structural change in animal agriculture has important ramifications for local and regional environmental, health, and community well-being. Environmental quality issues, particularly water quality issues, have been primarily addressed by federal and state laws. Policies and jurisdiction for other environmental issues, such as water allocation or air quality, vary on a state-to-state basis and are often less clear.

1. Nutrient/Water Quality Issues

As animal production becomes more specialized and intensified, more nutrients in the form of animal feed are brought into a region than when the farm was an integrated crop-livestock operation. Typically, only about one-third of these nutrients leave the farm with the animal or animal products.⁵⁹ As a result of expanded contract production that has accompanied industrialization, responsibility for dealing with the residual nutrients generally lies with the producer. Since most animal manure is costly to transport and usually has low economic value, it often is spread on or near farm fields. In many areas and regions, expansions in animal agriculture have dramatically increased the burdens placed on local environments to accept these wastes, leading to degradation of water supplies with nitrogen, phosphorus, or bacteria. Available evidence, while not complete, suggests that animal production has significantly contributed to the pollution of surface and groundwater

58. C. W. Abdalla & J. D. Shaffer, *Politics and Markets in the Articulation of Preferences for Attributes of the Rapidly Changing Food and Agricultural Sectors: Framing the Issues*, 29(1) J. AGRIC. & APPLIED ECON. at 61-2 (July 1997).

59. L. E. Lanyon, *Implications of Dairy Herd Size for Farm Material Transport, Plant Nutrient Management, and Water Quality*, 74 J. DAIRY SCI. 334, 334-44 (1992).

supplies.

2. *Federal Clean Water Act*⁶⁰

The federal approach to addressing environmental problems attributable to animal agriculture has been largely piecemeal, decentralized, and typically reactive. Under the Federal Clean Water Act, permits for discharging waste into surface water are required only for confined animal feeding operations with greater than one thousand animal unit equivalents.⁶¹ Implementation of the permitting process varies by EPA region. Moreover, the implementation of the permitting process varies greatly across the country. As of 1995, 1987 of an estimated 6600 feedlots with greater than one thousand animal units had discharge permits.⁶² As an overall national program, this program's implementation has been limited in scope.⁶³ The lack of nationwide implementation of the CAFO permit program has been an additional factor that has fueled controversy about ILOs and diminished some citizens' and organizations' faith in the ability of government officials to effectively regulate them.

In December 2000, the EPA proposed the first major revisions to the federal CAFO permitting program.⁶⁴ This was in part due to environmental groups' lawsuits to enforce EPA's implementation of the Clean Water Act.⁶⁵ In addition, EPA noted that the structure of the farm animal industry had significantly changed since the rules were developed in the 1970s.⁶⁶

C. *Policy Responses to Other Consequences from Industrialization*

A variety of policy initiatives have emerged at the local and state levels in response to the effects of industrialization. Citizen concern about expansion of animal facilities often extends beyond environmental

60. Clean Water Act, 33 U.S.C.A. §§ 1251-1387 (2002).

61. National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations, 66 Fed. Reg. 2960, 2962 (proposed Jan. 12, 2001) (to be codified at 40 C.F.R. pts. 122 & 412).

62. UNITED STATES GOVERNMENT ACCOUNTING OFFICE, ANIMAL AGRICULTURE: INFORMATION ON WASTE MANAGEMENT AND WATER QUALITY ISSUES, S. REP. NO. 95-200, at 3 (June 1995).

63. K. R. Smith & P. J. Kuch, *What We Know about Opportunities for Intergovernmental Institutional Innovation: Policy Issues for an Industrializing Animal Agriculture Sector*, 77 AM. J. AGRIC. ECON. 1244, 1244-49 (Dec. 1995).

64. See 66 Fed. Reg. at 2960.

65. See *id.*

66. See *id.*

degradation to include noxious odors; negative impact upon existing farms, jobs, businesses, infrastructure and property values; and change in the character of the rural landscape.⁶⁷ In some states or regions, no state or local law exists to regulate odor control, insect population growth, and water quantity appropriation, and there is no "institutional home" for these concerns. Citizens who feel they have been hurt have no state agency to complain to or go to for help. In some cases, frustrated citizens with heightened concerns about animal operations, particularly large hog farms, have pressured local politicians to impose stringent local environmental or land use controls, moratoria, or other ordinances that regulate animal agriculture. Such decisions have led to disputes over state-local control and preemption and increased uncertainty about who can make decisions about ILOs.⁶⁸

V. Industrialization Impacts Challenge Our Institutions and Policies

In the last section, the consequences of industrialization are considered from a broader institutional economics perspective. Specifically, insights from a framework developed by Shaffer are applied to animal agricultural issues.⁶⁹ Emphasis is upon how industrialization leads institutions to become obsolete, citizens' tendency to perceive only the negative impacts of animal industrialization of import to them, and problems citizens face in articulating the concerns about such impacts.

A. *Institutional Obsolescence*

While current policies lead to achievement of certain food system performance goals such as providing low cost meat and milk of the kind desired by consumers, they fall short in meeting environmental quality goals. As a result of many prior policy decisions, an elaborate infrastructure and incentive system currently exists for hauling animal feed and other inputs long distances for use in specialized animal production. While residuals in the form of manure are significant by-products, little incentive exists for relocating nutrients away from the farm. Thus, they accumulate on or near farms, leading to environmental

67. N. D. Hamilton, *Trends in Environmental Regulation of Agriculture*, in INCREASING UNDERSTANDING OF PUBLIC PROBLEMS AND POLICIES 111 (1995); Smith & Kuch, 77 AM. J. AGRIC. ECON. at 1245-46.

68. C. W. Abdalla & J. D. Shaffer, *Politics and Markets in the Articulation of Preferences for Attributes of the Rapidly Changing Food and Agricultural Sectors: Framing the Issues*, 29(1) J. AGRIC. & APPLIED ECON. at 67.

69. J. D. Shaffer, *On Institutional Obsolescence and Innovation-Background for Professional Dialogue on Public Policy* 51 AM. J. AGRIC. ECON. 245-267; J. D. Shaffer, *Food System Organization and Performance: Toward a Conceptual Framework*, 62 AM. J. AGRIC. ECON. 310, 310-18 (May 1980).

degradation and other concerns.

Another indicator of institutional obsolescence is that some concerns that do not yet have legal or regulatory status, such as odor, are often bundled and expressed with those that do, such as water quality. Academics or government agency staff can partition the complex issues and discuss the “water quality” issue or the “odor” issue. In the real world, such distinctions are blurred. In impacted areas for which no rules exist to deal with new or newly perceived consequences from industrialized animal agriculture, there are important barriers for those who wish to express their concerns about such issues. Nuisance issues, such as odor, have no existing legal framework to either define them or force them to be taken into account. People concerned about them get frustrated and attempt to get their suggestions registered by whatever means open to them. One way this can be accomplished is by attaching one issue to another issue that already is recognized as legitimate, such as protecting water quality.⁷⁰ Interest group politics and selective perception of rights may result in preferences being worked out in unexpected jurisdictions. In some instances, odor may be the real local issue, but the preferences for protection from odor of livestock enterprises may be expressed by support for more stringent state water quality rules.

B. A Call for Institutional Innovation

Viewed in a structural context, the institutions that have evolved are incomplete; the current system’s markets and institutions provide no incentives for producers to relocate nutrients off-farm where environmental harm may be reduced. An urgent research and policy education challenge is the design and testing of new institutions that effectively allow stakeholders affected by manure (*i.e.*, nearby residents and communities) to articulate their concerns and have their preferences considered by decision-makers. Since one perspective is that ILOs are a locally unwanted land use, research and education could benefit from experiences in using negotiation and compensation that have been met with success in dealing with the conflict associated with sitting landfills and other locally unwanted land uses.

70. N. D. Hamilton, *Trends in Environmental Regulation of Agriculture*, in INCREASING UNDERSTANDING OF PUBLIC PROBLEMS AND POLICIES 111 (1995); C. W. Abdalla & T. W. Kelsey, *Breaking the Impasse: Helping Communities Cope with Change at the Rural-Urban Interface*, 51 J. SOIL & WATER CONSERV. 462, 462-66 (Nov.-Dec. 1996).

VI. Conclusion: Greater Attention on Boundary Issues Needed

Jurisdictional boundaries are a key concept in analyzing animal waste issues and a critical choice variable in designing institutions and policies to address the consequences of industrialization. This section discusses three levels at which jurisdictional boundaries are a critical decision variable affecting the resolution of ILO conflicts: within firms, within governments (vertically within federal, state, and local units), or within agencies (horizontally within different government agencies). For controversies over ILOs to be more effectively resolved, public policy makers will need to emphasize boundaries at each of these levels.

1. *Firm Boundaries*

At the firm level, a business makes decisions that spill over its property boundaries. Current policies and institutions dictate what effects firms have to take into consideration as costs and what effects they can ignore. Public policies about water quality, nutrient management, or nuisance issues are essentially defining the boundary of the firm's domain. Effectively, such policies cause firms to take third-party effects into their internal cost accounting. Moreover, such public policy decisions redefine property rights and thereby determine the burdens (costs) and benefits of particular decisions and actions.

2. *Governmental (federal, state, and local) Boundaries*

The external effects may also cross governmental boundaries and are borne by nearby residents (or future residents). Concerns about pollution are often expressed in local government units and result in changes at the county or municipal level where the authority to control land use lies. Since the boundaries do not coincide with the decision-making domain of firms to which the producer is linked or within which he or she operates (*i.e.*, regional, national, and global markets), a local jurisdiction may have little recourse in affecting the problem. Enactment of a local land-use law may cause production to shift to other areas where less stringent rules exist rather than changing the firm's behavior to modify operations within the jurisdiction. If the alternate location has less appropriate physical conditions, greater nutrient surpluses, or sensitive or unique ecosystems, even greater net environmental damage may result from the change. However, a shift could also reduce total environmental damage. At this point, no higher authority coordinates change and attempts to ensure that regional shifts will be made to places where environmental harm is the least. Federal policy has been moving in the direction of transferring authority to the states. Also, some states,

including Pennsylvania, have enacted laws limiting local governments' abilities to regulate animal operations. Such approaches have had some advantages in uniformity within a state, but they may also inhibit development of policies appropriate to local conditions and preferences. It is at this level that many of the conflicts over animal agricultural issues arise.

The institutions that allow expression of concerns about the positive or negative effects of animal operations and procedures for mediating conflicts vary considerably by state and local areas. Given that the federal government is moving toward decentralizing authority and that important federal policies (*e.g.*, farming taxes) continue to encourage industrialization processes, the variation among policies affecting animal agriculture is likely to be even greater in the future. A critical policy issue is the possible effect that differences in local and state institutions and policies for water quality laws, land use laws, right-to-farm laws, and public participation have on location of production. Hurt and Zearing suggest that in the early 1990s, less stringent water quality regulations in North Carolina were an important factor influencing movement of hog farms into that state.⁷¹ Additional research is needed to better document these relationships.

3. *Government Agency Boundaries*

A third level at which boundary issues are important is related to inter-agency decisions. A horizontal perspective on such issues looks at the different agencies that tackle a particular issue or concern. For animal waste issues at the federal level, the answer to this boundary question relates to the relative degree of involvement of the USDA and EPA. At a state level, the choice of different agencies is the Department of Agriculture, Department of Environmental or Natural Resources, or the Department of Health and Economic Development. Because each agency's mission, approach, operating procedures, and organizational structure differ, the answers for resolving controversy over ILOs and developing and implementing policy will likely differ depending on each agency's role.

71. C. Hurt & K. Zering, *Hog Production Booms in North Carolina: Why There? Why Now?*, PURDUE AGRIC. ECON. REP. 13 (Aug. 1993).

