

# Hog CAFOs and Sustainability

## The Impact on Local Development and Water Quality in Iowa

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### **The Iowa Policy Project**

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# The Iowa Policy Project

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Fall 2007

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By Jan L. Flora, Qiaoli (Lily) Chen, Stacy Bastian and Rick Hartmann

#### INTRODUCTION

Iowa, like the Midwest in general, has experienced chronic population loss in many rural, farming-dependent counties since the 1930s, with a brief reprieve in the 1970s. In response to a declining tax base, many state and community leaders have sought to spur economic development by embracing industrial livestock production. While the recent restructuring of the livestock industry — and particularly the hog industry — presents new opportunities and challenges for struggling counties, how realistic is it to view industrial hog production as a vehicle for the sustainable development of Iowa's rural communities? More specifically, how are Concentrated Animal Feeding Operations (CAFOs) and their expansion related to local educational levels and quality and degree of experience of the workforce (human capital), to individual and community-level financial well-being (financial capital), to civic engagement (social capital), and to pollution events and environmental quality in the county (negative natural capital)?

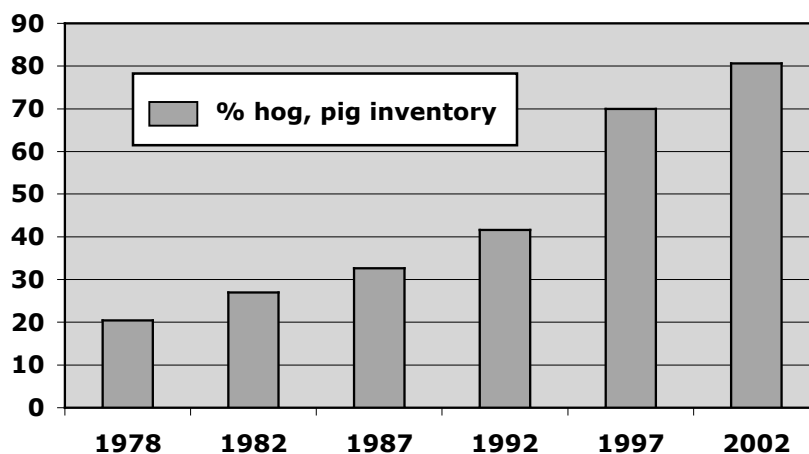
How does the structure of the hog industry interact with community economic viability, ecological health and social well-being? This report systematically analyzes impacts of hog CAFOs (Concentrated Animal Feeding Operations)<sup>1</sup> on indicators of these community impacts by examining natural, financial, human and social capitals in Iowa's 99 counties. Our results can help determine whether Iowans can consider such "hog lots" a form of sustainable local development.

#### Structural Changes in Iowa Hog Production, 1974-2002

Nationwide, ownership and control in the swine industry has become appreciably concentrated. Fifty years ago, nearly 3 million farms in the U.S. raised hogs. By 2003, only about 3 percent of that number, or 85,000 farms, raised the same number of hogs (Caspers 2003). The number of hogs per farm has increased dramatically.

While hog confinement hog operations began as early as the 1970s in Iowa, the greatest growth was in the mid-1990s (See Figure 1). Iowa produced an average of about

**Figure 1. Growth in Percent of Hog and Pig Inventory Farms with more than 1,000 head, Iowa 1978-2002**

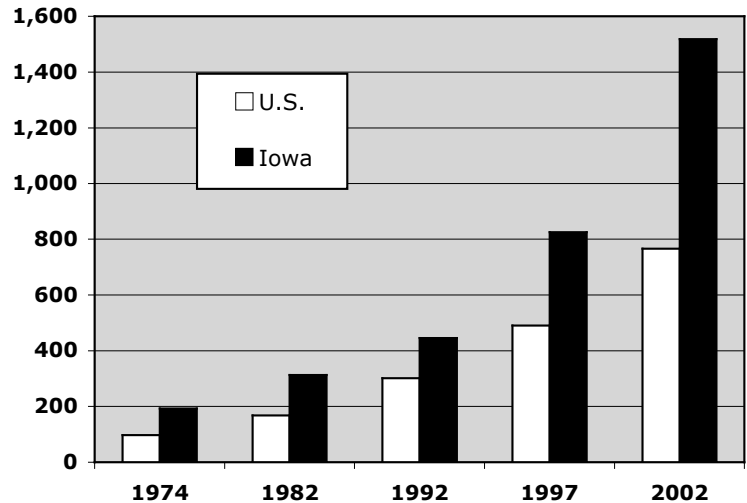


Sources: U.S. Censuses of Agriculture, 1978-2002

250 hogs per farm on 80,000 farms in 1980, with an average of 1,500 hogs per farm on only 10,000 farms in 2002. Number of hogs per farm increased more rapidly in Iowa than in the nation as a whole (ISU-UI Study Group 2002: 29) and by 2002 was nearly double the national average (see Figure 2).

In addition to the increase in concentration of hogs on particular farms, hog farms are increasingly concentrated in particular counties and regions of Iowa. Whereas 1987 shows a relatively uniform distribution of hogs across the entire state (see Figure 3), a decade later one sees a notable increase in overall density in certain counties and, regionally, in three clusters of counties in the northwest corner, and in north central, northeast, and in southeast Iowa. In most counties of southwest Iowa, there has been either visible decline or little change in hog density (Figure 4).

**Figure 2. Average Number of Hogs Per Farm Iowa & U.S., 1974-2002**



*Note: Only farms with hogs included in denominator  
Source: U.S. Censuses of Agriculture, 1974-2002*

**Figure 3. Total Number of Hogs by County, 1987**

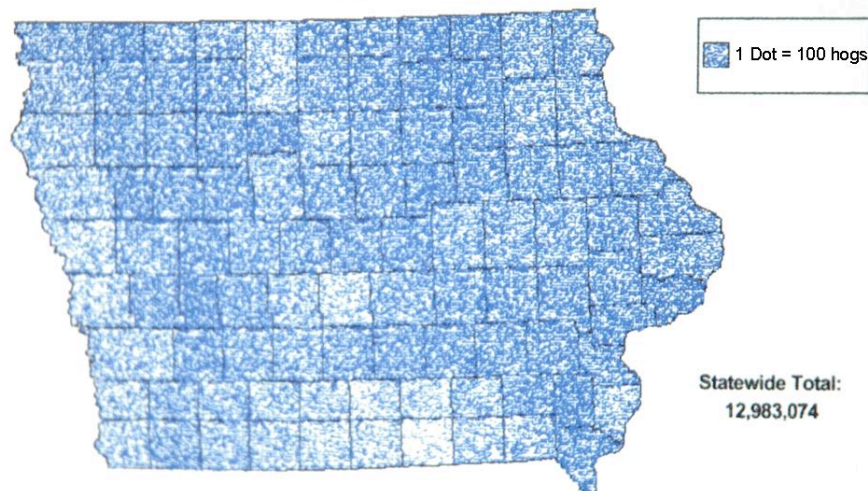
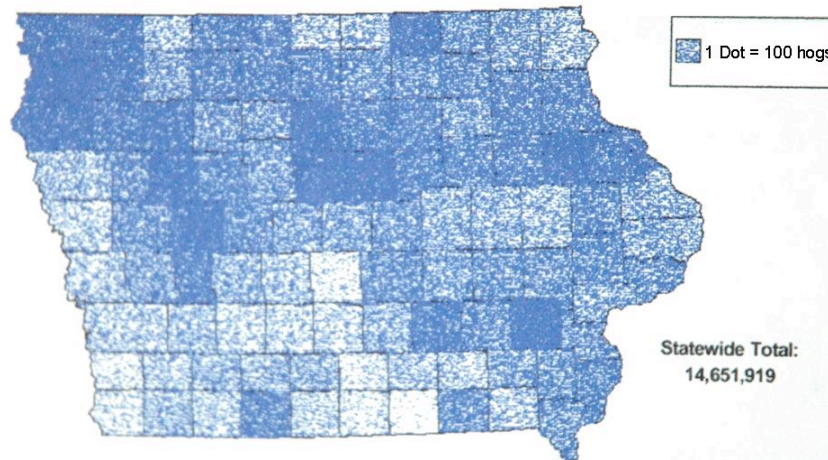


Figure 4. Total Number of Hogs by County, 1997



We will see later that this “crowding” of hogs into certain parts of the state has implications for water quality.

A third way concentration has increased is through greater centralization of control and ownership throughout the hog and pork industry. Over the 16 years between 1980 and 1996, the number of hogs slaughtered by the four largest packers increased from 34 to 55 percent (Ollinger et al. 2005:12; MacDonald 2000:8), and by 2003 had reached 64 percent (Hendrickson and Hefferman 2005). Many of these processors also owned the hogs. By 2005, the top four firms owned at least 23 percent of all sows in the country and the top 20 firms owned more than 43 percent (USDA, NASS 2006; Successful Farming Pork Powerhouses 2005). This ownership pattern is an example of vertical integration.

Integration exists when different stages of production occur within the same enterprise. In fully integrated industrial swine operations, a particular company owns the hogs from genetics and breeding to the eventual sausage or pork chop. Farmers can be contract growers, independent producers, or indeed integrators. The farmer/grower as integrator owns the sows and pays other farmers to fatten the pigs, then negotiates to sell them to a packer. Contract growers own the land and buildings and provide labor, and are in essence renting out hog “parking spaces” in their facilities; the contractor provides the animals, feed, and much of the management. The contractor may also be a processor. Table 1 shows the

Table 1. Hogs and Pigs – Inventory by Type of Producer, Iowa, 2002

<i>All hog farms</i>	<i>Independent Grower</i>	<i>Contractor or Integrator</i>	<i>Contract grower (contractee)</i>
# of Farms with hogs	7,548	305	2,801
# of hogs (000) and % of inventory	8,371 (51.4%)	2,526 (15.5%)	5,374 (33.0%)
Avg. number of hogs/farm	1,109	8,281	1,918
% of inventory in CAFOs (1000+ hogs)	79.9%	98.1%	89.0%
Median size of hog farm	Between 2,000 and 4,999 head	Between 7,500 and 8,281 head	Between 2,000 and 4,999 head

Source: 2002 Census of Agriculture, Table 23.

extent of integration/contracting in Iowa. Contract growers produced about one-third of hogs in 2002, and integrators produced an additional 16 percent, leaving independent growers producing slightly more than half of all hogs and pigs. Most independent growers sell to large packers, but without a contract. Independent growers with CAFOs and contract growers average a similar number of hogs per farm. Integrator-operated facilities tend to be four or more times as large as other CAFOs.

Integration in Iowa is incomplete, as the local farmers own the land and the buildings. In other states, such as North Carolina, the processor is more likely to own the land, buildings, and the hogs. Preliminary analysis conducted by the sociology department at Iowa State University suggests that residents of rural Iowa respect local hog farmers; they believe the farmers have integrity, even though their hogs in CAFOs may generate annoying odors. This may help explain why North Carolina has for several years placed a moratorium on the construction of new hog CAFOs, while in Iowa there has been limited support for such action, among either legislators or voters.

Industrial swine production by the largest integrated or vertically coordinated companies relates differently to the local economy than do traditional small-scale producers. Typically, integrated and contractor companies do not purchase fattening pigs locally. The integrator/contractor delivers feed, rather than the hog grower/farmer producing feed crops on the same farm, as was generally true before industrial production became the norm. The company provides its own drugs and veterinary services. Direct employees of the company or contract farmers perform the labor on the larger CAFOs. The contract arrangement normally requires the farmer to dispose of the manure generated. Even when ownership of the swine does change hands, the grower does not usually purchase pigs or sell hogs locally — thus, such transactions do not have as large an impact on the local economy (Martinez 1999:8-9; Weida 2000: 9-11).

## **Sustainability and Types of Capital**

Sustainability is the ability of a community to utilize its resources to ensure that present and future members of that community can attain a high degree of health and well-being, economic security, and a say in shaping their future. At the same time, the community maintains the integrity of the ecological systems on which all life and production depend (Kline 1994). Observing trends and identifying changes in large industries, such as the swine industry, is a relatively straightforward process. In contrast, measuring the impacts such industries have on community sustainability is more complicated. Because of this inherent complexity, impact assessments of industrial livestock production are generally relatively narrow in scope. Input-output analyses determine the contribution of packing plants or CAFOs to the local or regional economy. Environmental Impact Statements address the likely effects of such facilities on water quality, air pollution and other elements of the environment. Sociologists and anthropologists look at the community conflict around the construction of CAFOs. Very rarely is a holistic perspective taken to address the overall environmental, social, economic, demographic and human elements associated with changing industrial structures.

To capture this broader picture, we have employed the community capitals framework (C. Flora, et al. 2004; Emery and Flora 2006). This framework considers communities (or in the present case, counties) in terms of their natural, financial, human, social and other resources. These resources, if invested to create new resources, become capital. To what degree do these capitals collectively lead toward or away from sustainability? While financial capital is often given the greatest (at times, exclusive) emphasis by state and community leaders when considering development strategies, implicit in our approach is the view that it is better to optimize each of the capitals, rather than to maximize one. The maximization of a

single community resource can undermine long-term sustainability. A brief discussion of the meaning of each capital follows.

### *Human Capital*

Human capital includes individual occupational skills, human health, values and individual leadership ability. Conventionally, economists and others have measured human capital in terms of formal educational attainment (probably because of ease of measurement and readily available census figures on this variable). Increasingly, there is a concern for leadership skills as a crucial part of human capital necessary for community development to take place. Human capital also includes non-formal skills that are associated with experience in carrying out a particular task or possession of indigenous knowledge about an area. Health status is another aspect of human capital important in development and sustainability. Sick people are less able to utilize their talents than healthy people. Strategies of sustainability aim at increasing the skills of individuals within a community and diversifying the community's human capital resources.

### *Social Capital*

Social capital is an interactive phenomenon. Putnam describes social capital as “features of social organization, such as networks, norms and trust, which facilitate coordination and cooperation for mutual benefit. Social capital enhances the benefits of investment in physical and human capital.” (1993:35-36) Social capital involves networks that link persons of similar background and organizations of social homogeneity, and reaching out to those both within and beyond the community who are different from oneself, one's organization, or one's community. The interactive ties generated through social capital contribute to a sense of common identity and shared future. Social capital develops over time, is group-focused, and is therefore location- or situation-specific. Political capital, discussed in the conclusions, is akin to social capital. It involves networks, reciprocity and socio-political values. It differs from social capital in that it takes power explicitly into account.

### *Financial Capital*

Financial capital in a community consists of private and public capital goods and financial assets (C. Flora et al. 2004). Financial capital consists of money or financial instruments used for investment — for the creation of additional wealth, rather than for consumption. Built capital is a community's physical infrastructure. Financial capital is important for communities and individuals within them because they can readily transform it into built capital: schools, roads, factories, community centers, parks, and so on, all of which augment the other capitals within communities.

There is a tendency to judge community development in terms of the increase in financial and built capital, in part because they are easy to see and measure, and because both are already monetized or immediately translated to monetary terms. Strategies of sustainability aim at maintaining financial and built capital over time, but do not privilege maximizing financial and built capital, to the detriment of other forms of capital investments. Financial capital is highly mobile, generally undeterred by local, state, or national boundaries.

### *Natural Capital*

Natural capital encompasses fresh air, high quality and abundant water and soil, quality food and fiber, biodiversity (plants and animals), and a pleasing landscape. The components of natural capital are highly interrelated and tend to enhance one another. Attention to biodiversity helps maintain soil cover, which decreases soil erosion and enhances soil quality in terms of organic materials and biological communities within the soil. This in turn contributes to water quality. The natural beauty of a place can be natural capital if it is linked with other kinds of capital to encourage people to come to an area temporarily (tourism) or permanently (amenity-based in-migration).

## **ASSESSING THE EFFECTS OF HOG CAFOS ON SUSTAINABLE DEVELOPMENT: HUMAN, SOCIAL, FINANCIAL, AND NATURAL CAPITAL**

### **Study Method**

This study utilizes Iowa's 99 counties as units of analysis. We used multivariate statistical analysis<sup>2</sup> to define associations between the various capitals, on the one hand, and CAFOs on the other. When both independent and dependent variables were available at both times, we looked at their degree of covariance over the decade of the 1990s. In other words, did they change in relation to one another? From a strict statistical point of view, if they did show a significant positive (or negative) relation over time, we cannot claim that one caused the other, only that changes in one were associated with changes in the other.

We used multiple regression to examine human, social, financial and natural capital outcomes of different kinds of Concentrated Animal Feeding Operations (CAFOs). That statistical technique allows us to examine the impact of hogs in CAFOs, holding constant the other types of CAFOs and indicators of urban influence and agricultural structure.

We used bar graphs to show the relative strength of relationship between substantive independent variables (percentage change number of hogs per county) and dependent or outcome variables (county capitals). The height of each bar represents the standardized regression coefficient and can range from -1



to +1. Coefficients of about 0.2 or greater are statistically significant (see Glossary). We present results in four sections, each dealing with a particular type of capital.<sup>3</sup>

### **Variables**

In examining the contribution of hog CAFOs to changes in human, social and financial capital, we measured the main variables around 1990 and again around the year 2000 to determine the extent to which changes in independent and dependent variables occurred simultaneously over the decade of the 1990s.<sup>4</sup>

We devised the following variables to measure changes in large-scale animal feeding operations. We calculated these change measures from the U.S. Censuses of Agriculture of 1992 and 2002, and attempted to match them as closely as possible with the EPA definitions of CAFOs for each species (see CAFO in the Glossary). A positive value means an increase and a negative value means a decrease over the decade.<sup>5</sup> (Only the first of the four measures below — change in hogs in CAFOs — is of substantive interest in this paper. The other three will serve as control variables):

- Percent change in number of hogs on farms w/1,000+ hogs, 1992-2002
- Percent change in number of layers (on farms with 10,000+ layers) and broilers (on farms with 60,000+ annual broiler sales), 1992-2002,
- Percent change in number of cattle in beef feedlots w/ 500 head+, 1992-2002,
- Absolute change in number of dairy cows in herds > 500 head, 1992-2002.<sup>6</sup>

Other control variables included the following:

- Change in percent of employment in agriculture, forestry, fisheries and mining, 1990-2000.
- Change in percent of land in corn and soybeans, 1992-2002,
- Urban influence code. The urban influence code combines geographic proximity to the nearest metropolitan county with the population of the county in question. The 1993 codes are:<sup>7</sup>
  1. Rural (no place of 2,500 population), not adjacent to metro county.
  2. Rural (no place of 2,500 population), adjacent to metro county.
  3. Urban population of 2,500-19,000, not adjacent to metro county.
  4. Urban population of 2,500-19,000, adjacent to metro county.
  5. Non-metro county, urban population of 20,000 or more, not adjacent to metro county.
  6. Non-metro county, urban population of 20,000 or more, adjacent to metro county.
  7. County in metro area of < 250,000 population.
  8. County in metro area of > 250,000 population.

Each of the next four sections is devoted to presentation and discussion of the analysis in relation to a different capital as outcome, beginning with human capital, followed by social, financial and natural capital. We report only the results related to the expansion of hogs in CAFOs. Unlike the first three capitals where we examined simultaneous changes, we analyzed CAFOs' association with natural capital in static or cross-sectional terms.

## Human Capital Outcomes

Human capital outcomes are important in understanding the impacts of concentrated animal feeding operations. Communities or counties that are successful in providing for their inhabitants and contributing to the general welfare are ones that seek the “increased use of the skills, knowledge and ability of local people” (C. Flora, et al. 1999). Capacities of local people are the basis for community success. At times, much of a community's existing human capacity is neither recognized nor used in community efforts. At other times, a lack of skills or knowledge keeps community members from making good decisions or achieving what they set out to do.

Economic developers often view confinement livestock and poultry operations as a form of economic and community development, arguing that they enhance both the quantity and quality of human capital. Do hog CAFOs, the most prevalent confinement operations in Iowa, stem population loss and contribute to employment growth? If so, what is the quality of that employment growth? We will examine how both the quantity and quality of human capital relate to hog CAFO growth.

### *Quantity of human capital*

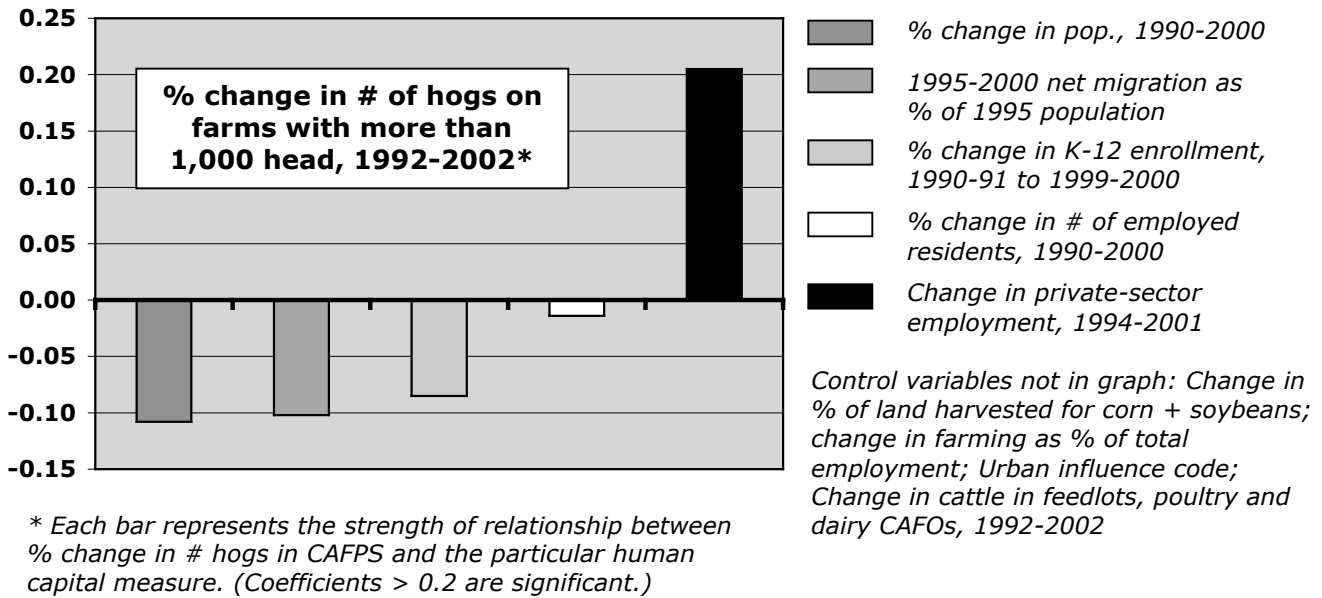
Quantity of human capital in the context of geographic communities involves population growth or at least its stabilization. This goal is particularly important for rural localities, because in the Midwest, and Iowa in particular, community residents and scholars view the loss of population negatively. Population loss over an extended period results in the loss of services and key institutions such as schools, hospitals, grocery stores, or even a post office. Not only do members of that community have to travel further to obtain the goods and services they desire, but the fact that they no longer obtain many such items locally may also result in a decline the residents’ civic engagement in that community (i.e., a decline in social capital).

Five indicators of changes in the quantity of human capital were examined for their relationship with change in hogs in CAFOs, net other changes in agricultural structure and the effects of urban influence. They consist of the following indicators.

- ❑ Percentage change in county population, 1990-2000 (U.S. Census, 1990, 2000).
- ❑ Percentage change in K-12 enrollment between 1990-91 and 1999-2000 school years (Iowa Department of Education, Basic Educational Data Survey).
- ❑ Percentage change in number of residents who are employed, 1990-2000 (U.S. Census, 1990, 2000).
- ❑ 1995-2000 net migration as a proportion of estimated 1995 population (U.S. Census, 2000).
- ❑ Change in private-sector employment, 1994-2001 (County Business Patterns)

Growth in hog numbers in CAFOs related to a slight decline in most measures of quantity of human capital (see Figure 5). However, one indicator of change in the quantity of human capital showed a statistically significant *positive* association with the growth in hogs in CAFOs: change in private-sector employment within the county for the period 1994 to 2001. Apart from indexing change in a slightly different period from the decennial population census, this indicator is based on employment *within* the county (data for *County Business Patterns* are gathered from firms, not individuals). The decennial census figures on employment derive from the employment status of those who *live in* the county.

**Figure 5. Relation of Change in No. of Hogs in CAFOs with Quantitative Human Capital Changes, 99 Iowa Counties**



Thus, the rapid expansion of hog CAFOs during the 1990s did contribute to private-sector employment growth within the county, although the relationship is not strong enough to reverse out-migration or the so-called brain drain. That may be partly because confined hog facilities tend not to purchase inputs or sell fat hogs locally and to the fact that persons who work in CAFOs and related businesses may live outside the county.<sup>8</sup>

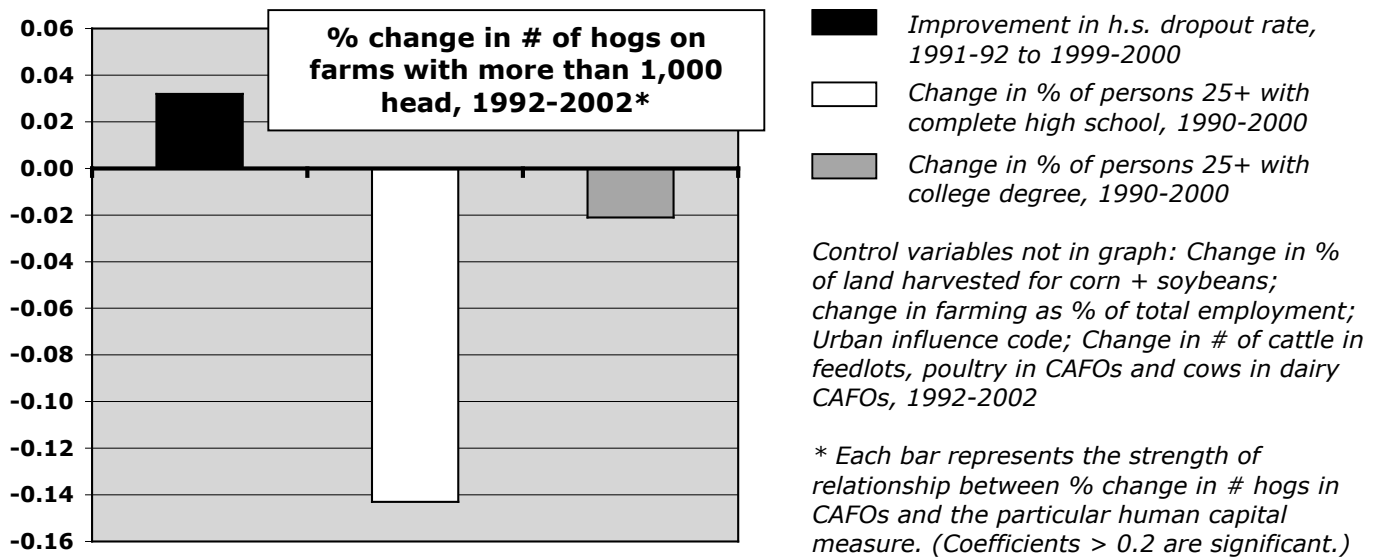
**Quality of human capital**

Our best over-time indicators of *quality* of human capital were as follows:

- ❑ Reduction in high school dropout rate, 1991-92 to 1999-2000 school years (Iowa Department of Education, Basic Educational Data Survey).
- ❑ Change in percent of population over 25 completing high school, 1990-2000 (U.S. Census of Population)
- ❑ Change in percent of population over 25 with college degree, 2000 (U.S. Census of Population)

Improvement (decline) in the high-school dropout rate is an indicator of educational effort during the decade of the study. The other two measures — changes in high-school and college completion — are indicators of past educational efforts and ability to retain or attract an educated adult populace or workforce. The proportion of the adult (over age 25) population with completed high school and completed college increased at a slower rate where confinement hog numbers increased (see Figure 6).<sup>9</sup>

**Figure 6. Relation of Change in No. of Hogs in CAFOs with Qualitative Human Capital Changes, 99 Iowa Counties**



### Summary of Effects on Human Capital

Expansion of hog CAFOs in the 1990s is significantly related to private-sector employment generation, but not to net migration or retention of population, employed residents, or school enrollments.<sup>10</sup> The impact on quality of education is nil, and there is a hint that workers who have not completed high school move to counties experiencing strong CAFO growth. In the early 21st century, we may see that hog (and dairy) CAFOs will also encourage modest growth in the low-wage (working poor or near poor) workforce, if the trend toward larger CAFOs continues and CAFO operators therefore find it necessary to hire more help.

### Social Capital Outcomes

One goal that most communities or localities agree on is the need for *strengthened relationships and communication*, which is another way of defining social capital. According to the *Measuring Community Success* workbook (C. Flora et al. 1999), these strengthened relationships go hand in hand with improved communication and sharing among those with different backgrounds, ideas, and perspectives both within and beyond the local community. A second goal related to social capital is that of *improved community initiative, responsibility and adaptability*:

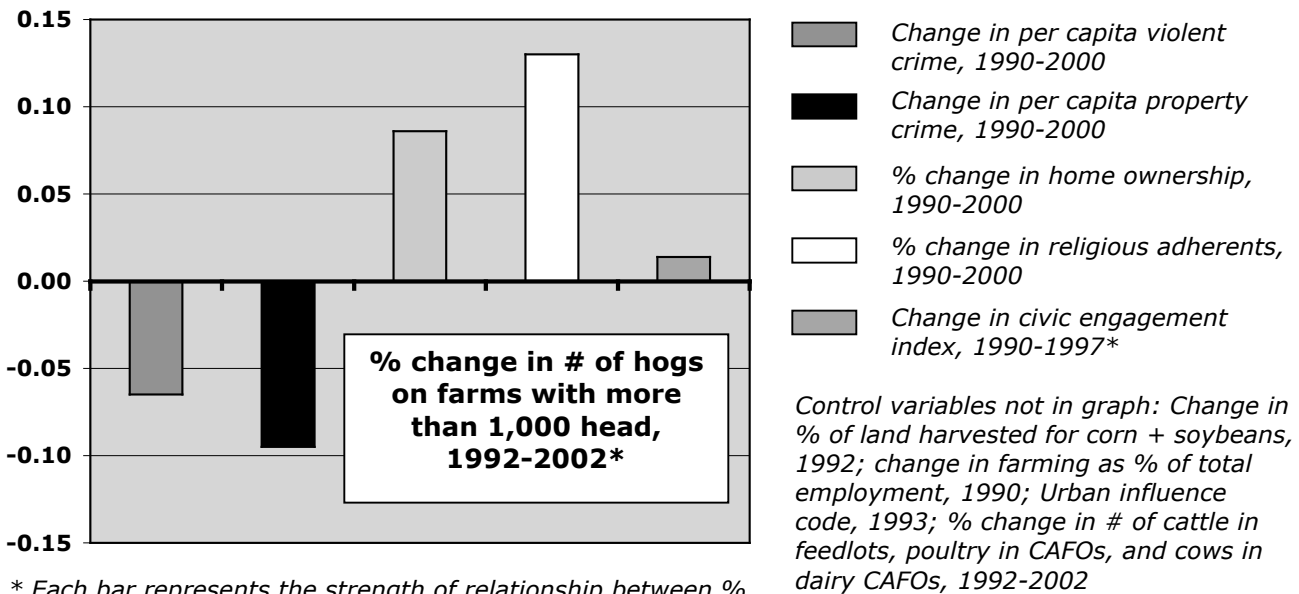
A community that is responsible for its own future shares a well-crafted and widely considered vision for the future, turns it into reality through strategic local action, and makes changes when conditions or assumptions change. A community that monitors and documents the results of its actions, and that regularly reflects on its progress and barriers, learns from its experience. It becomes more resilient, more capable of adapting to change, and better able to improve its efforts and sustain itself over time (C. Flora et al. 1999:43).

The Bureau of the Census and other standard sources of secondary data do not routinely collect social capital indicators per se. Thus we selected measures that other studies have shown are related to social capital. These include levels of security and insecurity indexed by crime rates and inequality (these measures suggest low social capital), homeownership, civic engagement, and church adherence (positive measures of social capital). These indicators suggest different degrees of mutual trust, reciprocity and shared norms and identity — essential aspects of social capital.

The most comprehensive measure of social capital we were able to find at the county level was what we are calling the *civic engagement index*. It is a factor score developed by Rupesingha and Associates (2006) and consists of the following four components:

- ❑ Associational density: Sum of the number of each of the following types of establishments compiled from County Business Patterns published by the U.S. Census Bureau: civic organizations, bowling centers, golf clubs, fitness centers, sports organizations, religious organizations, political organizations, labor organizations, business organizations, and professional organizations.
- ❑ Percentage of voters who voted in the most recent presidential election,
- ❑ County-level response rate to the decennial Census of Population and Housing, and
- ❑ Number of tax-exempt non-profit organizations in the county, obtained from the National Center for Charitable Statistics (see Rupesingha, et al., for complete source references).

**Figure 7. Association of Change in Hogs in CAFOs with Social Capital Changes, 99 Iowa Counties, circa 1990-2000**



None of the change measures of social capital is significantly related to rate of growth in hogs in CAFOs, although all the relationships to social capital-like variables are positive. The strongest relationships are the negative association of change of hogs in CAFOs and change in property crime (a negative indicator of social capital — two negatives equals a positive) and the positive association between growth in church adherents and CAFO expansion. But the measure that most closely approximates social capital growth, the civic engagement index, measured by Rupesingha, et al. (2006) in 1990 and 1997, is virtually unrelated to expansion of hogs in CAFOs.

### *Social Capital Summary*

Perhaps, the most remarkable of the social capital findings was the virtual absence of association of hog CAFOs expansion with civic engagement and the positive relation with the other social capital-like measures. This finding was contrary to other studies that have concluded that hog CAFOs in particular can lead to rancorous conflict in the community, thereby threatening the level of civility and social capital in the community (deLind 1995, 1998; Wright, et al. 2001). It may be that for hog-lot expansion to affect community social capital negatively there must be another intervening variable, such as absentee ownership of the largest CAFOs or the development of an organized movement opposing CAFO expansion. Kleiner et al. (2000) found in two hog-CAFO counties in Missouri that social capital declined in the county with absentee ownership, but not in the one with independent CAFO producers.

Still, a number of studies suggest that the odors that arise from hog CAFOs in particular can be a source of contention and rancor among residents (DeLind 1995, 1998; Lasley 1995, 1998; cited in J. Flora, Hodne, Goudy, Osterberg, Kleibenstein, Thu, and Marquez et al. 2002.). Some suggest that community social capital is compromised as a result (Wright et al. 2001; Kleiner et al. 2000). While that may be true in certain localized instances, the pattern does not appear to be sufficiently generalized to affect the overall civic involvement of the population as a whole. It may well be that the conflicts generated by odors from CAFOs do not reach the level of the whole community and only involve, directly or indirectly, certain subgroups whose disagreements do not notably affect social capital at the community (county) level.

### **Financial Capital Outcomes**

The economic impact of the confined livestock sector in Iowa is quite large (Lawrence et al. 2003; Cryan 2004). However, impact studies generally fail to look at the geographic distribution of benefits within the state or the distribution of those benefits to different socioeconomic groups within localities (Weida 2000).

Our approach is to examine indicators of economic vitality and financial well-being of residents and localities to see how they relate to different types of livestock and cropping patterns. Again, we borrow from the *Measuring Community Success and Sustainability* handbook to articulate appropriate goals related to financial capital:

Vital economies deploy financial, natural and human resources to create, maintain and improve local livelihoods. A diverse industry base helps maintain services, businesses and households when the economy fluctuates. In healthy economies, community residents move toward self-sufficiency and prosperity, local businesses modernize and find new markets, local ownership of homes and businesses increases, and local people and financial institutions invest in the community. (C. Flora, et al. 1999:67)

We note that this characterization leaves out goals with respect to the state, which, through a functioning democracy, should allow civil society to influence the rules by which the market should operate; be efficient and non-corrupt in collecting revenue and in disbursing it for purposes desired by civil society.

We first examined the relation between the overall measure of numbers of hogs in CAFOs over the decade of the 1990s and indicators of financial capital measured at the end of that period. We found no important associations. We then turned to an examination of the simultaneous change of hogs in CAFOs and financial capital change. We examined three kinds of financial capital change.

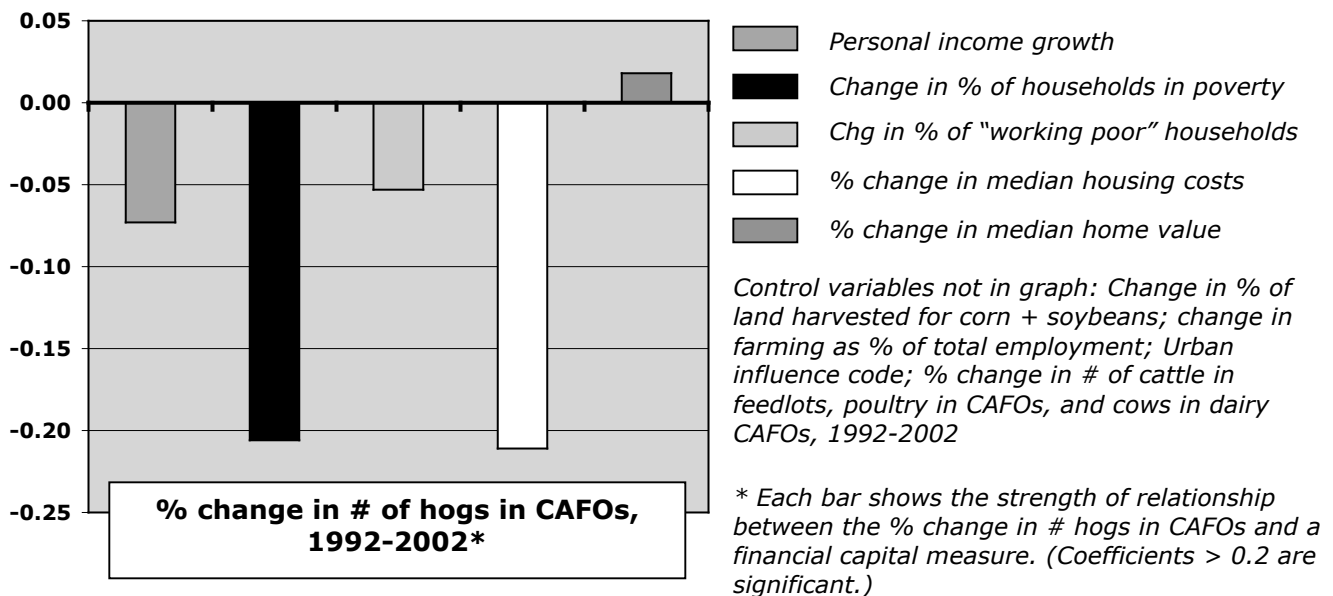
***Personal and Household Income Growth and Poverty Change***

We examined household income and wealth trends from the 1990 and 2000 U.S. Census of Population:

- ❑ Percentage change in median households income, 1989-1999
- ❑ Percentage change in per capita income, 1989-1999
- ❑ Change in percentage of households in poverty, 1989-1999
- ❑ Change in percentage of persons in households with incomes between 100 and 200 percent of poverty, 1989-99
- ❑ Percent change in median housing costs
- ❑ Percent change in median housing value

Figure 8 shows the relationship between change in numbers of CAFO hogs and the income and wealth change variables. We combined changes in median household income and in per capita income, which

**Figure 8. Relation of Change in Hogs in CAFOs to Changes in Household Financial Capital, 99 Iowa Counties, circa 1990-2000**



are highly correlated with one another, to form a measure of *personal income growth*. The two low-income measures, which behave somewhat differently, remain separate. Counties experiencing a growth in hogs in CAFOs experienced a significant decline in (official) poverty, but change in hogs in CAFOs was unrelated to change in household and per capita income and proportion of the population in near poverty.<sup>11</sup>

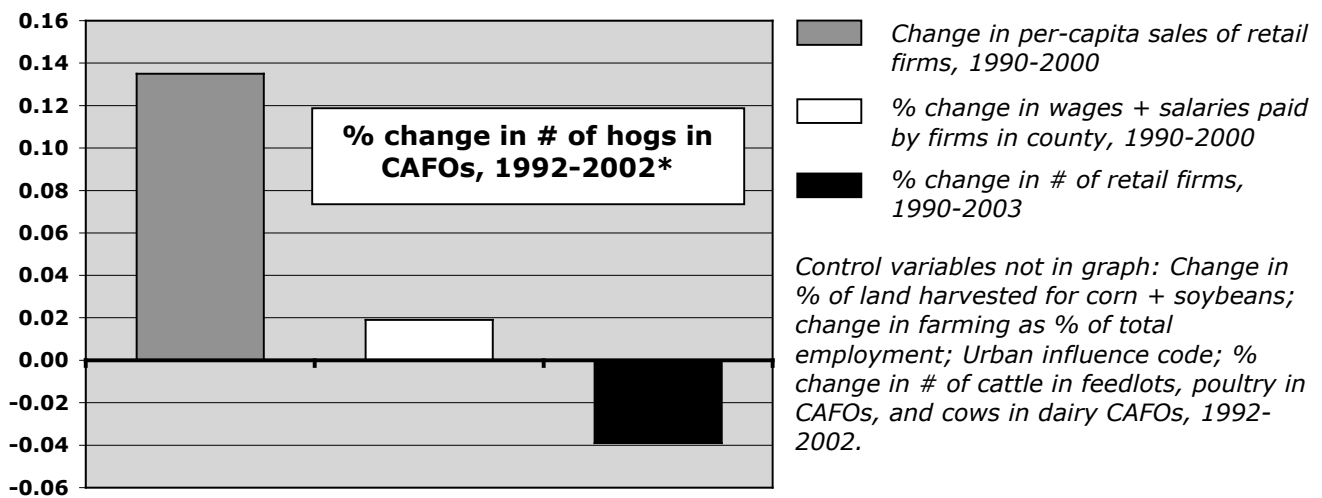
The final indicators of household financial capital are average county housing values (as estimated by their owners in the Census of Population) and housing costs based on actual sales. Counties with large numbers of confined hogs show a significant decline in value of those houses sold, but no change in estimated housing values. A number of studies have found that hog CAFOs depress the value of homes that happen to be located near them (Hamed et al. 1999; Palmquist et al. 1997). Our study suggests that hog CAFO expansion does not affect the overall value that residents assign to their homes, but it appears to depress the median sales price of housing for the county as a whole.

**Locality-Based Financial Capital**

Figure 9 shows the relationship of CAFO growth and the financial change measures that indicate locality-based financial capital. Three change indicators index growth of the local economy without it becoming concentrated or highly capital-intensive (wage and salary disbursements appear to be keeping pace with growth), as well as growing capacity of the local government to provide services to the community (measured by an increase in sales tax collections, an indicator of government serving the public good):

- ❑ Change in per capita county retail sales, 1990-2000 (Iowa Department of Revenue and Finance)
- ❑ Percentage change in wage and salary disbursement by firms in the county, 1990-2000 (BEA-LAPI)
- ❑ Percentage change in number of retail firms, 1990-2003 (County Business Patterns)

**Figure 9. Relation of Change in Hogs in CAFOs to Changes in Locality-Based Financial Capital, 99 Iowa Counties, circa 1990-2000**



\* Each bar shows the strength of relationship between the % change in # hogs in CAFOs and a financial capital measure. (Coefficients > 0.2 are significant.)

Figure 9 shows a modest positive relationship between the rate of growth in CAFO hogs and retail firm sales in the county. Growth in wage and salary disbursements by county firms and change in number of retail firms are essentially unrelated to the growth of hogs in CAFOs.



### *Financial Capital Summary*

There is only a tepid relationship between hog CAFO expansion and measures of county-wide business growth, and *no* contribution of CAFO expansion to business diversification. The mixed results raise doubt that confined hogs contribute directly or indirectly to economic development. We know from other studies that livestock production, much more than row crop production, has been a value-added activity for the farm and the community where the livestock are grown (Monchuk, et al. 2005: 20). However, it would appear that in the case of hog CAFOs the forward and backward linkages to local communities are much weaker than occurred under conditions of more diversified crop-livestock farms where hogs were not raised in confinement.<sup>12</sup>

On the household level, hog CAFO expansion is related to a decline in core poverty, but is largely unrelated to other indicators of income change. Interestingly, housing costs, but not housing values, showed a steep decline in these counties. These data raise serious questions as to whether the growth of hog, poultry, and beef cattle confinement operations in the 1990s and into the present decade in Iowa could be considered successful local economic development.<sup>13</sup>

## **NATURAL CAPITAL OUTCOMES**

Natural capital includes air, water, soil, plants, animals and landscape. These assets are not included in corporate or government balance sheets. This absence does not mean that environment does not have value; only that for too long people and their leaders have taken that value for granted. When we take something for granted, we fail to appreciate it until it is greatly impaired or diminished. The *Measuring Community Success* handbook identifies broadly held community goals regarding natural capital:

Human communities are part of natural ecosystems. The responsible stewardship of natural resources sustains businesses and families in communities over the long term. Finding common ground among people who have emotional, symbolic, or economic identification with a place, whether or not they live there, is essential to making decisions about development and resource use that will enable communities and their resource base to survive and thrive... Ecosystem health is maintained best when citizens have and use knowledge about their ecosystem to guide their behavior (C. Flora et al. 1999: 53).

Unlike with the other capitals examined, it was not possible to examine the simultaneous change in natural capital indicators and the growth in hog (and other livestock) CAFOs, for two reasons: 1) Since we were examining natural capital indicators related to water quality, we felt it was important to quantify the amount of manure produced by livestock in CAFOs. Those data are available from the Iowa Department of Natural Resources and are an artifact of its regulatory activities. Construction permits for CAFOs, required since 1986, allow a cumulative estimate of the authorized capacity of CAFOs and it is not easy to calculate that capacity for two points in time. 2) Regulatory agencies also collect indicators that relate to water quality and in some counties, the number of cases is too small to develop over-time indicators because of the short period in which they have been collected and the small number of reported pollution cases per annum per county. Thus, it was also appropriate to cumulate these events and measurements over the period that agencies have collected the data. It was necessary to limit our analysis to examining cross-sectional relations of hog manure production to contamination events and pollution levels in Iowa's 99 counties.

We calculated the potential for water pollution by hogs in CAFOs for the period of the 1990s in the following fashion: The total weight of hogs allowed under manure management plans filed by producers (Source: I-DNR Data base: MMPs2.xls) and multiplied the total county weights by 0.18/1000.<sup>14</sup> This means that hogs that collectively weigh 1000 pounds would produce 0.18 pounds of Phosphorus in their manure daily. The control variables that are included in the regression are similar to those we used to determine the relation between change in numbers of hogs in CAFOs and the three capitals already analyzed, except that we calculated phosphorus production by the other kinds of CAFOs and used the scores of the farm structure variables for the period around 1990.<sup>15</sup>

To understand the impact of hog CAFOs on natural capital, we examined four negative indicators of natural capital. Two are contamination events: manure spills and fish kills. The other two measure pollution of surface and ground water directly: coliform bacteria levels in ground water, and impaired rivers and lakes.

### *Issues of water quality*

Traditional livestock agriculture has not been a significant cause of point-source pollution. However, modern concentration of animals has raised concerns about their contributing to groundwater and surface water pollution (Schepers et al. 1991). Since the sources of such water pollution cannot be precisely determined, this contamination is designated non-point-source pollution.

While pollution from factories and sewage treatment plants has been dramatically reduced [point pollution], runoff from city streets, agricultural activities (including animal feeding operations), and other sources continue to degrade the environment and puts drinking water at risk [non-point pollution]. (USDA and EPA 1998; 1.1. Introduction.)

Since confinement operators dispose of hog manure as liquid slurry, the costs of transporting it outside the local area are prohibitive, and so operators generally contract to spread it on their own or other local farmers' fields. Animal manure can provide valuable crop nutrients, particularly nitrogen and phosphorous. Crop farmers' yields improve and crop production costs decrease when they use manure generally provided free by a neighboring hog producer. However, nearby farmers cannot always utilize the massive amounts of manure created in confinement facilities. Jackson and colleagues (2000) documented this in a study they conducted in north central Iowa:

Public records were used to document the manure management practices of 10 CAFOs housing 59,700 finishing hogs in a 1,554 ha area of Hamilton County, Iowa. Together, the CAFOs generated an estimated 811,500 kg of nitrogen (N) each year, more than 70% of which volatilized into the atmosphere. CAFOs minimized the area required for applying manure by underestimating manure N content, projecting above average crop yields, and applying manure to soybeans. Some fields were claimed by more than one CAFO, and some field sizes were overestimated. Manure application based on crop demand for phosphorus would require 9,350 ha of cropland, compared to the 990 ha used by CAFOs. (p. 205.)

Hog waste is commonly stored in the ill-named "lagoons," or open-air storage pits lined with clay or geo-membrane plastic liners. Though there are many systems to handle hog waste, lagoons are the cheapest available — but also relatively ineffective when compared with other more costly materials — for disposing of the manure. Because of seepage and other problems with earthen lagoons, called by the IDNR *unformed manure storage structures*, regulating agencies are encouraging producers to build *formed* structures (with walls and a floor constructed of concrete, concrete block, wood, steel, plastic,

rubber, fiberglass, or other synthetic materials). There is no fail-safe method of waste storage and treatment. In Iowa and other states, mismanagement of lagoons and extreme weather events has created animal waste overflows and spills.<sup>16</sup>

Manure nutrients, so necessary for crop production, can also be pollutants when farmers, growers, and packers treat them as waste or when they exceed the ability of soils and crops to use them. Excess manure nutrients, such as phosphorus and nitrogen can have serious health or environmental impacts and therefore affect community sustainability. Excessive phosphorus causes algae blooms, depleting oxygen needed by fish and other aquatic life. Excessive nitrogen can be toxic to aquatic life and cause human health problems. Congress enacted the Safe Drinking Water Act in 1974 to ensure that every water supplier provides drinking water that meets minimum health safety standards. The Environmental Protection Agency (EPA) sets these standards. The EPA has set health-based limits for over 80 contaminants in drinking water, many associated with industrial agriculture. These contaminants include metals (e.g., lead), fertilizers (e.g., nitrates/nitrites), pesticides (such as atrazine), and microorganisms (such as coliforms).

How do these large amounts of concentrated nutrients from CAFOs affect surface and ground water in Iowa and thereby its natural capital? In order to shed light on this question, we analyzed data from the 99 counties of Iowa to pinpoint whether specific kinds of confinement operations are associated with contamination events or pollution levels. We weighted CAFOs by the amount of manure the animals in them generated and converted the manure produced into calculations of the amount of nitrogen and phosphorus produced. Independent variables used in the equations included estimates of phosphorus produced by hogs in CAFOs, based on and the capacity of facilities requested in applications for construction permits issued from 1986 to 2003.<sup>17</sup>

### ***Manure spills***

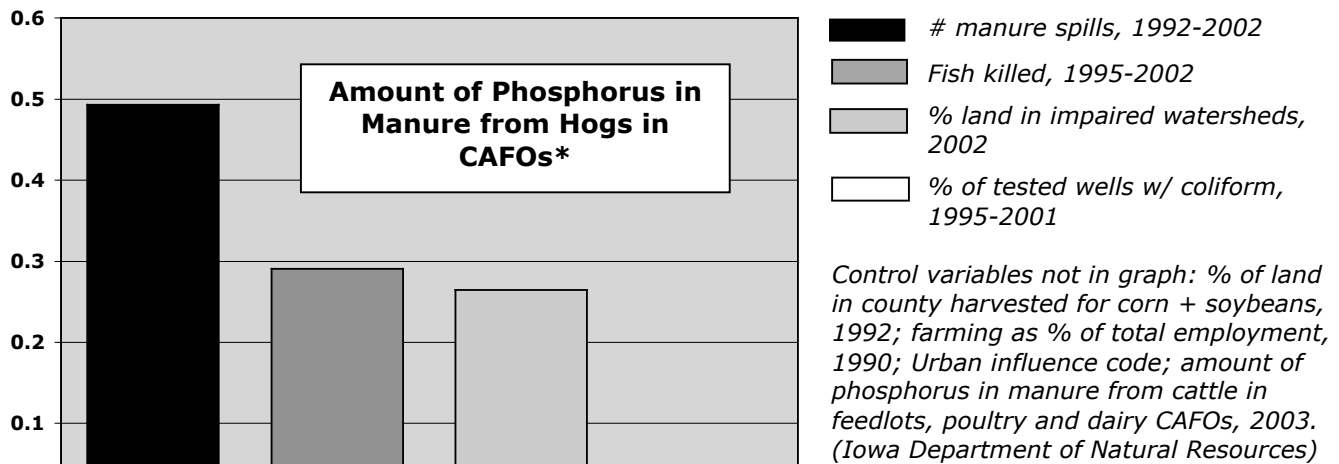
As one would expect, manure spills are due to the presence of CAFOs, particularly hog CAFOs (See Figure 10). In an 11-year period, two-thirds of Iowa counties reported two or more manure spills and 13 percent experienced more than one spill every two years. Only 12 percent reported no manure spills during the 11-year period. The two counties with the greatest number of spills were Sioux and Hamilton counties. The presence of manure spills increases the risk of contamination of surface and ground water.

### ***Fish Kills***

An overview of the causes of fish kills reported to and investigated by the Iowa Department of Natural Resources (I-DNR) during the period 1995-2002 indicates that at least 55 percent of fish kills come from livestock operations — whether from confinement operations/open feedlots or from livestock grazing on or near the banks of streams. Nearly half of Iowa's counties had no fish kills reported, while 29 percent of counties had reports of 10,000 or more fish killed over the eight-year period. The top 10 percent of counties reported more than 100,000 fish killed.

Counties that had large numbers of fish kills were counties in which we calculated hog and dairy CAFOs had produced large amounts of manure. (See results in Figure 10.)

**Figure 10. Relation of Hog Manure and Production to Water Contamination Events and Pollution Levels (Negative Natural Capital), 99 Iowa Counties**



Each bar represents the (positive) strength of relationship between phosphorus excreted by hogs in CAFOs and the particular pollution measure. (Coeff. > 0.2 is significant.)

### ***Impaired watersheds***

Impaired watersheds are those that generally do not support drinking, fishing or swimming. Major causes of watershed impairment in Iowa in 2002 included low biological diversity, siltation and turbidity, habitat and flow alteration, nutrients, bacteria and low dissolved oxygen.<sup>18</sup> What do the data show with respect to the collocation (in the same county) of different kinds of confinement operations with impaired watersheds?

The ISU GIS Laboratory calculated for us the proportion of land in each county that was in watersheds with impaired waterways. The laboratory found a moderately strong relationship between the production of hog manure in CAFOs and Iowa's impaired waterways (see Figure 10).

### ***Coliform bacteria***

We examined the relation between confined livestock and the proportion of wells tested that had unacceptable levels of coliform bacteria. Table 2 shows the number and frequency of wells tested by county. Except for a very few counties there was a sufficient number of tests over the seven-year period from 1995 to 2001 to get a rather clear picture of the incidence of coliform bacteria contamination. The estimated quantities of manure produced by hogs in CAFOs were unrelated to the proportion of wells that tested positively for coliform bacteria (see Figure 10).

**Table 2. Total number of wells tested, 1995-2001**

Number of Wells Tested	Number of Counties	Percent	Cumulative Percent
3-43	14	14.2	14.2
55-100	13	13.1	27.3
111-246	22	22.2	49.5
257-494	24	1.0	61.6
521-930	14	1.0	85.9
1031-4625	14	1.0	100.0
Total	99	100.0	

**Summary of Water Quality Results**

Hog excretions strongly relate to three of the four contamination measures: manure spills, fish killed, and land in impaired watersheds. However, they are unrelated to the percentage of private wells tested that had unacceptable levels of coliform bacteria. Home septic systems may have the greater influence on coliform detection from private well testing. Thus, hog CAFOs do not appear to be major contributors to groundwater pollution.<sup>19</sup>

The effect of manure from hog CAFOs on surface water quality appears to be substantial. Our results suggest the hypothesis that hog CAFOs may be the largest agricultural polluter of Iowa’s streams and lakes, although our analysis shows that large confinement dairies would appear to be a not-so-distant second (table available from first author). Since among the states, Iowa is the largest up-country contributor to hypoxia in the Gulf of Mexico near the mouth of the Mississippi, surface water pollution of Iowa’s rivers and streams has important national implications as well.

European nations have recognized the consequences of degrading natural capital and have promoted measures to control odor, nitrogen, ammonia and phosphorus emissions from livestock operations. These measures include: 1) economic incentives combined with a regulatory approach involving production quotas, manure manifests, application standards, and fees, 2) public *and private* investment in odor research and development, and 3) environmental education (Chapin, Boulind and Moore 1998:43; Fontein et al. 1994). Many technical adjustments and innovations used in Denmark, the Netherlands and Germany that address the odor and emissions problems of industrial livestock production complement these control measures (Chapin, Boulind and Moore 1998:49). The measures adopted in these European countries are suggestive for crafting Iowa and U.S. environmental policies.

## DO HOG CAFOs GENERATE SUSTAINABLE LOCAL DEVELOPMENT?

### DISCUSSION AND CONCLUSIONS

Social scientists and ecologists generally regard three elements as being essential for sustainability to occur: social equality and well-being, economic viability, and environmental soundness. With respect to the social component (human and social capital), counties with expanding hog numbers in CAFOs also experienced significant private sector employment growth within their borders, but that CAFO expansion made no positive contribution to quantity of human capital for residents — whether measured by population retention, in-migration, increased employment of residents, or school enrollments growth. While industrial hog expansion may contribute to private-sector regional employment, it does not appear to have any relation to demographic growth in the county in which the hog expansion occurs, net other changes in agricultural structure and the effects of urban influence. As regards change in the *quality* of human capital, the only measure with even a modest relation to CAFO-hog expansion is the growth in the proportion of non-school age adults *without* a high school education.

Regarding social capital, an increase of hogs in CAFOs is unrelated to changes in civic engagement. CAFO expansion relates quite modestly to reduction in crime, and to increases in home ownership and numbers of religious adherents. Contrary to what others found in case studies focused on the issue, growth of hogs in CAFOs seems not to have depressed the level of social capital. Perhaps other variables such as the development of a protest movement must intervene for the relationship between community social capital and hog CAFOs to turn negative. Perhaps in Iowa, because state law prevents localities from regulating CAFOs, mobilization against CAFO expansion has been focused on the state level, thereby defusing local conflict around the issue.

With respect to financial capital and local economic viability, hog CAFO expansion is associated with reduced core poverty, but is by-and-large unrelated to changes in median county income levels, housing values, and to change in the share of near-poor households. Regarding locality-based indicators of financial capital, hog CAFO growth relates to a quite modest increase in retail sales, but is unrelated to changes in wages and salaries paid by county firms or to a change in the *number* of retail firms.

While expanding hog-CAFO counties were associated with new private-sector employment in the 1990s, that job growth does not appear to have been sufficient to stem out-migration and population decline, perhaps partly because it did not contribute to indirect and induced job growth, with particularly small relation to public sector employment. Selling prices of homes that were on the market in the 1990s declined significantly in counties where hog confinement operations were expanding most rapidly, although homeowners' assessment of the value of their homes remained steady. The relative decline in the value of houses sold in hog-CAFO-expansion counties may be due to the decline in housing prices near CAFOs and/or to increased movement in the affordable or low-value housing market as new workers move into the county. Whether we measured economic development in terms of growth in retail sales, increase in wage and salary disbursements by local firms, or by an increase in the number of firms in the county, the effect of hog CAFO expansion was anemic. It is important to remember that over the past quarter century, a rather constant number of hogs produced in Iowa have been concentrated geographically, increasing the density in some counties and decreasing density in many. That concentration has not generated local economic development in the counties where it occurred, suggesting there may be a countervailing effect of concentration: integrated or contract-feeding CAFOs often do not purchase inputs from within the county. Alternatively, one might argue that throughout

much of the 1990s, the oversupply of market hogs kept prices low, and hog farmers had little to spend in the local economy, but it is not likely that the hog production industry as a whole substantially reduced its purchased inputs.

Finally, as regards the third leg of the sustainability stool, natural capital, manure production from hog CAFOs strongly and positively related to three of the four contamination measures: manure spills, fish kills, and impaired waters.<sup>20</sup>

Together, these data raise serious questions as to whether we can consider the growth of hog confinement operations in the 1990s in Iowa to have generated sustainable local development. Indeed, in certain parts of Iowa, the opportunity costs may have been substantial. It is possible that their growth has hampered rural tourism, recreation, and destination retirement development, particularly in certain counties of northeast and southeast Iowa that have natural amenities as well as a high density of hogs (see Figure 4). The economic, social and human development impacts of CAFOs are, at best, modest. The research of Monchuk and colleagues on counties of Iowa and the surrounding states indicates that although growth in livestock sales has a modest positive effect on county income growth, the contribution of outdoor recreation amenities is more than five times as great (Monchuk, et al, 2005: 17-18). Because of the odor of concentrated hog manure (and the negative impacts of hog CAFOs on surface water quality), recreational amenities and CAFOs cannot exist cheek to jowl. Our results are clear that Concentrated Animal Feeding Operations are negatively associated with surface water quality in Iowa and beyond its borders.

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## Glossary

(Unless otherwise indicated, the source for these definitions is the ISU-UI Study Group, 2002: 216-220.)

**Coliform bacteria** — A group of long-living bacteria predominantly inhabiting the intestines of warm blooded animals, but also found in soil. It includes all aerobic and facultative anaerobic, gram-negative nonspore-forming bacilli that ferment lactose with production of gas. This group of “total” coliforms include *escherichia coli* which is considered the typical form of fecal origin. The fecal coliforms are often used as an indicator of the potential presence of pathogenic organisms (Source: Hodne, 2005:35)

**CAFO** — Concentrated Animal Feeding Operation. (Sometimes called *Confinement* or *Confined Animal Feeding Operations* by other agencies and writers on the subject.) The federal Environmental Protection Agency has developed a specific regulatory definition of CAFO for the purpose of enforcing the Clean Water Act. Following is their definition: “Generally, a facility where large numbers of farm animals are confined, fed, and raised, such as dairy and beef cattle feedlots, hog production facilities, and closed poultry houses. The EPA has developed a specific regulatory definition of CAFO for the purposes of enforcing the Clean Water Act. The Act requires individual facilities that are potential sources of water pollution to obtain point source discharge permits that specify the allowable levels of effluent from each facility. The EPA regulations define ‘animal feeding operations’ as those confining livestock or poultry for 45 days or more in a 12-month period in a facility that has no vegetative ground cover. Such places are further considered ‘concentrated,’ and therefore required to have an EPA permit, if they reach certain size limits or meet other criteria specified in the EPA regulations. Those size limits are 700 mature dairy cattle, 1,000 beef cattle, 100,000 chickens, 55,000 turkeys, 2,500 swine, or 10,000 sheep.” (See “Concentrated animal feeding operation (CAFO),” AgricultureLaw.com, 2007.)

**Concentrated Feeding Operations (CFOs)** — A term used by the Iowa Department of Natural Resources (IDNR) that is equivalent to the U.S. Environmental Protection Agency (EPA) term CAFO (see immediately above). (Source: IDNR 2005a).

**Concentration** — the trend of increased monopolization and vertical and horizontal integration by fewer and fewer corporations at national and international (Source: Hodne, 2005: 35)

**EPA** — The U.S. Environmental Protection Agency

**Groundwater** — underground water stored in aquifers. Groundwater is created by rain which soaks into the ground and flows down until it collects above an impervious zone

**Integration** exists when different stages of production occur within the same enterprise. Production may be horizontally integrated or vertically integrated. **Horizontal integration** means that the same firm or family owns various facilities at different sites. The facility(ies) at each site perform(s) the same part of the production-processing-marketing process. **Vertical integration** means that the same firm, family, or other entity owns two or more stages in that process. **Total vertical integration** means that the same firm owns the commodity/product from beginning to end.

**Industrial livestock production** — large-scale production of livestock that involves standardized procedures and products produced at the lowest possible price. Generally, different people have roles of managers, owners and workers.

**Lagoon** — an earthen facility for the biological treatment of wastewater. It can be aerobic, artificially aerated, anaerobic or facultative depending on the loading rate, design, and type of organisms present.

**Manure** — the fecal and urinary excretion of livestock and poultry. Often referred to as livestock waste. This material may also contain bedding, spilled feed, water or soil.

**Multiple regression** — A statistical procedure which allows one to determine simultaneously the relative strength of independent effects of various contributory (causal and control) variables on a single outcome variable.

**Nonpoint-source pollution** — any source of pollution not associated with a distinct discharge point. Includes sources such as rainwater, runoff from agricultural lands, industrial site, parking lots and timber operations.

**Point-source pollution** — pollution from a specific source that is readily determinable

**Regulation** — a requirement or rule passed by an agency or department of federal, state, or local government that is authorized to create and enforce a requirement or rule through an authorizing statute or constitutional authority.

**Statistically significant** — describes a research finding that is unlikely to be due to chance (usually less than a 5 percent probability).

**Volatilize** — the conversion of ammonia to a gas and thereby being released into the atmosphere.

## Data Sources

### Independent Variables:

U.S. Department of Agriculture. National Agricultural Statistics Service. 1992 Census of Agriculture. Table 16. Poultry - Inventory and Sales: 1992. [http://www.nass.usda.gov/census/census92/volume1/ia-15/ia2\\_16.pdf](http://www.nass.usda.gov/census/census92/volume1/ia-15/ia2_16.pdf)

U.S. Department of Agriculture. National Agricultural Statistics Service. 2002 Census of Agriculture: **Table 1. Livestock and poultry - Hogs and pigs inventory (number) (farms) Historical Highlights: 2002 and Earlier Census Years (Except AK & HI) (US - State Data).** [http://151.121.3.33:8080/Census/Pull\\_Data\\_Census](http://151.121.3.33:8080/Census/Pull_Data_Census)

Data on manure, nitrogen, and phosphorus from hog, fed cattle, dairy cattle, chickens, and turkeys in CAFOs:

- Iowa Department of Natural Resources, “Ag Construction Permits Issued Since 1986 (13 Oct. '03 most recent entry), Electronic data base provided by IDNR, (Ag Const Perms2.xls).

In devising measures representing hogs in CAFOs for the period of the 1990s, we combined data from three data sources: 1) confinement hog capacity by weight of registered CAFOs based on construction permits; 2) number of hogs in CAFOs under manure management plans filed by producers; and 3) the estimated number of hogs on farms with more than 1000 hogs in 1992 and 2002. Sources of data are as follows:

1. Iowa Department of Natural Resources, “Ag Construction Permits Issued Since 1986 (13 Oct. '03 most recent entry), Electronic data base provided by IDNR, (Ag Const Perms2.xls).
2. Iowa Department of Natural Resources, “Manure Management Plans,” Electronic data base provided by IDNR, October 2003.. (MMPS2.xls)
3. Source: U.S. Census of Agriculture: 1987, 1992, 1997, “Table 15. Hogs & pigs-inv, litters & sales: Iowa Total.” Accessed on 10/27/2006 at: <http://agcensus.mannlib.cornell.edu/show2.php>

USDA National Agricultural Statistics Service, U.S. Census of Agriculture, US - State Data, “Table 19. Hogs and Pigs - Inventory: 2002 and 1997,” accessed on 10/27/2006 at [http://www.nass.usda.gov/Census/Pull\\_Data\\_Census](http://www.nass.usda.gov/Census/Pull_Data_Census)

### Control variables:

#### **% of land harvested for corn and soybean in 1992**

U.S. Department of Agriculture. National Agricultural Statistics Service. 2002 Census of Agriculture. **Table 13. Selected Crops: 1992 and 1987.** can be found at:

[http://www.nass.usda.gov/census/census92/volume1/ia-15/92\\_15\\_ia.htm](http://www.nass.usda.gov/census/census92/volume1/ia-15/92_15_ia.htm)

**Agriculture, forestry, fisheries, and mining as % of total employment, 1990**

U. S. Department of Commerce. Bureau of the Census. Population Census, 1990, Table P077  
Industry

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC2&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180891125121](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=180891125121)

**1993 Urban Influence Code**

U.S. Department of Agriculture, Economic Research Service

<http://www.ers.usda.gov/Briefing/Rurality/urbaninf/1993UIC.htm>

**Human Capital****1991-1992 Public School District Dropouts**

Source: Iowa Department of Education, Basic Educational Data Survey, Dropout File and BEDS Enrollment File 1991-1992.

[http://www.iowa.gov/educate/component/option,com\\_docman/task,doc\\_details/gid,1203/Itemid,55/](http://www.iowa.gov/educate/component/option,com_docman/task,doc_details/gid,1203/Itemid,55/)

**1999-2000 Public School District Dropouts**

Source: Iowa Department of Education, Basic Educational Data Survey, Dropout File and BEDS Enrollment File 1999-2000

[http://www.iowa.gov/educate/component/option,com\\_docman/task,doc\\_details/gid,1146/Itemid,774/](http://www.iowa.gov/educate/component/option,com_docman/task,doc_details/gid,1146/Itemid,774/)

**Public schools in Iowa, with zip code, membership, FTE teachers, pupil-teacher ratio, agency ID number and name, and ID number and name of county where school district offices are located: 1991-92**

Source: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), School and Agency Universes, 1991. (This extract compiled 11/20/2003 by Mark Glander, National Education Data Resource Center, Request 944502)

**Pupil/Teacher Ratio, 1999-2000**

Source: Source: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), CCD build a table. Accessed 5/6/04 at <http://nces.ed.gov/ccd/bat/>

**2000-2001 Iowa Public School Teacher Information by School District**

Source: Iowa Department of Education, Bureau of Planning, Research, and Evaluation, Basic Educational Data Survey, Staff File, and Certified Enrollment File.

**Social Capital:****Goetz civic engagement index:**

Rupasingha, Anil, Stephan J. Goetz, and David Freshwater, "The production of social capital in US counties," *The Journal of Socio-Economics*, 2006: 83-101. Data and paper are available at

[http://www.nercrd.psu.edu/Social\\_Capital/index.html](http://www.nercrd.psu.edu/Social_Capital/index.html)

**Church Adherents as Percent of Population, 1990 and 2000:**

*Religious Congregations & Membership in the United States: 2000*. Nashville: Glenmary Research Center, 2002. Online data source is Association of Religion Data Archives (ARDA):  
<http://www.thearda.com/Archive/Files/Descriptions/RCMSCY.asp>

Download data for 1990 from  
[http://www.thearda.com/Archive/Files/Downloads/CMS90CNT\\_DL2.asp](http://www.thearda.com/Archive/Files/Downloads/CMS90CNT_DL2.asp)

Download data for 2000 from  
[http://www.thearda.com/Archive/Files/Downloads/RCMSCY\\_DL2.asp](http://www.thearda.com/Archive/Files/Downloads/RCMSCY_DL2.asp)

### **Financial Capital:**

#### **Percentage change in median households income, 1989-1999 (Source: U.S. Census of Population, 1990 and 2000)**

P080A. Median Household Income in 1989

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC2&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180894785019](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=180894785019)

P53. Median Household Income in 1999

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC1&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180896845691](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC1&_submenuId=datasets_1&_lang=en&_ts=180896845691)

#### **Percentage change in per capita income, 1989-1999 (Source: U.S. Census of Population, 1990 and 2000)**

P114A. Per Capita Income in 1989:

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC2&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180894785019](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=180894785019)

P82. Per Capita Income in 1999

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC1&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180896845691](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC1&_submenuId=datasets_1&_lang=en&_ts=180896845691)

#### **Change in percentage of households in poverty, 1989-1999 (Source: U.S. Census of Population, 1990 and 2000)**

P127. Poverty Status in 1989 by Age of Householder by Household Type

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC2&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180894785019](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=180894785019)

P92. Poverty Status in 1999 of Households by Household Type by Age of Householder

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC1&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180896845691](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC1&_submenuId=datasets_1&_lang=en&_ts=180896845691)

#### **Change in percentage of persons in households with incomes between 100 and 200% of poverty, 1989-99. (Source: U.S. Census of Population, 1990 and 2000)**

P121. Ratio of Income in 1989 to Poverty Level

[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC2&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180894785019](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC2&_submenuId=datasets_1&_lang=en&_ts=180894785019)



[Census 2000 Summary File 3 \(SF 3\) - Sample Data](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC1&_submenuId=datasets_1&_lang=en&_ts=180896845691), P88. Ratio of Income in 1999 to Poverty Level  
[http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_tabId=DEC1&\\_submenuId=datasets\\_1&\\_lang=en&\\_ts=180896845691](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_tabId=DEC1&_submenuId=datasets_1&_lang=en&_ts=180896845691)

**Change in per capita retail trade, 1990-2000 (Original Source: Iowa Dept of Revenue and Finance)**

Iowa State University Extension. Office of Social and Economic Trend Analysis (SETA)  
<http://www.seta.iastate.edu/select/geography.aspx?limit=1&level=county&loc=/retail/retail.aspx?>

**Percentage change in number of retail firms, 1990-2000**

1990 Data: U.S. Census Bureau, "CBP Download Page, Available at

<http://www.census.gov/epcd/cbp/download/cbpdownload.html>

2000 Data: U.S. Census Bureau. County Business Patterns, 2000: Iowa. Washington D.C., 2002.

"Table 6. Counties—Employees, Payroll, and Establishments by Industry: 2000." Column: Total Number of Establishments. <http://www.census.gov/epcd/cbp/view/cbpview.html>

**Percentage change in wage and salary disbursement by firms in the county, 1990-2000.**

U.S. Bureau of the Census. Bureau of Economic Analysis, *Local Area Personal Income*;

<http://www.bea.gov/beat/regional/reis/> Select Table CA34. Total wages, wage employment, average wage per job

**Natural Capital:**

**# of reported manure spills, 1992-2002:**

Iowa Environmental Council, from IDNR data. <http://county-map.digital-topo-maps.com/iowa.shtml>

**# of fish reported killed, 1995-2002:**

Iowa Department of Natural Resources, "Fish Kills in Iowa 1995-2002," Iowa DNR TMDL and Water Quality Assessments. University of Iowa United Hygienic Laboratory, "County Well Water Data," 2005. Accessed 7/1/05 at

<http://www.uhl.uiowa.edu/services/environment/waterquality/wellwater/countydata/index.html>

(Source of county-level coliform and nitrate data.)

**% of county's land in impaired waters (excluding lakes):**

Iowa Department of Natural Resources, "Iowa's 2002 303(d) List," Iowa DNR TMDL and Water Quality Assessments. Accessed 7/1/05 at:

<http://www.iowadnr.com/water/tmdlwqa/wqa/303d/2002/2002list5.pdf>

**% of private wells tested that had unacceptable levels of coliform bacteria, 1995-2001:**

University of Iowa United Hygienic Laboratory, "County Well Water Data," 2005. Accessed 7/1/05 at <http://www.uhl.uiowa.edu/services/environment/waterquality/wellwater/countydata/index.html>

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<sup>1</sup> See Glossary for the definition of a CAFO.

<sup>2</sup> Mainly factor analysis and multiple regression.

<sup>3</sup> Data sources, correlation matrices, factor analysis tables, and the full regression models are available from the first author on request.

<sup>4</sup> Complete references for the sources of variables used in the analysis are in the “Data Sources” Section at the end of this paper.

<sup>5</sup> In all cases, we subtracted the 1992 figure from the 2002 figure. We then divided the result by the 1992 value and multiplied by 100 to get the percentage change.

<sup>6</sup> Since in 1992, only one county had one dairy with 500 or more cows, it was not possible to calculate the percent increase in numbers of cows in CAFOs. Hence, the absolute change in the number of dairy cows in CAFOs was calculated.

<sup>7</sup> The original typology is reverse coded to give urban influence a higher value than lack of urban influence.

<sup>8</sup> Private sector employment growth relates modestly to the growth of dairy CAFOs. Growth of cattle in large feedlots and of poultry in CAFOs does not relate to growth in private sector employment in the county. Only the growth in dairy CAFOs increased in parallel with an increase in the *quantity* of human capital. It appears that dairy CAFOs have stronger forward and backward linkages at the local level than occurs for the other CAFOs and feedlots.

<sup>9</sup> Expansion of two kinds of CAFOs was significantly related to an influx of adults with incomplete high school: beef feedlots and poultry (mostly egg) CAFOs (Appendix Table 2.4). An increase in large beef feedlots occurred simultaneously with an increase in the pupil-teacher ratio in the county (Appendix Table 2.5), although, because of heavy net out-migration from many agricultural counties in the 1980s, at the beginning of the 1990s many of those counties had rather low student-teacher ratios (compared to metropolitan counties). Growth in CAFOs of any kind was unrelated to a change in the dropout rate.

<sup>10</sup> Different kinds of Concentrated Animal Feeding Operations relate differently to human capital development. Expansion of dairy CAFOs seems to contribute to population retention and modest employment generation. Growth of concentrated beef feedlots and poultry CAFOs seem to be largely unrelated to population retention or employment growth. Counties experiencing an expansion of beef cattle in feedlots and poultry in CAFOs also experienced an increase in the percentage of adults 25 years and over lacking complete high school. Larger beef feedlots and poultry CAFOs directly or indirectly generated new low-wage jobs in counties where they experienced growth.

<sup>11</sup> Counties showing a growth in the numbers of cattle in feedlots experienced significant decline (or slower growth than other counties) in income, and a near significant (.057) increase in core poverty. A growth in confined dairy cattle meant a significant decrease in the “working poor” (those with incomes between the official poverty level and twice the poverty level) as a share of the population, with little impact on income growth or officially defined poverty reduction. Growth in poultry (mostly layers) in CAFOs was significantly related to increase in official poverty, but was not significantly related to the near poverty measure nor to change in median household income.

<sup>12</sup> Population and employment growth and positive net migration over the decade of the 1990s are more likely to occur in counties that at the beginning of the 1990s had large numbers of confined cattle (beef and dairy) rather than fewer, although the relationship was not quite significant. However, like hogs, chickens in CAFOs at the

initial period appear to have little impact on population retention, employment stabilization, or on retention or attraction of college-educated adults over the succeeding decade.

<sup>13</sup> In analysis not shown here, we found that dairy CAFOs, which are of more recent vintage in Iowa, seem to have done a better job of contributing to the local economy. Will that trend continue or, as confinement dairies become larger, will they also bypass the local economy for inputs and marketing of their milk?

<sup>14</sup> **Livestock manure production in I-FARM**

livestock	specific manure production (1000# = 1000 lb of body weight)						average
	weight	volume	Mois- ture	N	P	K	body weight
	lb/d per 1000#	Gal/d per 1000#	%	lb/d per 1000 #	lb/d per 1000#	lb/d per 1000#	lb
dairy cow unit (240 cwt/year)	86	10.3	87	0.45	0.09	0.29	1,376
beef cattle on hay	58	6.9	92	0.34	0.09	0.21	825
beef cattle on silage	58	6.9	92	0.34	0.09	0.21	825
beef cow/calf unit	63	7.5	87	0.34	0.09	0.21	1,389
finishing hog	84	10.1	90	0.52	0.18	0.29	150
nursery pig	84	10.1	90	0.52	0.18	0.29	35
lactating sow+litter	84	10.1	90	0.52	0.18	0.29	380
gestation sow	84	10.1	90	0.52	0.18	0.29	430

Note: I-FARM uses the body weight based values from the [ASAE standard D384.2](#) (2005).

Source: [http://i-farmtools.org/calculators/manure/tools\\_manure\\_frame2.asp](http://i-farmtools.org/calculators/manure/tools_manure_frame2.asp)

<sup>15</sup> Specifically, control variables included separate variables for pounds of phosphorus produced by dairy cattle, by beef cattle, and by poultry (chickens and turkeys) in CAFOs; percent of employment in agriculture, forestry, fisheries, & mining, 1990; percent of land in corn and soybeans, 1992-2002; and urban influence code, 1993.

<sup>16</sup> The IDNR requires growers to obtain a permit for an *unformed* manure storage facility if they design it for 500 or more animal units. If the storage facility will be a *formed* structure, a permit is required for 1,000 or more animal units. The IDNR also distinguishes between CFOs and open feedlots. An open feedlot is a confined space

where livestock are fed intensively, but which has no roof. Unlike CFOs, Iowa regulations allow open feedlots to discharge manure in streams during storms (IDNR 2005b).

<sup>17</sup> Within species of livestock or poultry in CAFOs, individual counties ranked the same on manure, nitrogen, and phosphorus production, so that any one of the three measures would have produced the same results in the regressions.

<sup>18</sup> Iowa Environmental Council analysis based on IDNR data.

<sup>19</sup> In separate analysis, we also looked at the impacts of the three most important contributors to employment in urban areas—manufacturing, retail trade, and service employment as a percent of total employment—to determine if urban economic structures contributed to any of the contamination events or pollution indicators. Apart from the fact that manufacturing employment and service employment were strongly *negatively* related to positive tests for coliform bacteria (which is not surprising, since coliform bacteria contamination comes mainly from beef feedlots in Iowa), these variables were largely unrelated to the indicators of pollution we examined. We did not use the two agricultural structural variables listed in the text above in these equations because of colinearity problems; the urban and agricultural structural variables correlated strongly and negatively with one another.

<sup>20</sup> The estimated quantity of cattle manure produced in confinement dairies is also associated with numbers of reported manure spills and numbers of fish killed, but not directly with surface or ground water contamination. Estimated manure produced by fattening cattle in 1000-head or larger open feedlots was strongly associated with both coliform bacteria and impaired watersheds. Poultry manure from CAFOs was largely unrelated to pollution events and water contamination.