THE ECONOMIC IMPORTANCE OF AGRI-FOOD INDUSTRIES IN IOWA

A Report for the Coalition to Support Iowa's Farmers

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EXECUTIVE SUMMARY

There were 90,655 Iowa farms in 2002. These farms included

- 31,729,490 acres or 49,477 square miles of land
- 88.7 percent of Iowa's land area

In 2000, 171,374 Iowans (5.86 percent of the Iowa population) lived on farms.

The 2002 market value of land, buildings, and machinery averaged $808,000 per Iowa farm. This was 33.7 percent higher than the average value of investment per farm nationwide.

The U.S. Bureau of Economic Analysis credited 5.59 percent of Iowa's jobs to farming in 2002.

From 1990 to 2002, farming employment generated 4.65 percent of Iowa's inflation-adjusted earnings by place of work. This was nearly five times greater than the national level.

Ag production (farming) generated 3.73 percent of Iowa's Gross State Product (GSP) in 2002, for the fifth highest proportion in the nation. Food processing generated 4.5 percent of Iowa's 2002 GSP, the third highest proportion in the nation. The combined 8.22 percent of Iowa GSP generated by ag production and food processing in 2002, was the highest combined proportion in the nation.

Corn, soybeans, cattle, and hogs consistently account for nearly 90 percent of Iowa farm marketing receipts.

From 2000 through 2003, Iowa

- Was first or second in the nation in annual sales for corn, soybeans, and hogs
- Was the sixth largest marketer of cattle in the nation
- Generated over one-fifth of the corn and hogs sold in the nation
- Generated nearly one-sixth of the soybeans sold in the nation
- Reclaimed the title of number one egg producer in the nation

Iowa is consistently the third largest supplier of agriculture commodities in the nation, following California and Texas.

The USDA's compilation of farm and farm-related employment (which includes grocery stores and other peripheral industries) credited 20.6 percent of Iowa's 2002 employment to agriculturally related pursuits. 5.6 percent of this was tied directly to ag production, 5.0 to farm input manufacturing, farm supply, and food processing, and 10 percent to related retailing activities and peripheral industries.

Summing direct industry data from the IMPLAN input-output modeling system, Iowa's agricultural production, farm input industries, and food processing industries generate

- 19 percent of Iowa's industrial output
- 10 percent of Iowa's jobs
- 9.7 percent of Iowa's economic value-added

Reallocating IMPLAN industry data to credit Iowa-produced intermediate goods (inputs) to industries of final sale (out-of-state export or non-household consumption) shows

- 25.15 percent of Iowa's total output goes into agri-food sector exports from Iowa
- 18.25 percent of Iowa's total economic value-added is contained in agri-food exports
- 28.3 percent of Iowa's export base production goes into finished agri-food sector exports
- 21.07 percent of Iowa's export base value-added is contained in agri-food sector exports

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The agricultural production and manufacturing industries (the agri-food sector) are very important components of the Iowa economy. With a rich natural resource base and favorable growing climate, Iowa has long been synonymous with agricultural bounty. In the early decades of settlement, nearly all employment in the state was related to farming. Over time the proportion of the population directly engaged in farming has declined steadily as technological change has increased the productivity of farm labor and other industries have expanded. Concurrently, Iowa's farm input manufacturing and food-processing industries have grown to serve expanding farm mechanization and technology needs and continually more convenience-oriented demand for household food.

While the total value of agri-food sector output continues to increase over time, agriculture's relative share of state economic activity is declining because of more rapid growth in nonagricultural sectors of the economy. Within the agri-food sector industries, the distribution of economic activity, risk, and reward is also changing. This study provides a look at the value of Iowa's agri-food economy from a number of perspectives.

Evaluating the value of the agri-food sector is not a simple task. It seems that any time the value or impact of agriculture is discussed, at least one participant in the discussion believes that agriculture is too narrowly defined and at least one other participant believes that agriculture is defined too broadly. This is complicated by the fact that both, from reasonably defined perspectives, are right.

Agriculture or the agri-food system is variously defined as including only farm-level production; as including farm-level production, input manufacturing, and food processing; or, from the gate-to-plate perspective, as including all of this plus processed agricultural product distribution and retailing. These distinctions are complicated in geographically defined studies (such as this one) by questions of which values and activities should properly be credited to the subject-area economy.

These are all questions of scope – how do we define the activities that are included under the umbrella of the agri-food system, in general, and in the context of specifically identified geographic areas and inquiries. Once scope is defined, a study must deal with the issue of identification, or how to identify relevant activities and estimate their value using the statistics available. While identifying and measuring activities would seem to be a simple task once scope is defined, the activities included in any definition of the agri-food system extending beyond basic agricultural production are intermingled with other industries in most state and federal statistics. Production agriculture, itself, has generally been reasonably separable in reported statistics where such statistics exist, but much of production agriculture is exempt from reporting under employment security law (payroll tax), and much of agricultural production is marketed on a time-frame that does not match standard reporting periods for other industries. This leaves large gray areas in the data stream, even where identification would not otherwise be a major problem.

Beyond scope and identification issues, there are frame-of-reference issues. The value of agriculture, regardless of the scope defined, depends upon the perspective of the audience. Clearly, it is in society's best interest to be fed and clothed as inexpensively as possible. This leaves more resources for education, housing, automobiles, movies, vacations, etc. On the other hand, in economies where resources and activities are specialized, some areas specialize in agriculture. In those areas agriculture is not so much sustenance as it is an export or income-generating industry. Maintaining the size and stability of agriculture is an important issue. This is magnified in an environment where public policy is driven largely on the basis of economic development, job counts, and tax streams. In this context, size is important and bigger is better.[1]

Answering questions of scope, identification, and frame-of-reference creates a range of measurement environments where reasonable and well-meaning individuals can and do disagree on the size of agriculture, the agri-food sector, or any industry in any given economic area.

In this study, we are going to look at the Iowa agri-food sector. We will try to be explicit, at every stage, concerning the scope of the sector under discussion and how we identified the data and tools used in estimation and measurement. We will also be mindful of the effects of our frame of reference and note how differences in that frame of reference affect the evaluations of the measurements made.

The remainder of this paper will be divided into five sections dealing with

1. A descriptive evaluation of the agricultural commodity production (farm) environment

2. A job-based measure of the size of agricultural commodity production, input manufacturing, food processing industries, finished agri-food product distribution and sales, and indirectly related industries relative to the total Iowa economy

3. An evaluation of the economic importance of agricultural commodity production, input manufacturing, and food processing industries based on the production structure specified in IMPLAN, a commonly used input-output model

4. A discussion of dynamic issues in agri-food sector valuation

5. Conclusions

AGRICULTURAL COMMODITY PRODUCTION

In its most basic form, the agri-food system depends upon activities that produce primary agricultural commodities. Traditionally, these activities have taken place within the context of a firm called a "Farm." Changes in production control and capital ownership have changed the form of the agricultural production firm in some cases, but the direct production of primary agricultural commodities still serves as the base level for defining the scope of agriculture. The Census of Agriculture defines "Farm" as any operation that produces for sale at least $1,000

[1] An additional dimension regarding frame-of-reference issues that must be accounted for is the perspective of the individual or individuals evaluating the value of the industries in question. There are a variety of tools and statistics available and a variety of implementations and interpretations of the results for each of these tools. The authors' predispositions and points of reference with regard to scope and identification are also variables in any evaluation of industry value.

worth of agricultural commodities, or would produce $1,000 worth of primary agricultural commodities for sale in a normal year. This definition is applied to traditional farms, to second-career or hobby farms, and single-purpose production or finishing units that may or may not be characteristic of traditional concepts of the term, "Farm." The definition is based on expected output or product rather than expected ownership or operating characteristics.[2]

According to the 2002 Census of Agriculture,[3] there were 90,655 farms in Iowa in 2002. These farms included 31,729,490 acres or 49,477 square miles of land.[4] This is approximately 88.7 percent of the 35,759,932 total acres in Iowa. The average size of an Iowa farm in 2002 was 350 acres. The 2000 U.S. Census indicates that 171,374 people or 5.86 percent of Iowa's population live on farms. This compares with 1.06 percent of the population, nationwide, living on farms.

The number of farms in Iowa has been declining steadily. In 1997 there were 96,705 farms in Iowa utilizing 32,313,119 acres of land (an average size of 334 acres per farm). Between 1997 and 2002, the number of farms in Iowa declined by 6.26 percent, while the average size of farms in Iowa increased by 4.79 percent. Nationally, the average farm size was 441 acres in 2002, up from 431 acres in 1997, an increase of 2.32 percent. The number of farms, nationwide, decreased by 3.92 percent from 1997 to 2002.

Production agriculture in Iowa reflects a substantial capital investment. The 2002 Census of Agriculture reports a total estimated market value of land and buildings on Iowa farms as $64.16 billion. Estimated market values of machinery and equipment totaled $8.9 billion and averaged $100,422 per farm. Adding land, buildings, machinery, and equipment gives a total estimated market value for major capital investments of over $808,000 per Iowa farm. This compares to a national average of $604,403 per farm.[5]

In 2002, total cash receipts and other income for these Iowa farms totaled $12.545 billion according to U.S. Bureau of Economic Analysis (BEA) estimates. Realized net income from these receipts totaled $1.06 billion or about $11,700 per farm. The sum of these net receipts, statewide, was 2.59 percent of the total earnings by place of work[6] received by Iowa residents. This total was somewhat lower than the BEA estimates that attributed 5.59 percent of Iowa's 2002 jobs to farming.

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[2] With the exception of the floor under output values, this definition is compatible with the definition used by the North American Industrial Classification System for "Agriculture."

[3] This report uses 2002 and 1997 Census of Agriculture statistics that have been adjusted by the U.S.D.A. National Agricultural Statistics Service to reflect expected values for nonresponders. The numbers of farms in these statistics are somewhat higher than the numbers of farms reported under the pre-1997 Census of Agriculture conducted under the auspices of the U.S. Bureau of the Census.

[4] Farmland in Iowa would cover a square almost 223 miles to a side. Nonfarm land would cover a square just over 79 miles to a side. All land in Iowa would cover a square just over 236 miles to a side.

[5] These statistics reflect current estimated market value in 2002, not total funds invested over time. It is more appropriate to look at this as the potential receipts from selling out than as the expected costs of starting up.

[6] Within the official terminology of national income statistics, "Earnings" consist of individuals' receipts from personal employment, either as wage or salary workers in the employ of another party or as a proprietor contributing labor to a personal business enterprise. "By place of work" indicates that the earnings are reported at the place of employment rather than at the workers' places of residence.

Table 1. Selected Iowa Farm Statistics From the Census of Agriculture

	2002	1997
Number of farms	90,655	96,705
Average farm size in acres	350	334
Market value, per farm, of		
Land and buildings ($)	707,730	559,678
Machinery and equipment ($)	100,422	79,607
Farm products sold ($)	135,388	125,766
Inventory of cattle and calves	3,535,945	3,717,394
Beef cows	987,670	1,051,178
Milk cows	206,965	222,090
Cattle and calves sold	2,929,704	2,936,978
Inventory of hogs and pigs	15,486,531	14,513,319
Hogs and pigs sold	41,232,492	27,340,921
Inventory of laying chickens	38,650,210	
Inventory of broiler chickens	9,558,127	6,919,963
Production of (bushels)		
Corn for grain	1,851,276,224	1,581,093,092
Wheat for grain	961,995	932,358
Oats for grain	10,761,952	14,451,930
Soybeans	487,380,897	459,309,682

2002 Census of Agriculture

Using inflation-adjusted estimates, however, farming generated 4.65 percent of Iowa's earnings by place of work over the period from 1990 to 2002. Prior to 1998, this percentage regularly fluctuated between about 7.6 percent and 2.2 percent. Since 1998, however, the percentage of earnings by place of work attributable to farming has been well under the 4.65 percent average.

In placing the importance of agricultural commodity production to Iowa's economy and the importance of Iowa production to the nation, it is helpful to compare these numbers to similar statistics for the United States. Even in years when production agriculture makes up an unusually small portion of Iowa earnings, that portion is much larger than the typical agricultural production share of U.S. earnings. From 1990 through 2002, farm earnings nationwide accounted for only 0.94 percent of inflation-adjusted U.S. earnings by place of work. The range of yearly values, nationwide, ran from 1.26 percent to 0.55 percent. Like Iowa, this value has been well below average for the U.S. since 1998. The U.S. numbers do not fluctuate as widely as Iowa's due to the diversity of crops, growing seasons, and weather patterns that are enjoyed by the larger area.

A somewhat broader view of the importance of agri-food production in Iowa can be obtained by looking at Gross State Product (GSP) statistics provided by the U.S. Bureau of Economic Analysis. The table in Appendix 1 shows total 2002 GSP and the portions of GSP generated by

agricultural production and food processing for every state in the nation. In Iowa, ag production generated 3.73 percent of GSP in 2002 for the fifth highest proportion in the nation. Food processing generated 4.5 percent of Iowa's 2002 GSP, which was the third highest proportion in the nation. Together, ag production and food processing generated 8.22 percent of Iowa's GSP, which was the highest proportion, nationwide. These statistics do not indicate that Iowa was the largest producer of raw ag commodities and processed food in the nation. They do show, however, that Iowa had the largest proportion of any state's economic product directly generated through the production and processing of food during 2002.

Table 2. Value of Iowa Farm Sales From the Census of Agriculture

	2002		1997
	$1,000s	**% of total**	**$1,000s**
Total sales (see text) ($1,000)	12,273,634	100	12,162,165
Average per farm (dollars)	135,388		125,766
Grains, oilseeds, dry beans, and dry peas ($1,000)	5,858,528	47.7	(NA)
Livestock, poultry, and their products ($1,000)	6,202,362	50.5	5,780,489
Poultry and eggs ($1,000)	511,949	4.2	414,587
Cattle and calves ($1,000)	2,119,935	17.3	1,886,416
Milk and other dairy products from cows ($1,000)	442,431	3.6	407,897
Hogs and pigs ($1,000)	3,078,455	25.1	3,012,764
Sheep, goats, and their products ($1,000)	23,366	0.2	(NA)
Horses, ponies, mules, burros, and donkeys ($1,000)	13,643	0.1	(NA)

2002 Census of Agriculture

Corn, Soybeans, Cattle, and Hogs

Corn, soybeans, cattle, and hogs dominate Iowa production of primary agricultural commodities. Table 3 shows that these four commodities consistently account for nearly 90 percent of Iowa farm marketing receipts. Table 3 also shows that Iowa's production of these commodities is extremely important to national supply. From 2000 through 2003, Iowa was the first or second ranked state in the sale of corn, soybeans, and hogs and was the sixth ranked state in the sale of cattle. In 2003 Iowa generated over one-fifth of the hogs and the corn sold in the United States and nearly one-sixth of the soybeans. Iowa is consistently the third largest supplier of agricultural commodities (by value of market receipts), following California and Texas.

Regardless of price fluctuations at the farm level, the consistency of the state-level rankings show that Iowa's production of basic commodities maintains a relatively constant level from year to year. Inventory changes fluctuate widely, however, indications that price changes do affect decisions on marketing and cash flow on Iowa farms. One indicator of the size of Iowa's commodity production base is that inventory changes in Iowa are regularly a major share of the total net inventory of the nation. In 2001 and 2003, the magnitudes of inventory changes in Iowa dwarfed the magnitudes of net inventory change for the nation as a whole.

Table 3. Iowa Farm Operating Receipts, Income Estimates, and State Rankings

	2000		2001		2002		2003		
	$000s	State Rank	$000s	State Rank	$000s	State Rank	$000s	State Rank	% of U.S.
Cash receipts from marketings	11,062,286	3	10,650,915	3	11,486,388	3	12,579,430	3	5.78
Total livestock and products	6,077,373	5	6,209,716	4	5,354,437	5	6,323,551	5	5.53
Meat animals and other livestock	5,292,263	4	5,257,071	4	4,504,006	4	5,256,253	4	7.59
Cattle and calves	1,967,884	6	1,875,548	6	1,864,971	6	2,419,146	6	4.63
Hogs and pigs	3,273,578	1	3,328,897	1	2,585,000	1	2,775,352	1	22.36
Sheep and other livestock	50,801	26	52,626	22	54,035	25	61,755	25	1.34
Dairy products	455,247	12	550,368	12	455,323	12	478,592	12	2.25
Poultry and poultry products	329,863	20	402,277	19	395,108	19	588,706	14	2.47
Total crops	4,984,913	4	4,441,199	4	6,131,951	2	6,255,879	2	6.06
Total grains	4,780,103	2	4,182,832	2	5,863,651	1	6,016,413	1	14.07
Corn	2,650,777	2	2,425,136	2	3,570,090	1	3,543,839	1	20.41
Oats	6,541	2	8,027	1	10,812	1	8,601	3	9.16
Soybeans	2,120,576	1	1,747,126	2	2,279,815	1	2,460,632	1	16.30
Value of inventory change	-529,246	-1	44,756	15	243,077	2	-778,071	-1	
Value of inventory change: livestock	-52,543	-8	-42,975	-10	13,117	11	-52,033	-9	
Value of inventory change: crops	-536,418	-2	145,155	6	114,821	4	-690,646	-1	
Total cash receipts and other income	13,975,563	3	13,255,267	3	13,056,448	3	14,400,591	3	5.75
Tot. net income including corporate farms	1,698,856	6	1,120,625	9	1,526,478	4	1,067,700	11	2.82
less: Net income of corporate farms	382,644	8	214,098	10	319,018	5	242,148	13	1.91
Total net farm proprietors' income	1,316,189	5	906,546	7	1,207,476	3	825,547	10	3.28
Tot. farm labor and proprietors' income	1,655,760	5	1,289,561	8	1,571,624	4	1,190,761	10	2.61
% of cash receipts from marketings	%		%		%		%		
Cattle and calves	17.79		17.61		16.24		19.23		
Hogs and pigs	29.59		31.25		22.50		22.06		
Corn	23.96		22.77		31.08		28.17		
Soybeans	19.17		16.40		19.85		19.56		
Major commodities (percent sum)	90.51		88.04		89.67		89.03		

Data from U.S. Bureau of Economic Analysis (BEA)
Negative ranks on inventory change denote relative size of decrease (e.g., "-8" refers to eighth greatest decline among all states)

Finally, while corn, soybeans, cattle, and hogs dominate Iowa's agricultural production totals, Iowa is a significant national producer of other commodities as well. From 2000 through 2003 Iowa has consistently ranked in the top three national producers of oats and has regained its position as the nation's largest egg producer.

USDA FARM AND FARM-RELATED EMPLOYMENT

While there is room for discussion as to what rightly should and should not be included as parts of the agri-food sector, there are few arguments that its inclusion should be strictly limited to farming or primary commodity production. A broad and simple employment-based representation of the agri-food sector and its importance to the wider economy is provided by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). Table 4 shows the ERS's allocation of Iowa employment to farm and farm-related industries in 2002. Related industries, except "Indirect agribusiness" are defined as having more than 50 percent of their national workforce engaged in providing goods and services necessary to satisfy the final demand for agricultural products. For "Indirect agribusiness," the necessary percentages range from 32 to 50 percent.

This definition represents a near maximum in terms of possible scope for the agri-food system. At the output-distribution end of the spectrum, it includes paperboard mills and paperboard box manufacturing, pallet and wooden container manufacturing, food distribution to the retail level, and eating and drinking establishments. This aggregation reflects a gate-to-plate delineation of scope, where all goods and processes associated with agricultural commodity production at one end and final consumer purchase at the other are swept into the agri-food system.

The breadth of this definition opens the door to questions of both scope and identification and often generates animated discussion. Discussions regarding the scope of the definition break down into two basic issues.

1. To what point are these activities driven by agriculture (at what point are the activities more appropriately tied to the consumer or resident population?)
2. What portion of the individual activities is actually agriculture-related?

With respect to the first of these, even the USDA's own discussion of this measure acknowledges that low population states, such as North Dakota, have very low proportions of peripheral activity, "…as these industries depend on consumer markets not found in less populated areas.[7]" In general, basic food processing takes place close to production. Grain milling, and livestock slaughter reduce the size of the commodity packages that must be shipped from producer to consumer. Where different components of the commodity are bound for different consumer populations, basic processing also allows segregation of those shipments. Both of these factors reduce cost and increase value.

Final food processing, however, is more likely to take place near the point of final consumption. Up until the last half of the 20th Century, most final food processing actually took place in the household kitchen. These activities take place close to the consumer for a number of reasons. First, final processing generally reduces portions and increases packaging in terms of both weight and volume, increasing shipping costs. Second, final processing often accelerates perishability, reducing shelf life and, again, increasing shipping costs. Finally, the final product of the process is often tailored to local or regional consumer preferences. All or these factors tend to move final processing from production centers to consumer centers. Any delineation of scope will have to address the logic of justifying where in this chain of events do activities change from being agriculture-production driven to being consumer driven. The broader the delineation of scope, the more critical this discussion becomes. There is no simple right or wrong answer to this question.

The closer to the consumer that we get with this first issue of scope, the more important it becomes to deal with the second issue. Walk through a modern supermarket. Among the food products are aisles of paper and plastic products, household cleaners, and personal care products. There are often photo finishing and shipping services, movie rentals, and personal services. Food retailing is a low-margin business. While food makes up the bulk of the final sales in these establishments, thereby assuring establishment classification as a grocer for statistical reporting purposes, a disproportionate share of the margins or profits generated are non-food in nature. The extent to which these activities are directly related to the production and processing of

[7] Majchrowicz, Alex. "Agricultural Wholesale and Retail Trade Jobs Account For Two-Thirds of Farm and Farm-Related Employment." Rural America. May 2001, Volume 16, Issue 1. www.ers.usda.gov/publications/ruralamerica/ra161/ra161.pdf.

agricultural commodities is an open question. Whether the division of these activities should be by volume, by value, by margin, or by some other parameter is also unresolved.

Table 4. Iowa Farm and Farm-related Employment, 2002

	Total		Metro		Non-metro	
	Emp.	Pct.	Emp.	Pct.	Emp.	Pct.
Farming:						
Farm production	106,808	5.59	24,281	2.25	82,527	9.91
....Farm proprietors	92,066	4.82	20,975	1.95	71,091	8.54
....Farm wage and salary workers	14,742	0.77	3,306	0.31	11,436	1.37
Closely related:						
Agricultural services	9,640	0.50	4,380	0.41	5,260	0.63
Agricultural input industries--	21,279	1.11	9,144	0.85	12,135	1.46
....Agricultural chemicals	1,778	0.09	212	0.02	1,566	0.19
....Farm machinery and equipment	8,700	0.46	4,972	0.46	3,728	0.45
....Farm supply & mach. wholesale trade	10,367	0.54	3,747	0.35	6,620	0.79
....Commodity contract brokers	434	0.02	213	0.02	221	0.03
Agricultural processing and marketing--	64,240	3.36	26,139	2.43	38,101	4.57
....Meat products	28,807	1.51	11,021	1.02	17,786	2.14
....Dairy products	3,516	0.18	1,085	0.10	2,431	0.29
....Can., frozen, and pres. fruit and veg.	2,512	0.13	1,497	0.14	1,015	0.12
....Grain mill products	7,987	0.42	4,060	0.38	3,927	0.47
....Bakery products	1,377	0.07	654	0.06	723	0.09
....Sugar and confectionery products	674	0.04	468	0.04	206	0.02
....Fats and oils products	761	0.04	385	0.04	376	0.05
....Beverages	880	0.05	562	0.05	318	0.04
....Misc. food prep. & kindred products	3,061	0.16	1,980	0.18	1,081	0.13
....Tobacco products	2	0.00	0	0.00	2	0.00
....Apparel and textiles	1,955	0.10	570	0.05	1,385	0.17
....Leather products and footwear	626	0.03	384	0.04	242	0.03
....Packaging	1,616	0.08	568	0.05	1,048	0.13
....Farm-related raw mat. whlsle trade	9,232	0.48	2,030	0.19	7,202	0.86
....Warehousing	1,234	0.06	875	0.08	359	0.04
Peripherally related:						
Agricultural wholesale & retail trade	186,044	9.74	108,543	10.08	77,501	9.31
Indirect agribusiness	5,625	0.29	3,026	0.28	2,599	0.31
Total farm & farm-related employment	393,636	20.61	175,513	16.30	218,123	26.19
All other employment	1,516,298	79.39	901,537	83.70	614,761	73.81
Total employment	1,909,934	100.00	1,077,050	100.00	832,884	100.00

Economic Research Service, United States Department of Agriculture. 31 March 2005. 20 May 2005: http://www.ers.usda.gov/Data/FarmandRelatedEmployment/DownloadData.htm.

Even if these issues could be agreeably settled, the debate would turn to measuring the chosen distribution, a question of identification. There is no clear way to separate these within-firm activities using official statistics on either a national or a local level. Resolving the scope issue, in this case, would only lead to another major obstacle to the analysis. As a result, this issue is generally dealt with in an all-or-nothing manner if it is dealt with at all.

In spite of these, the ERS employment-based estimates are widely used because they are easily understood and can be quickly reduced for general use in a variety of geographic areas and analytical situations. Overall, this aggregation credited 20.6 percent of Iowa's 2002 employment to the agri-food system. Of this, 5.6 percent was associated directly with the production of primary agricultural commodities, and another 5.0 percent was associated with agricultural services, input manufacturing and supply, and food processing. Summing these (dropping consumer sales and distribution and ag-related mining in the "Peripherally related" category) gives 10.6 percent of employment in commodity production, input manufacturing and supply, and ag commodity processing.

The disadvantage of restricting the definition to this subset of industries is that the final number gets smaller, fast. The advantage is that the final number is less subject to debate. In general, issues of scope get continually more contentious as we move into post-processing distribution and retail sales. In the discussion that follows, the IMPLAN input-output model will be used to look at a definition of the agri-food sector that runs from input manufacturing through food processing. While this may seem redundant, utilizing the production relationships estimated in an input-output model allows a more detailed aggregation and provides some substantially different valuations than those provided by the ERS employment allocations discussed in this section.

INPUT-OUTPUT (I-O) ANALYSIS

Another way to evaluate the importance of the agri-food sector to Iowa's economy is to estimate the composition of output throughout the economy and to credit the production of that output to various industries, factors of production, regions, or populations. This section presents basic information taken directly or derived from the IMPLAN economic modeling system database.[8] It is important to note that the researchers on this project did not use IMPLAN software to conduct this analysis. Instead, they extracted data for external analysis from the annually-purchased IMPLAN data base. In so doing, they were able to re-aggregate the data to clearly link all agriculture and agri-food sector industries in Iowa in a manner that maintained all of their original production relationships.

While the details of a working I-O model can be quite complex, conceptually, an I-O model is quite simple. An I-O model is basically a matrix of economic sectors. Sectors along one axis represent industrial inputs or suppliers to the industries on the other axis, which represent industrial users or demanders. Suppliers and demanders are connected by an interlocking set of mathematical relationships specifying how much of each input is required to make a unit of any output. When an industry decides how much final output it will produce, the model specifies how much of all necessary inputs are required.[9] Conceptually, it starts out looking like the large system of mileage charts (similar to those that you find in the back of a road atlas). Unlike the

[8] IMPLAN is an input-output model originally developed for the US Forest system. The model is currently available from the Minnesota IMPLAN Group (http://www.implan.com/index.html).

[9] Alternatively, input availability could be used to determine how much final output could be produced.

numbers in a mileage chart, however, each of the cells in an I-O model contains part of a system of production functions that is linked mathematically to all of the other cells in the model. The values of goods supplied or demanded can be changed for any of the industrial cells and the matrix system can be rebalanced, showing how that initial change affects all of the industries that supply inputs to or demand outputs from the industry altered.[10]

This is the basis of the type of I-O-based impact analysis commonly used to estimate the effect of a given economic change. In such a case, an initial shock to the economy, such as a new or closing manufacturing facility, changes in tax rates, etc., would be entered into the model by changing the values or relationships in one or more cells. The matrix system would then be rebalanced to see how the effects of that shock moved through the economy as transactions either increased or decreased in the affected sectors.[11]

This is not how agri-food sector valuation was estimated in this project. This analysis is an effort to evaluate existing industries within an existing economy. As a result, shocking the economy to create or eliminate parts of the industry is not appropriate. Instead, the 2002 data matrix that underlies the model was used to generate two aggregations of the economy and the agri-food sector.

The first is an industry-only aggregation of industry's output (total industry production or sales) jobs,[12] labor income (earnings), and value-added (the value of final industry product minus the value of any purchased inputs used to manufacture that product). Summary data for this aggregation is provided in Table 5.

The second aggregation (a production-process aggregation) allocates all in-state production that enters any industry's input-stream to that industry's final output. In this accounting, the output of an industry is counted for that industry only if it is at its final stage of production within Iowa. Any output that is subsequently used as an input in another industry within Iowa is aggregated into the industry of final processing within the state. This means that if the meat packing industry purchases all of its live cattle from Iowa farmers, the output value, value-added, and personal income generated in the production of those cattle is aggregated up to the meat packing industry. Similarly, the value of farm machinery purchased for use on Iowa farms is not included in the aggregation under farm machinery, but is subsumed under agricultural production (and partially subsumed, again, into food processing if the farm output that it was used to produce passes through Iowa based food processors on its journey to its final processed form within the state). In a nutshell, the output, value-added, and income estimates in the production process aggregation estimate the total share of the Iowa economic activity utilized to generate final output from the agri-food sectors (or any of the other listed sectors). Summary data for this aggregation is shown in Table 6.

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[10] For more on the use of input-output models, see Appendix 2.

[11] A brief explanation of some of the limitations and common misinterpretations of this process is included in Appendix 3.

[12] Remember that "Jobs" statistics refer to the number of jobs (regardless of hours worked or multiple jobs held) reported in an area rather than to the number of people employed or the adequacy of that employment.

Table 5. Industry-only Aggregations of Output, Value-Added and Employment

Agricultural Production	Output*	Jobs	Labor Income*	Value-added*	VA as % of Output	VA as % of Total
Oilseeds	2,259.388	17,902	745.248	1,214.759	53.76	1.31
Grain	3,643.427	43,706	885.133	1,649.974	45.29	1.77
Other Crops	546.929	2,409	127.014	309.117	56.52	0.33
Cattle	2,222.668	12,866	21.301	157.223	7.07	0.17
Poultry	374.546	548	50.078	122.269	32.64	0.13
Turkeys	*55.658*	*81*	*7.442*	*18.169*		
Eggs	*207.274*	*303*	*27.713*	*67.664*		
Remainder (incl. Broilers)	*111.615*	*163*	*14.923*	*36.436*		
Other Livestock	2,313.628	37,105	161.540	359.285	15.53	0.39
Hogs and Pigs	*1,962.651*	*31,476*	*137.034*	*304.781*		
Milk Products	*315.579*	*5,061*	*22.034*	*49.006*		
Sheep	*16.658*	*267*	*1.163*	*2.587*		
Remainder	*18.740*	*301*	*1.308*	*2.910*		
Other Ag Production	342.226	12,025	222.872	187.188	54.70	0.20
Sum of Ag Production	**11,702.812**	**126,561**	**2,213.186**	**3,999.815**	**34.18**	**4.30**
Primary Food Processing						
Crop	5,747.089	6,563	449.365	921.942	16.04	0.99
Dairy	1,822.099	3,832	205.145	477.794	26.22	0.51
Meat	9,213.120	29,158	1,095.348	1,309.096	14.21	1.41
Sum of Primary Food Proc.	**16,782.308**	**39,553**	**1,749.858**	**2,708.832**	**16.14**	**2.91**
Other Food/Ag Processing						
Animal and Pet Foods	1,731.902	3,169	185.296	296.413	17.11	0.32
Other Food Processing	2,059.894	8,349	336.143	738.482	35.85	0.79
Sum of Other Ag Proc.	**3,791.796**	**11,518**	**521.439**	**1,034.895**	**27.29**	**1.11**
Ag Input Manufacturing						
Ag Chemical and Fertilizer	585.657	1,377	127.368	271.973	46.44	0.29
Farm Machinery	2,602.415	9,375	612.476	1,018.305	39.13	1.10
Sum of Ag Input Mfg.	**3,188.072**	**10,752**	**739.844**	**1,290.278**	**40.47**	**1.39**
NonAg Industries						
All Other Manufacturing	34,499.411	164,893	8,302.084	11,820.314	34.26	12.71
Mining	337.044	2,123	117.405	210.541	62.47	0.23
Construction	9,923.074	102,052	3,654.066	3,962.677	39.93	4.26
Wholesale	7,964.980	69,325	3,190.767	5,766.609	72.40	6.20
Retail	10,262.767	226,648	4,668.911	7,724.969	75.27	8.31
# TCPU	15,988.821	116,101	5,083.298	8,496.511	53.14	9.14
** FIRE	21,210.695	143,363	5,381.204	12,356.680	58.26	13.29
Services	32,177.873	627,352	15,098.215	17,702.567	55.01	19.04
AllOther	17,980.569	241,937	9,060.270	15,891.530	88.38	17.09
Sum of NonAg Ind.	**150,345.234**	**1,693,794**	**54,556.220**	**83,932.398**	**55.83**	**90.28**
Totals	**185,810.222**	**1,882,178**	**59,780.547**	**92,966.218**	**50.03**	**100.00**

* Numbers represent millions of dollars

TCPU (Transportation, Communications, and Public Utilities)

** FIRE (Finance, Insurance, and Real Estate)

In terms of industrial scope, both aggregations include the manufacture of farm machinery and chemical manufacturing, primary agricultural commodity production, and food processing. Neither picture includes the food distribution or retailing system. Some implications of geographic scope and model definition will be discussed with the production-process aggregation, however. In terms of identification, the industry-only picture is a straightforward application of IMPLAN model data in nearly standard form. There are some identification issues regarding the production-process picture that will be discussed when that aggregation is presented below.

An Industry-only Aggregation

Table 5 provides data for an industry-only aggregation of the economic activity that takes place within Iowa's borders.[13] Output is the value of total in-state production for each industry in 2002. Value-added is the value that was added to Output by each industry's in-state production process. The difference between Output and Value-added is the value of physical inputs that go into the production process. For individual industries, these inputs may be sourced from out-of-state or from within the state. For the state totals, this difference represents the value of physical inputs that are imported from out of state (fuel, machinery, paper, food, etc.) Regardless of the level (industry or state) Value-added represents the value of Output at that level minus the value of physical inputs at that level. Table 5 also provides an estimate of jobs[14] and labor income (compensation for employees and proprietors).

From this perspective, production of primary agricultural commodities generated approximately 6.3 percent of statewide economic Output and 4.3 percent of statewide Value-added. Processing agricultural commodities added another 11.1 percent of Output and 4.0 percent of Value-added. Summing production and processing with input manufacturing gives a total of 19.0 percent of statewide Output and 9.7 percent of statewide Value-added for the agri-food sectors. This agri-food sector Value-added share is in the same ballpark as the total share of employment presented with the USDA employment aggregation above when food distribution, retailing, and peripheral industries were removed. This is not surprising when we recall that both sets of data rely heavily on the same labor statistics and that labor is the major recipient of Value-added in most industries.

Individual industries vary widely in how their Output totals translate into Value-added totals. For oilseed and other crop production over 50 percent of Output translates into Value-Added. For cattle, this ratio is only slightly over 7 percent. For other livestock the ratio is 15.5 percent.[15] This reflects the fact that an Input-Output model depends upon a fixed price vector (a list of prices for all inputs and outputs at a given point in time). Output and Value-Added are both dollar-denominated, as are input values. Identical physical quantities of output created using identical physical production processes can generate widely differing Output and Value-added values if relative prices between and among inputs and outputs change from year to year.

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[13] All lines other than those in *italics* are direct aggregations of IMPLAN industrial categories. Lines in *italics* are estimated allocations of IMPLAN industry groups to subgroups using commodity value estimates based on state and federal statistics.

[14] Jobs do not refer to the number of people working or to full-time-equivalent employment. Jobs can be full or part time. A single individual can hold multiple jobs. In short, jobs cannot be looked upon as interchangeable or comparable across industries, businesses, or location. Comparisons of wages and compensation are more appropriate in an economic value context.

[15] Because of the linear allocations used, the ratios for hogs, dairy products, etc., are the all identical to the overall ratio for their groups.

2002 was not a good year for livestock prices, and this is reflected by the data shown here. To the extent that this lowered input prices for processors while processed output prices remained high, the price structure would have moved Value-added to the processing sector. To the extent that protein output prices were low to the processor, also, this value would have disappeared from the industry process and become increased utility or value (a relatively lower cost of living) to the consumer. Finally, to the extent that low output prices may or may not have been offset by low input prices, Value-added at the farm or processing level may or may not have been affected at all. Because the scope of agriculture in this study includes a relatively long production pipeline, it is very difficult to speculate on what price changes at one level will do to the value of overall output in the chain. Some issues in the dynamics of changing price levels in the context of static input-output models DYNAMIC ISSUES IN AG OUTPUT AND INDUSTRY VALUATION below.

A Production-process Aggregation by Industry of Final Sale

A second perspective is gained by aggregating the Output and Value-added of Iowa-produced-and-used intermediate inputs into the results of the industry of final export from or consumption within Iowa. This gives a product valuation of output by industry where an industry's final values include all Iowa-produced input values. By doing this we show the total value of Iowa production that is driven by the final output of Iowa industries. This will increase the values of industries that use proportionately more Iowa inputs, because the values of those inputs are aggregated into these industries.

Table 6 shows a variation of this method. In addition to drawing Iowa-produced input values into the industry of final output, this variation removes Iowa-produced goods consumed by domestic households from the Output, Income, and Value-added totals by industry and presents them separately.[16] This is a partial reflection of economic base theory, which holds that the impact or value of a regional economy is reflected by the ability of that economy to produce beyond its needs (export). Economic base theory holds that the means to strengthen and grow a local economy is to strengthen the industrial sectors that have the ability to sell locally produced goods into the non-local market.

Strict interpretations of economic base theory would omit local government demand and local investment (capital and inventory) as well as local household consumption from the valuation of an industry's contribution to the economy. The scenario used in this analysis is less strict, interpreting local government expenditures and investment as increases in the local economy's capacity to produce goods in the future, just as the income streams from exports increase the regional economy's capacity. Some implications of this are discussed later in this section.

The Output numbers are higher for all of the agri-food industry groups except Agricultural Production under this aggregation (Table 6) than they are under the industry-only aggregation (Table 5). The Value-added numbers are higher under this aggregation for all of the agri-food

[16] In generating the production-process aggregates the job estimates of the model, which are included in the industry-only aggregation (Table 5), are lost. Job estimates are a report from the standard I-O model structure that is generated as a linear function of labor income and industry of interest. In re-aggregating the model to group activities of multiple industries as inputs into the industry of final sale, the ability to tie activities to a single industry was lost. In maintaining sums of all payments to households as a starting point to the process (along with out-of-state input purchases), labor income becomes mingled with dividends, interests, rents, and transfer payments. As a result, the job handle is lost in the aggregation

industry groups. This is because the agri-food sector utilizes a substantial proportion of local inputs in its production processes. Because this aggregation pulls local inputs into the totals of the industry of final local production, this increases the totals in sectors like agri-food, which use a relatively high proportion of local inputs.

Within the agri-food industry groups, the movement of commodity output at lower levels into production or processing at higher levels results in some individual segment totals dropping in this aggregation. This is particularly true in the meat production industry, where a very high proportion of livestock output goes directly into the Iowa meat processing industry, moving the value of that output from the agricultural production to the food processing industries.[17]

Table 6 shows industry-level Value-added under this aggregation in three contexts.

1. As a relative share of industry output (a production value yield rate)
2. As a relative share of total Iowa Value-added (a share of the economy's overall value)
3. As a relative share of Iowa Value-added net of production driven by Iowa household consumption (a share of Iowa's growth-driving production)

As with the industry-only aggregation shown in Table 5, Value-added's share of Output varies widely from industry to industry. The range of yields in Table 6 is narrower, however, with the top end being very similar between tables, but the bottom end in Table 6 being significantly higher than in Table 5. This is due to the aggregation of inputs from multiple industries into the final output aggregations by production process in Table 6. While the listed industry of final output is the major driver of the production value yield rate, the inclusion of inputs values from other industries tends to reduce the variations seen in individual industries.

Summing industry-level Value-added as a share of total Value-added for the agri-food sector industries shows that 18.25 percent of the Iowa economy's total Value-added is generated by the agri-food sector's production net of household consumption. In this representation, household consumption is treated as its own industry, and all production feeding local household demand is aggregated to household demand. Iowa economic production supporting this household demand generated 13.42 percent of Iowa Value-added, making household demand a major individual industry in its own right. Part of this 13.42 percent, however, is final household demand sourced from the agri-food sector. Removing household demand driven production from the agri-food sector industries and retaining it in the total Iowa economy understates the total agri-food production share of total Iowa Value-added.[18]

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[17] Values of Output and Value-added for the meat producing industries under this aggregation (Table 6) are also affected by the necessity to treat all meatpacking as a single industry. To make this work within the model, live animals are drawn to the nearest meat processing facility, regardless of type of animal. As a result, livestock types that are more likely to be packed out-of-state are over-allocated to the meat processing industry in this aggregation, understating livestock production Output and Value-added exports for those types. Livestock types that are less likely to be packed out-of-state are under-allocated to the meat processing, overstating livestock production exports for those types. This affects the allocation of livestock exports between Cattle, Poultry, and Other Livestock, but does not affect the total summed values for all livestock. It is a problem of allocation rather than measurement. It is the result of increasing concentration in the meatpacking industry, which prevents identification of industry statistics by type of animal due to data privacy and disclosure restrictions. This same type of issue is why the model cannot provide separate results for Hogs and Pigs, Milk Products, and Sheep. As both ag production and food processing continue to concentrate, the model may not be able to distinguish between any livestock categories in the near future.

[18] This would be true of shares calculated for any industry or sector under these constraints.

Table 6. Production-process Aggregation

	(Numbers below represent millions of dollars)			Value-added as % of		
Agricultural Production	**Output**	**Personal Income**	**Value-added**	**Output**	**Total VA**	**Non-hshld Demand VA**
Oilseeds	2,953.564	1,083.350	1,663.256	56.31	1.79	2.07
Grain	4,137.997	1,313.479	2,099.663	50.74	2.26	2.61
Other Crops	174.377	57.192	100.291	57.51	0.11	0.12
Cattle	24.843	3.621	6.616	26.63	0.01	0.01
Poultry	256.484	60.754	103.795	40.47	0.11	0.13
Turkeys	*38.114*	*9.028*	*15.424*			
Eggs	*141.938*	*33.621*	*57.440*			
Remainder (incl. Broilers)	*76.432*	*18.105*	*30.931*			
Other Livestock	1,811.123	328.612	567.767	31.35	0.61	0.71
Hogs and Pigs	*1,536.376*	*278.762*	*481.637*			
Milk Products	*247.037*	*44.823*	*77.443*			
Sheep	*13.040*	*2.366*	*4.088*			
Remainder	*14.670*	*2.662*	*4.599*			
Other Ag Production	21.670	10.498	12.188	56.24	0.01	0.02
Sum of Ag Production	**9,380.058**	**2,857.506**	**4,553.577**	**48.55**	**4.90**	**5.66**
Primary Food Processing						
Crop	10,410.639	2,311.980	3,765.533	36.17	4.05	4.68
Dairy	2,151.838	427.454	747.440	34.73	0.80	0.93
Meat	15,273.378	2,568.516	3,980.170	26.06	4.28	4.94
Sum of Primary Food Proc.	**27,835.854**	**5,307.950**	**8,493.144**	**30.51**	**9.14**	**10.55**
Other Food/Ag Processing						
Animal and Pet Foods	2,807.267	554.907	875.527	31.19	0.94	1.09
Other Food Processing	2,208.223	564.181	966.572	43.77	1.04	1.20
Sum of Other Ag Proc.	**5,015.489**	**1,119.088**	**1,842.099**	**36.73**	**1.98**	**2.29**
Ag Input Manufacturing						
Ag Chemical and Fertilizer	548.918	162.476	274.124	49.94	0.29	0.34
Farm Machinery	3,943.315	1,144.828	1,794.579	45.51	1.93	2.23
Sum of Ag Input Mfg.	**4,492.233**	**1,307.304**	**2,068.703**	**46.05**	**2.23**	**2.57**
NonAg Industries						
All Other Manufacturing	43,476.388	12,438.170	18,512.621	42.58	19.91	23.00
Mining	500.300	188.364	306.748	61.31	0.33	0.38
Construction	15,999.827	5,681.403	7,737.489	48.36	8.32	9.61
Wholesale	1,704.286	665.683	1,153.783	67.70	1.24	1.43
Retail	2,482.700	1,041.853	1,725.512	69.50	1.86	2.14
# TCPU	10,700.364	3,715.062	5,824.054	54.43	6.26	7.24
** FIRE	13,263.486	4,414.411	7,576.841	57.13	8.15	9.41
Services	14,935.148	6,080.969	8,448.426	56.57	9.09	10.50
All Other	15,309.599	9,262.726	12,250.676	80.02	13.18	15.22
Sum of NonAg Ind.	**118,372.099**	**43,488.641**	**63,536.150**	**53.67**	**68.34**	**78.93**
Household Demand	**20,714.488**	**32,038.280**	**12,472.544**	**60.21**	**13.42**	
Totals	**185,810.223**	**86,118.769**	**92,966.216**	**50.03**	**100.00**	

TCPU (Transportation, Communications, and Public Utilities)

** FIRE (Finance, Insurance, and Real Estate)

Recalling that this aggregation is a representation of an economic base model, which focuses on the non-consumed or growth-base output of the economy, the third relative share of agri-food sector Value-added can be calculated. This is agri-food sector Value-added as a share of total Iowa Value-added net of household demand driven Value-added. This calculation takes household demand out of both the numerator and the denominator of the agri-food share calculation.

The final column in Table 6 shows this relative share for Iowa's industries. Value added from agricultural commodity production is 5.66 percent of the state's total growth-base. Primary food processing generates 10.55 percent of total. Other agricultural commodity and food processing and agricultural input manufacturing generate 4.86 percent. Over all, this calculation of relative share results in the agri-food industries being attributed 28.30 percent of Iowa's growth-base Output, 19.59 percent of growth-base Personal Income, and 21.07 percent of statewide growth-base Value-added in 2002.[19]

Remember that these are not percentages of total Output, Value-added, and Income generated in the state's economy. This calculation has removed all Iowa-produced output that was consumed by Iowa households from both the industries (numerators) and the state totals (denominators) of each share calculation. The rationale is that exports and additions to capital and inventory increase the state economy's ability to produce in the future (increases the potential wealth of the state economy). Household consumption in this scenario is looked at as steady-state maintenance of the economy rather than production that has the potential to increase the economy's capacity to produce goods in the future. As a result, local household consumption is not part of the industry totals or the economy-wide totals in this share calculation. One way to interpret this is that 21.07 percent of what Iowa's households produce for others is generated through the final output of the agri-food sector.

Also recall that the production-process aggregation used to generate Table 6 was not a strict interpretation of economic base theory, because it was not strictly export based (the aggregation retained local investment and local government demand in addition to export demand). How the economic growth base is identified affects the values or shares of the sectors and industries within the economy. This generates identification issues in evaluating the share calculated. The table in Appendix 4 shows the percent of local institutional demand satisfied by each industry for seven demand categories as well as the percent of each industry's contribution to total state economic output.[20] All agri-food industry groups have export demand (summing domestic and foreign) shares that are significantly higher than their shares of total output. Conversely, all have local household demand shares that are significantly lower than their shares of total output. Removing household consumption from the agri-food industry totals increases the weight of their strong export presence, increasing their share of economic activity in this aggregation.

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[19] The total value-added share for the production-process I-O aggregation is similar to the total employment share for the USDA's ag-related employment (Table 4). Unlike the case with the industry-only numbers, however, this is not because there is a comparable basis for the numbers. The USDA share is the result of adding distribution, retail, and peripheral industries to the scope of the industry. The production-process I-O share was developed by strictly adding Iowa-sourced inputs into the values of the industry without expanding the scope of the industry beyond food processing. Similarity here is merely a coincidence.

[20] The numbers in Appendix 4 are derived directly from IMPLAN reports on *Institution Local Commodity Demand* and *Output, Value-added, and Employment* and are reasonably compatible with the industry-only aggregation presented in Table 5.

If, in addition to excluding household consumption, we were to exclude government commodity demand (not government farm program price effects) from our calculation of the economic share value of agri-food industries, our totals would increase further. Excluding local demand for capital goods would also increase our totals, but not to nearly as great an extent, because of the strong internal capital demand for farm machinery. On the other hand, excluding additions to inventory would lower the share value numbers for agri-food industries, due to the strong inventory growth in the ag production (farming) sector in 2002.[21] Over all, a strict export-only economic base theory accounting under this aggregation scheme would make ag-related industries appear to have a larger share of the Iowa economy's value.

Finally, whenever we divide local and nonlocal activities, we must be mindful of issues of geographic scope. In the production process aggregation (Table 6), local household consumption was removed from industry totals and the growth base of the economy. Exports to non-local environments were the major component of this growth base. Both of these are significantly affected by the definition of what is local and what is not. If we apply this logic at a global scale, there is nothing but local consumption, because everything has been defined as local. As a result there is no growth base and, presumably, no growth. On the other hand, if we define our geography in a way that the population lives outside of the areas of production there is no local household consumption. Everything is growth base. While these are extremes, they point out the importance of geographic definition in the process.[22]

DYNAMIC ISSUES IN AG OUTPUT AND INDUSTRY VALUATION

The survey responses from the 2002 Census of Agriculture, the job counts from the ERS farm related employment aggregations, and the prices and production-functions forming the structure of the IMPLAN I-O model are all static entities. They give pictures of agriculture at a single point-in-time. The world, however, is constantly changing, and some of the changes may significantly effect the valuation of the agri-food industry over time. This section looks at three issues regarding change.

1. Changing price levels
2. Changes in the industry structure
3. Annual income changes at the farm level

Changing Price Levels

As noted previously, an I-O model depends upon a fixed price vector for a given point in time. Our results from IMPLAN are based on the IMPLAN dataset for 2002. 2002 was selected

[21] The effects of including or excluding additions to inventory on agri-food industry shares should vary widely from year to year (see Table 3). In 2000, Iowa farms depleted inventory by over half a billion dollars. In 2002 (the year evaluated), farms increased inventory by nearly a quarter billion dollars. In 2003 (the latest numbers available), farms depleted inventory by over three-quarters of a billion dollars. Annual evaluations based on static point-in-time prices and demand values cannot effectively account for yearly swings of this magnitude.

[22] This is obvious to those who study both this state report and the accompanying county-level compilations. In general, county shares of export production relative to household consumption are higher than the statewide shares. This is because large amounts of in-state county-to-county trade counts as growth base for the counties but as household consumption for the state.

because it coincided with the most recently available data from the Census of Agriculture and was the most recent year for which IMPLAN data was available. It is often noted that another characteristic of 2002 was a relatively low level of farm and food prices. The tables in Appendix 5 provide evidence of this. These tables show a selection of consumer and producer price index numbers obtained from the U.S. Bureau of Labor Statistics (BLS). The indices in the first table show current price levels for each product as a ratio of its price in a base year (usually 1982). The second table recalculates these relationships for recent years using 2002 as a base, allowing us to do a fast and simple recent price comparison with 2002 levels.

These tables show that, nationwide, 2002 was not a good year for slaughter livestock prices on the farm or in the processed market. Alternatively, nationwide, while grain prices were not stellar, they were rising to recover from previous troughs. Overall, nationwide farm and processed food prices rose from 2002 through 2004. For the most part, farm level commodity price fluctuations also rippled through to consumer price fluctuations, although with smaller magnitudes.

A first reaction to this might be an attempt to revalue 2002 output levels with respect to more recent price levels. Conceptually, one could strictly compare changes in individual price levels assuming that all other prices and all outputs remain constant.[23] While this scenario is highly unlikely and quite limited in scope, it would generate substantially altered numbers. Applying national price level changes to individual Iowa industry output from Table 5[24] would increase value-added yield of slaughter cattle from 7.07 percent in the 2002 aggregation to 25.78. Slaughter hogs would move from 15.53 percent to 46.7 percent. Other large movers at the commodity production level are fluid milk and soybeans.

It must be noted that these calculations for individual industries absolutely cannot by summed into total effects. This is because each individual industry value change strictly assumes that price levels change only for that industry's output and that there are no price changes or effects anywhere else in the system. Summing effects would assume simultaneous changes in prices at all levels, causing cost-price interactions between industries that cannot be accounted for in this exposition.

Before using these calculations as a basis for action, remember that they only account for individual industry price level changes in the unlikely environment where these changes occur in complete isolation and have no effect upon the rest of the economy.

This would be hard to maintain in the agri-food sector or the economy as a whole. Much of what is sold at one level of the agri-food sector is purchased at another level. Increasing output prices for one level then become increasing input costs at the next. While rising grain prices are good for the farm-level producer, whether they are good for the agri-food sector as a whole depends upon the portion of grain consumed by the sector within the state (by livestock feeders, grain processors, etc.), and how sensitive those industries' output prices and profits are to the input cost of grain. Within the sector there are also several commodities or processed goods that compete

[23] While this is unlikely, it is logically possible to look at a solitary price change that is entirely absorbed by an expansion or contraction of consumer utility or standards of living, leaving all other prices and all output and consumption levels unchanged. In doing so, we would be interested only in comparing the static industry-only environment before the price change and immediately following the price change.

[24] This cannot be done with the data from Table 6, the production-process aggregation of the IMPLAN dataset, as it aggregates activities from multiple sectors into the industry of final sale. Using a single price change for aggregates of multiple industries would not yield results that were conceptually valid.

with one another (pork, beef, and poultry, for example). Changing prices in any one of these industries might be expected to immediately affect the outcomes of the others.

Even within individual industries in the agri-food sector, changing prices significantly affect behavior. The large inventory changes reported for production agriculture are largely a marketing response to output price changes. Commodity marketing cycles can span years, mitigating the effects of price changes on an individual year's output. These multi-year marketing cycles also make it difficult to attach the correct time-specific prices with time-specific production. Invariably, even the statistical estimation process tends to smooth price fluctuations at the ag commodity production level of the agri-food system.

Also, rising input prices reduce value-added. It has been noted that internal sales within the agri-food sector result in output price changes simultaneously becoming input prices in many instances. In addition, many of the agri-food sector's external inputs are also face rising price levels. For example, the agri-food industry is very energy-dependent, and energy prices have risen substantially since 2002. At the farm level, gas, fuel, and LP prices increased 21, 50, and 15 percent, respectively from Spring 2004 to Spring 2005.[25] Similar petroleum price changes have also affected the cost of fertilizer and chemical production, transportation, and food processing. The extent to which energy prices have risen and continue to rise will have a directly negative effect on the value-added by the agri-food industries.

The Economic Research Service (ERS) of the U.S. Department of Agriculture provides annual information on output values, input costs, value-added, and farm income at both a state and national level. This provides a broader picture of 2002 ag commodity production values than the price index information discussed above, because it accounts for changes in input expenses and provides a state-level perspective in addition to the national perspective. Table 7 provides summary data.

Table 7 shows that Iowa's experience was not directly analogous to the national experience in 2002. Nationwide, output values and both gross and net value added from farm production in 2002 were significantly lower than in either 2001 or 2003. In Iowa, 2002 output values were up from 2001, while 2002 gross and net value added declined from 2001 and continued to decline into 2003. In both geographies, the values of purchased inputs, net government transactions, and output (a combination of output volumes and prices) significantly affect the final operating results. In general, Table 7 shows that, while 2002 was not a stellar year for Iowa farm commodity producers, it was not noticeably atypical relative to recent years when input prices and production volumes are taken into account with market prices for outputs.

[25] Duffy, Mike and Darnell Smith. "Rising Energy Prices and Iowa Farmers." Iowa State University Department of Economics. April 2005.

Table 7. Recent Ag Commodity Production (Farm) Operating Results

										Forecasts		Averages	
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	95-04	95-03
Iowa													
Value of agricultural sector production	11.409	14.134	13.754	12.176	10.758	11.710	11.971	12.784	13.122				12.424
less: Purchased inputs	5.891	6.087	6.498	6.611	6.733	7.066	7.258	7.150	7.953				6.805
plus: Net government transactions	0.309	0.042	0.249	0.672	1.565	1.781	1.452	0.192	0.527				0.755
Gross value added	5.826	8.089	7.505	6.237	5.590	6.425	6.165	5.827	5.696				6.373
less: Capital consumption	1.195	1.205	1.199	1.203	1.193	1.195	1.203	1.208	1.199				1.200
Net value added	4.632	6.884	6.306	5.034	4.397	5.230	4.961	4.618	4.497				5.173
less: Payments to stakeholders	2.355	2.634	2.526	2.785	2.730	2.889	2.788	2.574	2.474				2.639
Employee compensation (total hired labor)	0.265	0.258	0.269	0.319	0.308	0.294	0.324	0.312	0.338				0.299
Net rent received by nonoperator landlords	1.163	1.385	1.250	1.432	1.384	1.485	1.439	1.326	1.184				1.339
Real estate and nonreal estate interest	0.927	0.992	1.007	1.034	1.038	1.111	1.024	0.935	0.952				1.002
Net farm income	2.276	4.250	3.780	2.249	1.667	2.341	2.173	2.044	2.023				2.534
United States													
Value of agricultural sector production	203.6	228.5	230.7	220.0	212.9	218.4	227.6	219.7	240.9	270.5	249.2	227.3	222.5
less: Purchased inputs	108.8	112.1	119.9	117.7	118.7	121.8	126.1	123.8	127.4	138.0	134.2	121.4	119.6
plus: Net government transactions	0.4	0.4	0.4	5.2	14.3	15.5	13.3	3.7	8.7	7.1	16.6	6.9	6.9
Gross value added	95.2	116.7	111.1	107.5	108.5	112.1	114.8	99.7	122.2	139.7	131.6	112.7	109.8
less: Capital consumption	18.9	19.1	19.3	19.6	19.9	20.2	20.7	20.9	20.8	21.6	22.2	20.1	19.9
Net value added	76.2	97.6	91.8	87.8	88.7	91.9	94.1	78.8	101.4	118.0	109.4	92.6	89.8
less: Payments to stakeholders	36.6	39.7	40.5	41.3	41.6	44.0	43.5	41.5	42.1	44.4	45.0	41.5	41.2
Employee compensation (total hired labor)	14.3	15.1	15.9	16.8	17.4	17.9	18.8	18.7	18.3	20.0	19.8	17.3	17.0
Net rent received by nonoperator landlords	9.6	11.4	11.3	10.8	10.4	11.2	11.1	9.8	10.7	11.2	11.8	10.7	10.7
Real estate and nonreal estate interest	12.7	13.2	13.4	13.7	13.8	14.9	13.6	13.0	13.2	13.3	13.4	13.5	13.5
Net farm income	39.6	57.9	51.3	46.5	47.1	47.9	50.6	37.3	59.2	73.6	64.4	51.1	48.6

Source: USDA Economic Research Service

Changes in Industry Structure – Ethanol Production

Point-in-time analyses are also of limited value in evaluating the effects changes in industry structure. Major changes are currently underway in agricultural commodity processing with regard to the expanding development of agriculturally derived fuels. In Iowa these include the production of soy-diesel from soybeans and, more prominently, ethanol from corn. To the extent that these change prices and market flows of grain from the farm, operations of grain consolidators, and prices and demand for alternative ag products, these developments will significantly affect the values of output, value-added, and income generated within the agri-food sector, both in their final values and their distribution among industry participants.

As of April, 2005, Iowa had 14 operating ethanol plants and 13 facilities in the planning or construction process. Current Iowa production capacity is 860 million gallons per year.[26] This is over double the ethanol production capacity reported by Otto and Gallagher as recently as April 2003. At a production ratio of 2.7 gallons per bushel of corn, current capacity would consume 318.5 million bushels of corn per year, and result in 3.6 million tons of dried distillers grains (22.57 lbs. DDG per bushel of corn used).[27] Estimated corn consumption is equal to 14.2 percent of Iowa's 2004 corn crop (2,244.4 million bushels) or one of every 7 bushels produced. The Iowa trend in ethanol capacity growth reflects the national trend. There are currently 83 ethanol production facilities, nationwide. One third of these are less than three years old. There are 25 plants under construction, nationwide.[28]

Assuming that there is continued demand for ethanol and its byproducts, including distillers grain, there are several expected impacts of this growth on the agri-food industries. First, increased demand for corn is good for output prices received by farmers and farm-level value-added. At the same time, increased farm-level corn prices will increase the input costs (reduce value-added) of all corn processors and merchandisers that will have to compete with ethanol producers for grain stocks.

Second, alternative local demand options for corn will reduce the volume of grain moving through grain merchandisers. This, along with the increase in grain costs will reduce output and value-added for grain merchandisers. Professor Robert Wisner of the Iowa State University Economics Department has estimated that increases in ethanol production capacity, if fully utilized, will reduce the amount of corn available for export from Iowa by between 50 and 80 percent from 2003 to 2008. This will have a significant impact on grain merchandisers and the value of merchandiser assets, which are largely held by farmers through membership in marketing cooperatives. Partially mitigating this loss for farmers' cooperative merchandisers will be the reduction in spoilage losses associated with outdoor storage, but this advantage will not offset the volume loss.

Third, the increasing supply of dried distillers grain will reduce feed costs to livestock producers, which will increase livestock's value-added. At the same time, increased availability of distillers grain for feed will reduce the value of competing feeds (notably soybean meal), reducing prices, output values, and value-added for soybean producers and processors.

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[26] Perkins, Jerry. "Low Prices Hit Ethanol." *Des Moines Sunday Register*. April 3, 2005.

[27] Production ratios derived from: Otto, Daniel and Paul Gallagher. "Economic Effects of Current Ethanol Industry Expansion in Iowa." Iowa State University Department of Economics. April 2003.

[28] Kilman, Scott. "In Midwest Investment Boom, Corn-to-fuels Plants Multiply." *Wall Street Journal*. March 9, 2005.

Assuming that the demand structure for ethanol and its byproducts is sufficient to absorb the rapid growth in industry capacity, the net effect on farm commodity producers will be positive, but there will very clearly be gainers and losers. Throughout the rest of the agri-food industry, however, it is unclear whether the overall gains from ethanol will outstrip the rising input prices faced by other processors. If demand for ethanol does not keep up with capacity growth, commodity demand benefits at the farm level will have to be compared with farm level investments in ethanol production capacity.

Farm Income Fluctuations and Iowa Total Earnings

Another dynamic impact that the agri-food industry has on the Iowa economy that is not cleanly amenable to static analysis is the year-by-year fluctuation of farm income. Farm income is subject to wide variations due to weather and price fluctuations. Drought, frost, exceptional growing conditions, etc., all directly affect the outcomes of all operators within a given geographic area. This is particularly true where all operators are specialized into producing a very limited set of commodities. Iowa is a very specialized commodity producer and is geographically small enough that weather patterns often affect the entire state's production outcomes. In addition to this, with only four major farm commodities, significant price changes in any commodity have a significant effect on farm earnings.

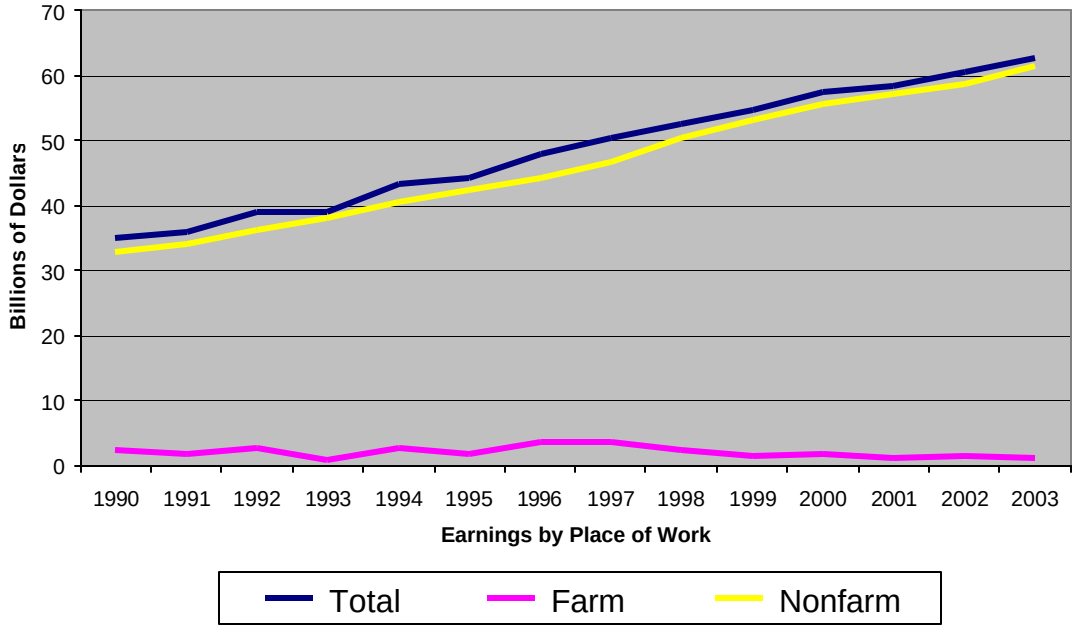
Figure 1 shows farm earnings, nonfarm earnings, and total earnings from personal employment by place of work in Iowa.[29] It is immediately apparent from Figure 1 that farm earnings make up a small portion of Iowa's total earnings by place of work. Also, while the level of farm earnings is fairly steady, it is a shrinking portion of total earnings because the nonfarm sectors in Iowa are growing. This is consistent with farming's fixed-resource land constraint. Iowa is heavily farmed, and most available farmland is fully engaged. It should also be recognized that the nonfarm industries that are growing include the farm input manufacturing and food processing industries that are included under the definition of the agri-food sector used in this analysis.

Figure 2 shows the same information from a different perspective, farm earnings as a percent of total earnings for the state. Through the 1990's, this representation shows substantial fluctuation in the share of total earnings generated by farm production. This fluctuation has been subdued since 1999. Figure 2 also shows the linear trend in the farm earnings share of total earnings for the state. Overall, the trend is downward, and the last several years follow the trend line fairly closely.[30]

[29] These earnings values have not been adjusted for inflation.

[30] 2002 sits almost directly on the trend line, providing some further evidence that 2002 was not, overall, an atypical year from an overall farm production, pricing, and outcomes perspective.

Figure 1. Farm, Nonfarm, and Total Earnings by Place of Work for Iowa



Data Source: U.S. Bureau of Economic Analysis

Figure 2. Iowa Farm Earnings as a Percent of Total Earnings by Place of Work

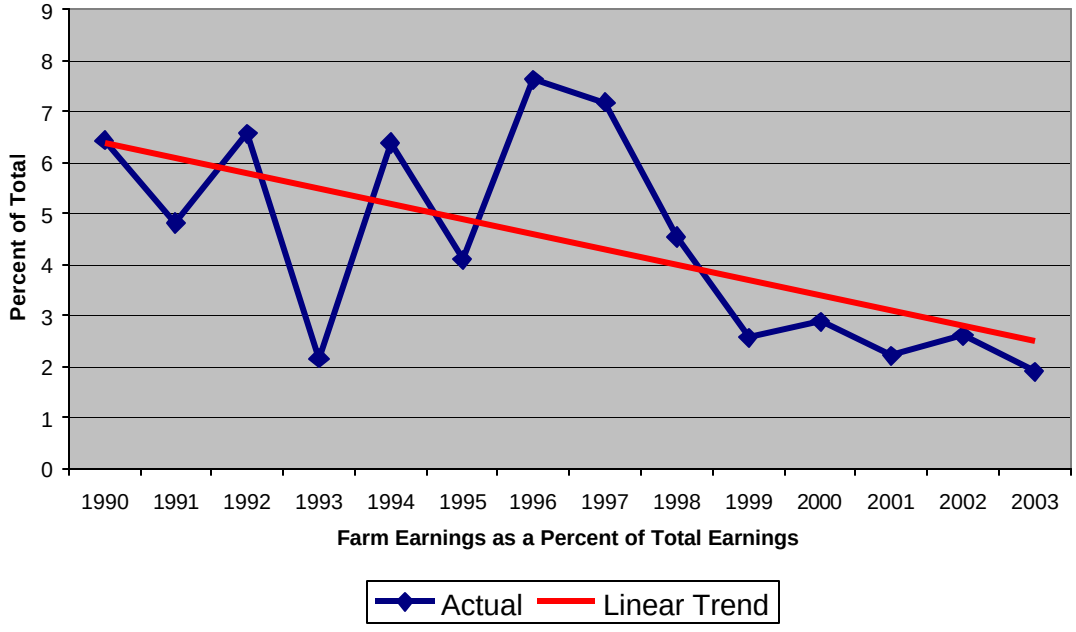
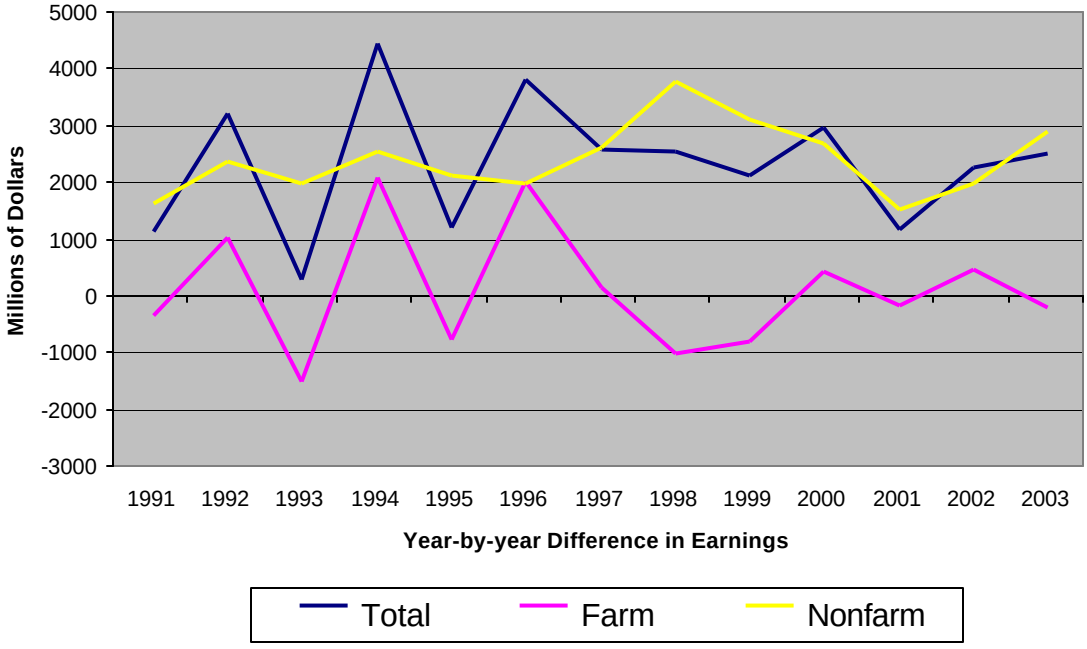


Figure 3 provides yet another perspective on the data displayed in Figure 1. In Figure 3, the annual farm, nonfarm, and total earnings data were differenced, year-by-year. As a result, Figure 3 shows the annual change in earnings for each of these categories. It is immediately apparent from Figure 3 that, while farm earnings are a relatively small portion of total earnings in Iowa and are not increasing, significantly, over time, farm earnings are the primary driver of fluctuations in the rate of annual income change. While nonfarm earnings are the major driver of increasing incomes in Iowa (at about a 2 billion dollar increase per year[31]), the fluctuations in this increase are closely tied to fluctuations in farm income. As a result, farm income variability provides a boom-bust component to Iowa income growth. Year-by-year variability in farm earnings regularly swing total earnings growth (and total earnings) in Iowa by billions of dollars. Four times in the past 14 years, farm earnings fluctuations have driven state swings of nearly 3 billion dollars or more. The figures here show this relationship for the state as a whole. These effects are significantly magnified for the rural areas of the state, where farm incomes drive much of the retail sales and investment purchases.

Figure 3. Yearly Earnings Differences



Data Source: U.S. Bureau of Economic Analysis

[31] These values are not adjusted for inflation.

CONCLUSIONS

In many ways, this has been an exercise in identifying or estimating the unknown in order to quantify the obvious. It is apparent that the agri-food industries in Iowa are important to the economy regardless of how the scope of the industry is defined or the relevant data is identified.

Farming utilizes almost 90 percent of Iowa's land area. Iowa is the leading producer of corn, soybeans, and hogs and pigs (by value of marketing receipts) in the nation. Over one-fifth of the nation's hogs and corn are Iowa-produced. Almost one in six bushels of soybeans comes from Iowa. Since 1990, 4.65 percent of Iowa's earnings by place of work have originated in farming, compared to 0.94 percent for the nation as a whole.

Using a broad definition of farm and farm-related industries, the USDA estimates that the Iowa agri-food sectors account for 21.1 percent of all employment in the state. In the non-metropolitan counties, this proportion grows to 27.1 percent. Under these assumptions, over 400,000 of Iowa's 1.9 million jobs are associated with ag or food-related industries.

Using a more limited definition to define the scope of agri-food industries and production relationships from the IMPLAN I-O model, this study aggregated industrial output in two ways to estimate the value of Iowa's agri-food system. The first, aggregating only industry specific output, jobs, labor income, and value-added for farm input manufacturing, farm production, and food processing industries, found the sum of their share of total Iowa economic value-added to be 9.7 percent. The second aggregation looked at the same set of industries, ignored production consumed by Iowa households, and aggregated inputs, regardless of industry, up to the industry of final sale. This provides a clear picture of how much of Iowa's unconsumed production is driven by the non-Iowa-household sale of products in the agri-food industry. This aggregation resulted in agri-food industry shares of Iowa economic output, value-added, and personal income of 28.3 percent, 21.07 percent, and 19.59 percent, respectively.

Farm income is a declining share of statewide income. This reflects increasing efficiencies in ag production. It also reflects growth in Iowa's nonfarm economy. Farming is a limited resource activity, and the limited resource (farmland) is almost completely utilized in Iowa. The growth in nonfarm industries includes growth in food processing, which is included in the agri-food sector in this report. In spite of its declining share of total income, however, farm income is a major factor in the variation of state income growth. Annual farm income swings of a billion dollars or more have a significant effect on the Iowa economy. In rural counties, where farm income is a larger proportion of total income, the local effect is even more substantial.

The scope of industries included in the agri-food sector for this report makes it very difficult to evaluate how changes in one industry affect the sector as a whole. Farm prices are revenues for farm families and costs for food processors. Whether increasing farm prices increase or decrease agri-food sector economic value-added depends upon how sensitive to these prices or costs the various sellers and buyers within the sector are. Ethanol is another case in point. While ethanol production will have far-reaching effects throughout the agri-food sector as it is defined here, there will definitely be winners and losers within the sector as these changes occur. Predicting the value of these individual changes is beyond the capacity of this effort.

Over all, regardless of the scope of industries included in the analysis or the effects of changes occurring within the agri-food sectors in Iowa, the system is a significant part of the Iowa economy.

APPENDIX 1. SHARES OF STATE GSP GENERATED THROUGH AG PRODUCTION AND FOOD PROCESSING

	Total	Ag Production			Food Processing			Ag. Prod. and Food Proc.		
State	GDP or GSP	$Millions	% of Tot.	St. Rank	$Millions	% of Tot.	St. Rank	$Millions	% of Tot.	St. Rank
US	10,412,244	96,918	0.93		172,484	1.66		269,402	2.59	
Iowa	97,810	3,644	3.73	5	4,400	4.50	3	8,044	8.22	1
Idaho	38,276	2,062	5.39	2	957	2.50	9	3,019	7.89	2
North Carolina	301,254	2,520	0.84	28	20,497	6.80	1	23,017	7.64	3
Nebraska	60,571	2,245	3.71	6	2,366	3.91	5	4,611	7.61	4
North Dakota	20,007	1,175	5.87	1	348	1.74	17	1,523	7.61	5
Arkansas	71,221	1,922	2.70	7	2,787	3.91	4	4,709	6.61	6
South Dakota	25,826	1,143	4.43	3	307	1.19	25	1,450	5.61	7
Virginia	288,840	1,016	0.35	42	13,648	4.73	2	14,664	5.08	8
Kentucky	121,633	1,591	1.31	20	3,920	3.22	7	5,511	4.53	9
Montana	23,913	904	3.78	4	117	0.49	47	1,021	4.27	10
Georgia	307,443	2,524	0.82	30	10,102	3.29	6	12,626	4.11	11
Oregon	115,113	3,099	2.69	8	1,539	1.34	21	4,638	4.03	12
Kansas	89,875	1,617	1.80	12	1,993	2.22	11	3,610	4.02	13
Mississippi	68,550	1,414	2.06	9	1,275	1.86	15	2,689	3.92	14
Wisconsin	189,508	2,653	1.40	16	4,712	2.49	10	7,365	3.89	15
Missouri	187,090	1,595	0.85	26	5,015	2.68	8	6,610	3.53	16
Minnesota	199,271	2,593	1.30	21	3,555	1.78	16	6,148	3.09	17
Oklahoma	95,343	1,664	1.75	13	1,252	1.31	22	2,916	3.06	18
Washington	233,971	4,484	1.92	10	2,610	1.12	27	7,094	3.03	19
Alabama	123,763	1,757	1.42	15	1,796	1.45	20	3,553	2.87	20
Tennessee	191,394	1,056	0.55	35	4,223	2.21	12	5,279	2.76	21
California	1,363,577	18,757	1.38	17	16,239	1.19	24	34,996	2.57	22
Illinois	486,182	2,586	0.53	36	9,617	1.98	14	12,203	2.51	23
Ohio	385,657	1,563	0.41	40	7,764	2.01	13	9,327	2.42	24
Vermont	19,419	264	1.36	18	202	1.04	30	466	2.40	25
New Mexico	53,414	912	1.71	14	301	0.56	43	1,213	2.27	26
Indiana	203,296	1,325	0.65	34	3,291	1.62	19	4,616	2.27	27
Maine	39,027	521	1.33	19	359	0.92	35	880	2.25	28
Pennsylvania	424,820	2,096	0.49	37	7,064	1.66	18	9,160	2.16	29
Texas	775,459	7,398	0.95	25	8,943	1.15	26	16,341	2.11	30

State	Total GDP or GSP	Ag Production GDP or GSP	$Millions	% of Tot.	St. Rank	Food Processing $Millions	% of Tot.	St. Rank	Ag. Prod. and Food Proc. $Millions	% of Tot.
Wyoming	20,326	366	1.80	11	61	0.30	50	427	2.10	31
Alaska	29,741	298	1.00	24	317	1.07	28	615	2.07	32
Colorado	181,246	1,514	0.84	29	2,202	1.21	23	3,716	2.05	33
Florida	522,340	5,500	1.05	23	4,496	0.86	37	9,996	1.91	34
Arizona	173,052	2,209	1.28	22	979	0.57	42	3,188	1.84	35
Utah	73,646	480	0.65	33	738	1.00	34	1,218	1.65	36
South Carolina	122,274	832	0.68	32	1,116	0.91	36	1,948	1.59	37
Michigan	347,014	1,679	0.48	38	3,528	1.02	32	5,207	1.50	38
Hawaii	43,806	372	0.85	27	256	0.58	41	628	1.43	39
Louisiana	134,360	1,045	0.78	31	862	0.64	40	1,907	1.42	40
Delaware	46,991	155	0.33	43	482	1.03	31	637	1.36	41
Maryland	202,840	525	0.26	44	2,153	1.06	29	2,678	1.32	42
New Jersey	377,824	605	0.16	50	3,806	1.01	33	4,411	1.17	43
Connecticut	167,235	289	0.17	49	1,400	0.84	38	1,689	1.01	44
New York	802,866	1,631	0.20	48	6,296	0.78	39	7,927	0.99	45
New Hampshire	46,106	180	0.39	41	250	0.54	45	430	0.93	46
West Virginia	45,259	212	0.47	39	187	0.41	48	399	0.88	47
Massachusetts	287,191	649	0.23	47	1,592	0.55	44	2,241	0.78	48
Nevada	82,389	190	0.23	45	417	0.51	46	607	0.74	49
Rhode Island	37,040	85	0.23	46	126	0.34	49	211	0.57	50

APPENDIX 2. A BRIEF DISCUSSION OF I-O MODELING

An I-O model is essentially a generalized accounting system of a regional economy that tracks the purchases and sales of commodities between industries, businesses, and final consumers. Successive rounds of transactions stemming from the initial economic stimulus (such as a new plant or community business) are summed to provide an estimate of direct, indirect, induced (or consumer-related) and total effects of the event. The impacts are calculated using the IMPLAN Input Output modeling system, originally developed by the US Forest system and currently maintained by the Minnesota IMPLAN Group (http://www.implan.com/index.html). This modeling system is widely used by regional scientists in the U.S. and worldwide to estimate economic impacts.

I-O models are capable of providing many types of reports on regional data and interactions among sectors. For economic studies, several of the more important indicators are:1) total output, 2) personal income, 3) value added, and 4) jobs. Total output for most industries is simply gross sales. For public institutions we normally include all public and private spending, all direct sales and subsidies received in order to isolate the economic value of their output. Personal income includes the wages and salaries of employees, along with normal proprietor profits. Value added is another appropriate measure of economic effects. Value added is analogous to gross regional product. It includes all personal income, plus estimates of returns to investors, and indirect business taxes paid to state and local governments. In short, value added gives us a measure of the income or wealth that accrues to individuals and governments as a result of industrial activity in an area. Jobs, the fourth measure, represent the number of positions in the economy, not the number of employed persons.

We can also get detailed breakdown of this data into direct, indirect, induced, and total economic effects. *Direct effects* in this case refer to the initial set of expenditures or production changes that lead to changes in a regional economy. *Indirect effects* measure the value of supplies and services that are provided to the businesses that experience the *Direct effects*. *Induced effects* accrue when workers in the direct and indirect industries spend their earnings on goods and services in the region. *Induced effects* are also often called household effects. *Total effects* are the sum of direct, indirect, and induced effects. They are the total of transactions attributable to the direct activity being measured.

The term *multiplier* is also often used when referring to economic effects or economic impacts. A multiplier is simply the total effects divided by the direct effects. It tells how much the overall economy changes per unit change in the direct effects (a dollar of output, a dollar of personal income, a dollar of value added, or a job). Multipliers help us to anticipate the potential change in the regional economy attributable to a change in direct activity in a particular industry. Firms with strong linkages to area supplying firms or that pay relatively high earnings may yield high multipliers. Firms that are otherwise not connected strongly locally or that pay lower than average wages will have lower multipliers. Urban areas with their more developed economies have, on the average, much higher multipliers than rural areas.

APPENDIX 3. INPUT-OUTPUT MODEL MULTIPLIERS AND ECONOMIC IMPACT

One of the most commonly used and generally misused tools of I-O analysis is the industrial multiplier. In a nutshell, a multiplier is a factor that is multiplied by a change in industry-level Output, Value-added, or Employment or a change in economy-wide income to estimate the summed value of this original change and all of the transactions that it stimulates as it causes additional transactions throughout the regional economy.

There are various levels or methods of constructing multipliers. Some multipliers only account for supply transactions that support the original change (multiplying transactions backwards into the supply and production process). For example, if an additional tractor is produced and purchased, the tractor manufacturer must purchase components from suppliers, which may generate other production, etc. In this case, the multiplier provides an estimate of the magnitude of these additional production activities.

Other multipliers account for the personal consumption transactions made possible by the payroll and income generated by the original change and its associated supply transactions (multiplying transactions forward into the household income and expenditure process). For example, our tractor manufacturer and its suppliers paid additional labor income to produce the additional tractor. This income increased the consumption potential of the workers that received it. To the extent that they spend this income, it generates personal sales and supply transactions beyond the production of one additional tractor. In this case, the multiplier provides an estimate of the magnitude of these additional consumption transactions.

Used within the context of the model and its assumptions, multipliers can be very useful. Unfortunately, multipliers seem to invite use that takes them beyond these constraints. The basic constraints on the model and its multipliers all derive from the fact that the model is a static depiction of a regional economy at a given point in time. The constraints are

> Prices throughout the economy remain constant. This also means that production functions and consumption patterns remain constant. There is no price substitution. There is no shortage or surplus of either inputs or outputs (more (less) can always be made, and what is (not) made can always be bought (lived without)).
>
> Production and consumption adjust continuously to scale. Adding the production of one tractor increases factory capacity by the same factor as it increases labor and input purchases. Adding income increases consumption, but increases the consumption of all goods at the same rate.

Within these constraints, small changes in income, production, employment, etc., can be reasonably interpreted with the model and multipliers, because they do not materially change production shares, consumption shares, or relative prices across the regional economy. Large changes cannot be reasonably interpreted with the model and multipliers alone, because they materially change relative prices, which change production and consumption shares as firms and individuals adjust to changing prices.

Determining the appropriateness of the model to estimating effects depends upon where the changes are made. Grain processing in Iowa, for example, faces an excess supply of inputs. Piles of corn at local elevators violate the model's constraints. This is clearly understood by the industry, as the development of new processing facilities or ethanol plants is never hailed as an incentive to increase production, but is always hailed as a way to change prices. Model

multipliers for the grain processing industry, however, assume that prices remain the same and production increases. In this case, even small (within the overall context of the grain processing industry) changes in capacity and output cannot be appropriately analyzed in the context of the multiplier because a fundamental assumption of the model does not hold true.

In all cases where the desired or expected effects of a change are discussed in terms of price changes rather than output changes, use of industry-level multipliers has to be viewed with suspicion.

The most egregious misuse of an industry multiplier is to multiply the total value of the industry times the multiplier, take the product as a portion of the total value of the regional economy, and assert that this is the industry's impact upon the economy. This goes far beyond the marginal changes in value that the model and multiplier are designed to explain, and is not acceptable for a number of reasons.

> First, the removal of the entire industry would certainly have major effects on production functions, consumption choices, and prices throughout the regional economy
>
> Second, doing this for every industry would result in estimated "impacts" far exceeding the value of the regional economy.

The table below provides a selection of output multipliers for Iowa industries taken from IMPLAN. These are presented for the purpose of illustration only, and should be used with restraint. To the extent that they can reasonably be applied to changes in output

- Direct effects refer to initial changes in industry output to be analyzed
- Indirect effects refer to transactions going backwards into the supply chain as a result of direct effects
- Induced effects refer to changes in household consumption due to changes in personal income resulting from payrolls associated with direct and indirect transactions
- Type 1 Multipliers account for direct and indirect effects
- Total Multipliers account for direct, indirect, and induced effects

It is important to remember that these output multipliers are based on the fixed production and transaction relationships that underlie the IMPLAN input-output model for the Iowa. To the extent that industry changes are large enough to alter relationships (prices) between industries and households in the local and surrounding areas, these estimates will not reflect actual industry-related effects. In general, the smaller the incremental change relative to the size of the impacted industry, the more confident we can be that relationships are not fundamentally altered. Also, the more completely the industries supply and demand relationships reflect the assumptions of the model, the more confident we are in the use of these multipliers. As larger changes are addressed, we can expect continually less accurate estimates due to the inflexibility of assumptions underlying the model.

	Effects				Multipliers	
	Direct	Indirect	Induced	Total	Type I*	Total**
Oilseed farming	1.00	0.294204	0.345565	1.639769	1.294204	1.639769
Grain farming	1.00	0.327206	0.287410	1.614616	1.327206	1.614616
Vegetable and melon farming	1.00	0.236813	0.286488	1.523301	1.236813	1.523301
Tree nut farming	1.00	0.325352	0.297589	1.622941	1.325352	1.622941
Fruit farming	1.00	0.262484	0.286731	1.549215	1.262484	1.549215
Greenhouse and nursery production	1.00	0.091930	0.366586	1.458516	1.091930	1.458516
All other crop farming	1.00	0.307517	0.240742	1.548259	1.307517	1.548259
Cattle ranching and farming	1.00	0.587640	0.127096	1.714736	1.587640	1.714736
Poultry and egg production	1.00	0.295738	0.177937	1.473675	1.295738	1.473675
Animal production, except cattle and poultry	1.00	0.438141	0.153274	1.591415	1.438141	1.591415
Dog and cat food manufacturing	1.00	0.435963	0.185987	1.621950	1.435963	1.621950
Other animal food manufacturing	1.00	0.436299	0.183958	1.620257	1.436299	1.620257
Flour milling	1.00	0.509551	0.236349	1.745900	1.509551	1.745900
Wet corn milling	1.00	0.526695	0.201767	1.728462	1.526695	1.728462
Soybean processing	1.00	0.530828	0.185603	1.716430	1.530828	1.716430
Fats and oils refining and blending	1.00	0.406157	0.131002	1.537160	1.406157	1.537160
Breakfast cereal manufacturing	1.00	0.516560	0.225347	1.741907	1.516560	1.741907
Fluid milk manufacturing	1.00	0.638585	0.187888	1.826474	1.638585	1.826474
Cheese manufacturing	1.00	0.834763	0.172855	2.007618	1.834763	2.007618
Dry, condensed, and evaporated dairy products	1.00	0.492008	0.178550	1.670558	1.492008	1.670558
Ice cream and frozen dessert manufacturing	1.00	0.516744	0.225561	1.742306	1.516744	1.742306
Animal, except poultry, slaughtering	1.00	0.795192	0.184368	1.979561	1.795192	1.979561
Meat processed from carcasses	1.00	0.869677	0.288964	2.158641	1.869677	2.158641
Rendering and meat byproduct processing	1.00	0.622182	0.253548	1.875730	1.622182	1.875730
Poultry processing	1.00	0.747434	0.303901	2.051335	1.747434	2.051335
Bread and bakery product, except frozen, mfg.	1.00	0.271697	0.316847	1.588544	1.271697	1.588544
Cookie and cracker manufacturing	1.00	0.311938	0.192217	1.504154	1.311938	1.504154
Mixes and dough made from purchased flour	1.00	0.310324	0.204145	1.514469	1.310324	1.514469
Dry pasta manufacturing	1.00	0.254529	0.279070	1.533599	1.254529	1.533599
Tortilla manufacturing	1.00	0.299539	0.307184	1.606723	1.299539	1.606723

* Type 1 = (Direct + Indirect)/Direct

** Total = (Direct + Indirect + Induced)/Direct

APPENDIX 4. INDUSTRY PERCENT SHARES OF SELECTED DEMAND CATEGORIES AND TOTAL OUTPUT

Industry Percents of Totals	Household	Gov't. Demand		Additions to		Exports		Sector
(by column)	Demand	Fed.	St. & Loc.	Capital	Inventory	Domestic	Foreign	Output
Agricultural Production								
Oilseeds	0.000	0.000	0.000	0.000	26.787	1.503	7.927	1.216
Grain	0.006	0.000	0.007	0.000	14.890	2.936	10.240	1.961
Other Crops	0.032	0.000	0.023	0.000	0.388	0.130	0.210	0.294
Cattle	0.003	0.000	0.000	0.000	0.000	0.000	0.058	1.196
Poultry	0.038	0.000	0.035	0.000	0.405	0.264	0.032	0.202
Other Livestock	0.034	0.003	0.000	0.000	21.875	1.541	0.871	1.245
Other Ag Production	0.054	0.012	0.000	0.000	0.226	0.034	0.024	0.184
Sum of Ag Production	**0.167**	**0.015**	**0.065**	**0.000**	**64.571**	**6.408**	**19.362**	**6.298**
Primary Food Processing								
Crop	0.032	0.068	0.204	0.000	1.656	7.291	6.264	3.093
Dairy	0.617	0.044	0.605	0.000	0.929	1.657	0.514	0.981
Meat	1.443	1.477	0.606	0.000	1.833	10.720	8.099	4.958
Sum of Primary Food Proc.	**2.092**	**1.589**	**1.415**	**0.000**	**4.417**	**19.668**	**14.877**	**9.032**
Other Food/Ag Processing								
Animal and Pet Foods	0.016	0.002	0.001	0.000	0.115	2.617	0.764	0.932
Other Food Processing	1.141	0.015	0.337	0.000	4.020	2.429	0.978	1.109
Sum of Other Ag Proc.	**1.157**	**0.017**	**0.338**	**0.000**	**4.135**	**5.046**	**1.743**	**2.041**
Ag Input Manufacturing								
Ag Chemical and Fertilizer	0.015	0.000	0.086	0.000	0.020	0.214	1.475	0.315
Farm Machinery	0.012	0.034	0.038	14.015	0.000	0.012	6.561	1.401
Sum of Ag Input Mfg.	**0.027**	**0.034**	**0.124**	**14.015**	**0.020**	**0.225**	**8.036**	**1.716**
Sum Total of All Ag Ind.	**3.442**	**1.655**	**1.942**	**14.015**	**73.144**	**31.347**	**44.017**	**19.087**
NonAg Industries								
All Other Manufacturing	3.337	14.588	3.766	28.020	16.843	31.344	39.799	18.567
Mining	0.000	0.000	0.004	0.027	0.113	0.539	0.088	0.181
Construction	0.000	2.467	20.183	51.156	0.000	0.365	0.007	5.340
Wholesale	4.537	0.957	2.146	0.000	0.000	0.000	5.607	4.287
Retail	15.268	3.057	0.039	2.162	0.000	2.173	0.000	5.523
# TCPU	6.041	2.604	7.739	1.164	9.543	7.858	3.383	8.605
** FIRE	10.436	0.320	3.901	1.020	0.000	11.400	4.521	11.415
Services	41.206	9.057	9.983	2.337	0.333	14.501	1.372	17.318
AllOther	15.732	65.295	50.295	0.098	0.023	0.473	1.205	9.677
Sum of NonAg Ind.	**96.558**	**98.345**	**98.058**	**85.985**	**26.856**	**68.653**	**55.983**	**80.913**
Demand Category Total	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**

APPENDIX 5. SELECTED PRICE INDICES ASSOCIATED WITH THE AGRI-FOOD SECTORS

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Consumer Price Index										
CPI - All Items	152.4	156.9	160.5	163.0	166.6	172.2	177.1	179.9	184.0	188.9
CPI - All food	148.4	153.3	157.3	160.7	164.1	167.8	173.1	176.2	180.0	186.2
CPI - Cereals and bakery products	167.5	174.0	177.6	181.1	185.0	188.3	193.8	198.0	202.8	206.0
CPI - All meats	135.5	140.2	144.4	141.6	142.3	150.7	159.3	160.3	169.0	183.2
CPI - Beef and veal	134.9	134.5	136.8	136.5	139.2	148.1	160.5	160.6	175.1	195.3
CPI - Pork	134.8	148.2	155.9	148.5	145.9	156.5	162.4	161.8	164.9	174.2
CPI - All poultry	143.5	152.4	156.6	157.1	157.9	159.8	164.9	167.0	169.1	181.7
CPI - Chicken				101.4	101.8	102.5	105.5	107.6	108.9	118.2
CPI - Other poultry (Inc. turkey)				101.0	101.6	104.9	108.8	108.2	109.5	113.1
CPI - Dairy and related products	132.8	142.1	145.5	150.8	159.6	160.7	167.1	168.1	167.9	180.2
CPI - Eggs	120.5	142.1	140.0	135.4	128.1	131.9	136.4	138.2	157.3	167.0
Processed Foods Prod. Price Ind.										
PPI - All processed food & feed	127.0	133.3	134.0	131.6	131.1	133.1	137.3	136.2	143.4	151.1
PPI - Cereal and bakery products	154.7	159.9	158.1	157.4	157.5	158.4	162.0	164.5	170.7	174.3
PPI - All processed meats	102.9	109.0	111.6	101.3	104.6	114.3	120.3	113.4	128.2	134.8
PPI - Processed beef/veal	100.9	100.2	102.8	99.4	106.3	113.7	120.6	114.7	137.9	141.2
PPI - Processed pork	101.5	120.9	123.1	96.6	96.0	113.4	120.3	109.0	115.7	132.6
PPI - All processed poultry	114.2	119.7	117.4	120.8	114.0	112.9	116.8	111.3	116.6	130.2
PPI - Processed chickens	113.5	121.5	118.6	125.2	113.4	110.4	117.2	109.7	119.7	138.9
PPI - Processed dairy products	119.7	130.4	128.1	138.2	139.2	133.7	145.2	136.2	139.4	156.0
PPI - Processed fluid milk	124.9	138.1	135.7	144.9	150.0	143.5	157.4	147.1	149.8	167.2
PPI - Processed Eggs	101.3	126.4	122.6	100.1	93.7	85.4	87.8	86.1	95.8	111.5
PPI - Prepared Animal feed	109.1	135.3	132.9	108.0	98.3	102.9	105.1	105.7	112.8	124.6
PPI - Soybean meal	78.4	114.0	126.3	78.6	66.9	80.1	79.4	79.2	91.8	
Farm Commodities Prod. Price Ind.										
PPI - Farm Products	107.4	122.4	112.9	104.6	98.4	99.5	103.8	99.0	111.5	123.2
PPI - Grains	112.6	151.1	111.2	93.4	80.1	78.3	81.2	91.5	95.5	99.5
PPI - Corn	109.0	158.5	110.1	91.7	78.2	76.4	78.8	89.4	93.8	97.5
PPI - Slaughter livestock	92.8	95.2	96.3	82.3	86.4	96.5	99.6	89.1	109.2	116.7
PPI - Slaughter cattle	99.5	95.8	97.9	92.5	97.6	104.1	108.4	100.8	124.3	126.2
PPI - Slaughter hogs	70.2	88.6	87.0	52.2	53.8	72.7	73.4	55.4	66.1	87.8
PPI - Slaughter lambs	135.4	149.7	155.2	129.7	126.2	133.6	119.3	124.1	145.2	155.7
PPI - Slaughter chickens	127.5	146.3	136.2	150.3	132.9	125.9	136.5	124.1	147.2	185.9
PPI - Slaughter turkeys	120.3	121.5	112.9	110.4	120.0	120.7	110.3	104.3	102.8	122.0
PPI - Chicken eggs	104.1	130.7	119.0	107.6	89.4	97.8	93.7	95.8	132.1	122.5
PPI - Fluid milk	93.6	107.9	97.5	112.9	106.3	92.0	111.8	90.8	93.8	119.9
PPI - Soybeans	102.2	127.9	131.0	103.4	80.1	83.4	78.6	87.7	108.8	130.0

U.S. Bureau of Labor Statistics
Producer Price Index base: 1982
2004 Producer Price Index numbers are preliminary
Consumer Price Index base: 82-84
Except chicken and poultry (base: 1997)

APPENDIX 5 (CONT'D.). RECENT PRICE INDEX LEVELS AS A PERCENT OF 2002 LEVELS

	2000	2001	2002	2003	2004
Consumer Price Index					
CPI - All Items	95.72	98.44	100.00	102.28	105.00
CPI - All food	95.23	98.24	100.00	102.16	105.68
CPI - Cereals and bakery products	95.10	97.88	100.00	102.42	104.04
CPI - All meats	94.01	99.38	100.00	105.43	114.29
CPI - Beef and veal	92.22	99.94	100.00	109.03	121.61
CPI - Pork	96.72	100.37	100.00	101.92	107.66
CPI - All poultry	95.69	98.74	100.00	101.26	108.80
CPI - Chicken	95.26	98.05	100.00	101.21	109.85
CPI - Other poultry (Inc. turkey)	96.95	100.55	100.00	101.20	104.53
CPI - Dairy and related products	95.60	99.41	100.00	99.88	107.20
CPI - Eggs	95.44	98.70	100.00	113.82	120.84
Processed Foods Prod. Price Ind.					
PPI - All processed food & feed	97.72	100.81	100.00	105.29	110.94
PPI - Cereal and bakery products	96.29	98.48	100.00	103.77	105.96
PPI - All processed meats	100.79	106.08	100.00	113.05	118.87
PPI - Processed beef/veal	99.13	105.14	100.00	120.23	123.10
PPI - Processed pork	104.04	110.37	100.00	106.15	121.65
PPI - All processed poultry	101.44	104.94	100.00	104.76	116.98
PPI - Processed chickens	100.64	106.84	100.00	109.12	126.62
PPI - Processed dairy products	98.16	106.61	100.00	102.35	114.54
PPI - Processed fluid milk	97.55	107.00	100.00	101.84	113.66
PPI - Processed Eggs	99.19	101.97	100.00	111.27	129.50
PPI - Prepared Animal feed	97.35	99.43	100.00	106.72	117.88
PPI - Soybean meal	101.14	100.25	100.00	115.91	
Farm Commodities Prod. Price Ind.					
PPI - Farm Products	100.51	104.85	100.00	112.63	124.44
PPI - Grains	85.57	88.74	100.00	104.37	108.74
PPI - Corn	85.46	88.14	100.00	104.92	109.06
PPI - Slaughter livestock	108.31	111.78	100.00	122.56	130.98
PPI - Slaughter cattle	103.27	107.54	100.00	123.31	125.20
PPI - Slaughter hogs	131.23	132.49	100.00	119.31	158.48
PPI - Slaughter lambs	107.66	96.13	100.00	117.00	125.46
PPI - Slaughter chickens	101.45	109.99	100.00	118.61	149.80
PPI - Slaughter turkeys	115.72	105.75	100.00	98.56	116.97
PPI - Chicken eggs	102.09	97.81	100.00	137.89	127.87
PPI - Fluid milk	101.32	123.13	100.00	103.30	132.05
PPI - Soybeans	95.10	89.62	100.00	124.06	148.23