

**THE ECONOMIC CONTRIBUTION  
OF THE FOOD AND AGRICULTURAL  
SYSTEM IN INDIANA**

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Staff Paper #96-18

August 1996

**Dept. of Agricultural Economics**

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**Introduction**

Indiana has a long and rich heritage as an agricultural area specializing in major field crops and livestock. Like much of the United States, earlier in this century most Hoosiers played some part in the food and agricultural system by either farming themselves, working on someone else's farm, transporting food to markets, processing raw agricultural goods into finished food products, producing farm inputs and machinery, or working in the wholesale or retail sector distributing food to consumers.

But much has changed since then. Tremendous gains in farm productivity throughout this century have reduced the need for such a large portion of the population to be involved in the production and distribution of food products. Technological innovation has freed up millions to pursue occupations in other industries, helping fuel rapid U.S. economic growth throughout much of this century. And this trend continues today, as technological change continues to reduce the need for large numbers of people to grow food.

The purpose of this report is to measure the impact of the food system on the economy of Indiana and a subset of rural counties in the 1990's. The report examines all levels of the food system from making farm inputs to the grocery store shelf, including all spending that is a direct or indirect result of the production of food. The report begins by looking at the manner in which income flows through an economy and is followed by a discussion of input-output models and the principles on

which they are based. Next, the input-output model used to measure the impact of the food system is evaluated, and the findings of an economic impact analysis of the food and agricultural system in Indiana are presented. The report concludes with a summary of the findings and some closing comments.

### **The Flow of Spending in an Economy**

Measuring the economic impact of the food industry on the economy of Indiana is not a simple matter. Income generation and spending within an economy is a complex activity. There are three distinct effects that occur as money flows through an economy: direct; indirect; and induced. *Direct effects* are those that benefit a business when it creates value in some product. For example, the farm sector benefits in a direct way when a farmer earns income by growing corn.

There are also *indirect effects* as a result of an increase in business activity. The farmer purchases inputs of seed, fertilizer, equipment, and business services to produce a crop, and the purchase of these inputs contribute to the economy as well. Indirect effects also occur when the output of an industry is used as an input to another industry to add value to a product.

Now consider that all of the individuals involved in the production of a good earn income for their efforts. The spending of their earned income on goods and services for consumption creates additional income for others. The generation of income as a result of this spending is called *induced effects*.

The direct, indirect, and induced effects are incorporated into the *multiplier effect*. The multiplier effect is defined as the relationship between some initial change in an economy and the succeeding economic activity that is generated as a result of that initial change. An economic impact analysis is based on the concept of the multiplier effect and traces the spending that occurs as a result of some initial activity, in this case food production and distribution, throughout the economy.

One way to explain the exchange of goods and services for money in the food industry is to trace the linkages in an economy (Figure 1). The rectangles in Figure 1 represent the five basic food-related industries: farm inputs; farm production; food processing; wholesale and retail; and food service. The ovals represent the final destinations of food production and distribution; households; and exports. The solid lines represent the flow of goods between industries, while the dashed lines represent the input of labor by households to the production of food products.

Figure 1 shows that farms purchase inputs from the farm input industry. Farm outputs flow primarily to the food processing industry or as exports outside the economy, but may also flow directly to wholesalers and retailers, food service providers, and households. Not shown in Figure 1 is a large flow of goods from one farm unit to another, such as a farmer selling corn to a hog producer. This intra-sectoral flow of goods also occurs in other rectangles as well, particularly food processing and the wholesale and retail sectors. Also omitted from Figure 1 is imported inputs such as coffee beans. Figure 1 also shows that the food processing industry receives inputs from farms and sends outputs to the wholesale and retail industry for later distribution to consumers and food service providers, or exports its products. The wholesale/retail sector sends its output directly to consumers, to the food service industry, or exports its products. The dashed lines show that households not only consume food products, but they also supply labor to all of the industries in the food chain.

All of the interactions shown in Figure 1 represent flows of income and goods or services throughout an economy. Through the multiplier effect the direct, indirect, and induced effects of these interactions can be estimated by using an *input-output model*.

### **Input-Output Models and the Food System**

If used properly, estimates using input-output models are a valuable tool for assessing the impact of a particular plant, industry, or group of industries on an economy. An input-output model contains a set of equations describing the relationships that link the output of one industry with all other industries in an economy. The U.S. Forest Service has developed a comprehensive input-output model called IMPLAN, which divides an economy into 528 separate industries (Lindall and Olson, 1993). IMPLAN includes data at the county level for all counties in the United States, and these counties can be combined to form regions in any manner desired.

Two important assumptions in IMPLAN, and all other input-output models, require special mention. Input-output models are static, which means that they estimate impacts with given technology and cannot reflect technological changes that occur over time. They also assume that market conditions accurately reflect the purchasing behavior of individuals and businesses in an economy. It is generally considered that IMPLAN provides conservative estimates of economic and employment impacts (Johnson and Wade, 1994).

The food system is difficult to define, especially the farm component, because it includes a preponderance of sole proprietors, family laborers, unpaid labor, dual occupational workers, seasonal labor, contract labor, home-consumed products, and government programs that affect income. Since the farm component is linked to other components of the food industry in a backward direction (through the purchase of inputs) and a forward direction (through the sale of products for processing and distribution), it is easy to double count some of the values used. For example, the value of the output of a food processor has the value of the raw farm product imbedded in it. Counting the value of the farm output along with the value of the output of the food processor would count the value of the raw farm output twice. To portray accurately the impact of the food industry it is important to avoid double counting, and this study has gone to great lengths to avoid this problem.

For the purposes of this study, the food system is defined as:

1. all farm output of crops and livestock, including farm management services,
2. processing of the above products, including food, tobacco products, and alcoholic beverages,
3. distribution activities including transportation, wholesale, and retail sales of food products, and
4. related input sectors, including all production of goods and services for the farm, processing, and distribution activities above.

This definition is a system-wide definition, which means that all activities which add value to farm products are included, regardless of where the raw products originate.<sup>1</sup> Hence, the processing industry includes the value added to food products purchased from out-of-state producers as well as those from Indiana. Likewise, the distribution industry includes value added to food products produced out-of-state but distributed to Indiana consumers. The value of the out-of-state products themselves is not included, nor is the value added to Indiana farm products processed by out-of-state processors considered in this analysis. It is important to understand that this definition of the food industry likely differs from definitions of similar studies in other states. For this reason the reader is advised to consider carefully how the industry is defined before making comparisons with results from other studies.

The impact analysis is conducted for both the state and a rural subset of the state which includes only those counties considered as being rural<sup>2</sup> (Figure 2). This was done because the economies of rural counties are generally less developed than urban counties, and hence may be more vulnerable to economic downturns in a specific industry, including agriculture.

Another feature of IMPLAN merits discussion. It is generally agreed that the farm production data in IMPLAN, which are based on the 1992 Census of Agriculture, suffer from data limitations (Johnson and Wade, 1994). These limitations are similar to those discussed earlier regarding the difficulty in defining the food industry. That is, better estimates can be derived from the model if more accurate data are used. Therefore, farm production and income estimates provided by the Indiana Agricultural Statistics Service were used instead of the IMPLAN data. The food processing and distribution sectors do not suffer from this problem, and therefore the IMPLAN production and income data were used for these sectors. The impact of government payments by farmers through commodity programs are reflected in the model as an increase in household income.

### **Impact Analysis of the Indiana Food System**

IMPLAN divides the economy into 528 industries, but industries of similar characteristics can be aggregated to simplify the analysis and make presentation of the data and results clearer. The model used in this analysis divides the economy into 41 groups of industries. Tables 1 and 2 list the impacts by sector. Sectors 1 through 9 are those industries related to agricultural production; sectors 10 through 15 represent the food processing industries; 16 and 17 represent grocery stores and places that serve prepared foods; 18 and 19 provide inputs primarily for agricultural production; and sectors 20 through 41 represent all other sectors in the economy.

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<sup>1</sup> This definition excludes some industries such as gas stations that sell food items, school cafeteria workers, etc.

<sup>2</sup> The definition of "rural" and "urban" in this analysis differs from the terms "metropolitan" and "nonmetropolitan" as used by the US. Census Bureau and the US Department of Agriculture. "Urban" in this analysis includes all counties with a population greater than 100,000, or those counties with a population greater than 50,000 and population density greater than 100 persons per square mile. Rural counties are defined as those counties that are not urban.

The results are presented in terms of value added, which refers to payments made by industries to workers, interest, profits, and indirect business taxes, and employment. IMPLAN measures the number of jobs rather than full-time equivalency, which makes the employment figures in industries with higher proportions of part-time workers (e.g., food services) appear larger than in those with low proportions of part-time workers. It also contributes to the difficulty in measuring employment in agriculture for reasons discussed earlier. Remember, also, that the estimates provided by IMPLAN are considered conservative.

Table 1 shows the value added and employment effects at the state level, while Table 2 shows the results for the rural counties. Seventy of the 92 counties in Indiana are considered rural. These 70 counties constitute 38 percent of the state's population but 77 percent of the agricultural production. Urban areas have a larger share of value added in food processing, commanding 70 percent of the value added in those sectors combined. Hence it appears that rural areas produce the raw materials, but the processing is done in urban areas.

The analysis indicates that the entire food industry accounts for \$16.7 billion in value added and over 548,000 jobs in Indiana. This translates to 13.3 percent of total value added to all goods and services in the state, and 17.3 percent of employment. In just the rural counties the agricultural and food system is somewhat more important, accounting for 16.0 percent of value added and 19.5 percent of employment. IMPLAN calculates employment as a proportion of income generated in an industry. Those industries which tend to have a greater portion of value added attributed to labor will have a higher jobs to value added ratio. For example, the portion of value added attributed to labor is particularly high in the Eating and Drinking Places industry. The ratio of employment to value added may be high in that industry because of a preponderance of low wage workers, which tends to reduce value added, and part-time workers, which tends to enlarge the employment figures. The farm production industries tend to have higher ratios of employment to value added, implying that much of the value added in agricultural production is attributed to labor. Service industries also typically derive a larger proportion of value from labor. In those industries which derive only a small portion of value added from labor, the ratio will be smaller. The Fats and Oils Processing industry, for example, is highly automated, using very little labor in the production process, and thus has a low ratio of employment to value added. Most manufacturing industries tend to have low ratios of employment to value added.

Figure 3 graphically shows the value added impact of the food system on the state and rural Indiana economies. As a proportion of the economy the farm sector is more than twice as big in rural areas as it is for the state overall, while the food processing sector is 40 percent larger in the state than in rural areas. Figure 4 shows how value added in the food industry compares with total value added in the state and rural economies.

Some of the results may appear puzzling to the reader. For example, the Farm Inputs and Machinery industry appears to generate a relatively small amount of economic activity and employment. Recall that for the purchase of farm inputs to have an impact it must be produced in Indiana. But Indiana does not produce a great deal of farm inputs such as farm machinery, chemicals, and fertilizer. These inputs are produced in other states. However, if the inputs are purchased by farmers from retailers or wholesalers in Indiana, the value added to that input by the merchant is included in the Wholesale and Retail Trade industry.

Large indirect effects relative to induced effects indicates that a particular industry is more closely tied to the food system than to consumer demand. For example, the indirect effects and the induced effects in the Construction industry are of roughly the same magnitude, indicating that the food industry purchases inputs from the construction industry. Other industries which appear to produce inputs to food production processes rather than for consumer demand include Glass, Stone, and Clay; Metal Industries; Machinery and Equipment; and Transportation and Communication. Conversely, in some industries the induced effects are substantially larger than the indirect effects. In the Health Services industry, for example, the induced effects are close to 100 times the magnitude of the indirect effects, indicating that health services are primarily purchased by consumers. Other industries whose impacts appear to reflect final demand by consumers include: Finance and Real Estate; Miscellaneous Services; Recreation and Amusement; and Education.

### **Summary**

The reader is again cautioned that input-output models are subject to some rather restrictive assumptions, and that the results described in this report are only estimates, and most likely conservative estimates. Nevertheless, these results show that the food and agricultural system contributes over \$16.6 billion in income, or 13.3 percent of the state economy, and over 500,000 jobs, or 17.3 percent of total employment. The results also show that rural areas of the state are not that much more dependent on the food industry than the state as a whole, with 16.0 percent of value added and 19.5 percent of employment being attributed to the food and agricultural system. The primary difference between the food industry in rural and urban areas is that rural areas typically produce the raw agricultural product, while the processing and refining of these raw goods is performed in urban areas. Since agricultural commodity prices are generally determined by world markets, rural economies are likely to be more vulnerable to changes in world economic and crop conditions than urban economies. The value of the raw agricultural product represents only a portion of the value of the output of food processors, implying that changes in commodity prices will have less of an impact on prices in the food processing industry.

The production of food has been, and continues to be, an important activity in the economy of Indiana. Changes in technology have allowed fewer and fewer people to produce more and more food, freeing up labor to participate in other sectors of the economy, fueling the economic growth that has occurred in the Indiana and U.S. economies for much of this century. It also helps provide American consumers with the lowest food prices of all industrialized countries, allowing us to use our income to purchase other goods and services, which raises our standard of living. Continued advancements will likely cause the food industry to decline relative to the rest of the economy in the years to come, even while farmers produce more and more food for consumers at low prices.

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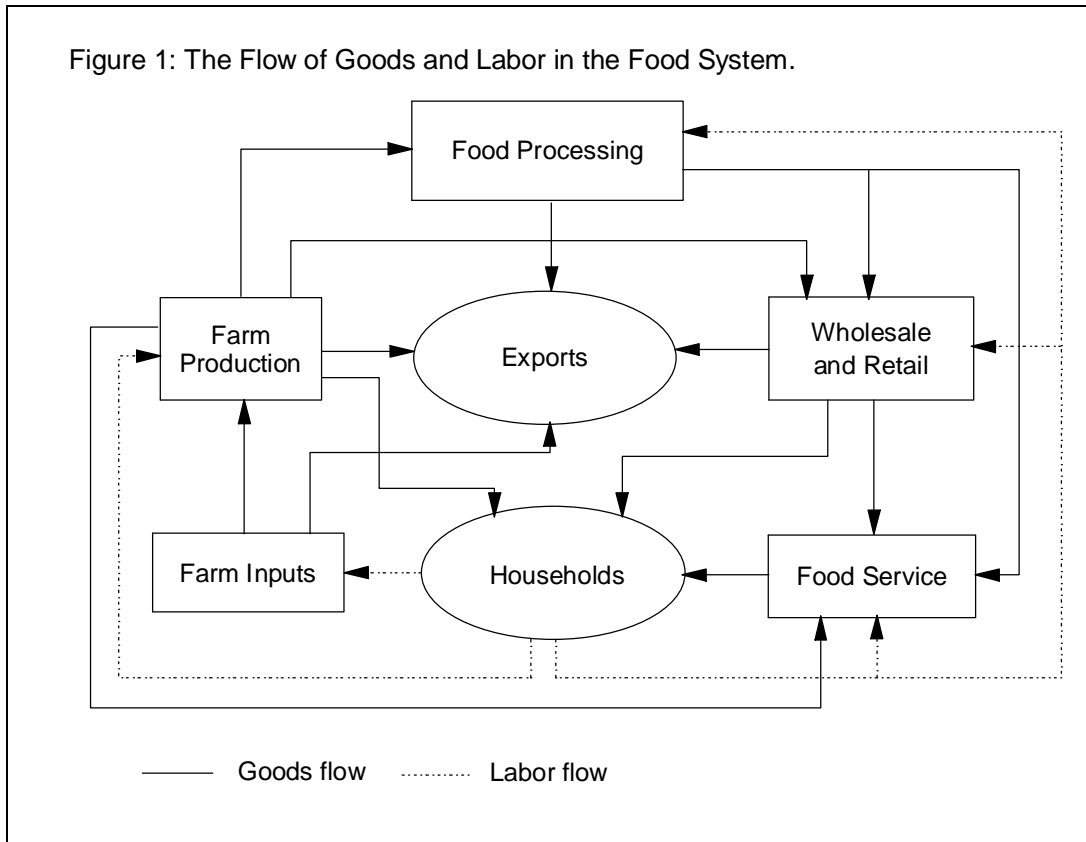


Figure 2: Rural (shaded) Counties in Indiana.



Figure 3: Value Added Impact of the Food and Agricultural System in 1994 in Millions of Dollars.

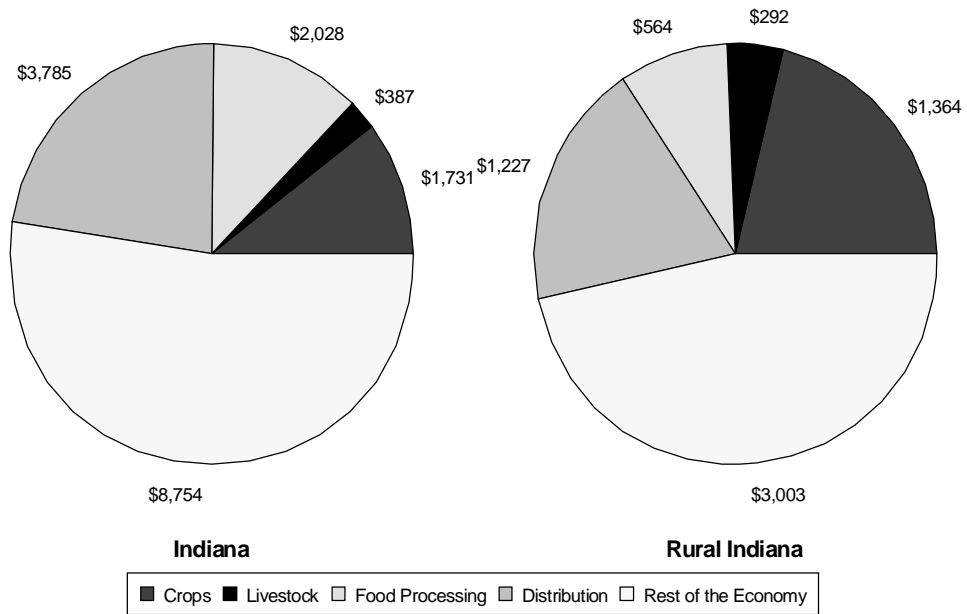


Figure 4: The Food and Agricultural Food System's Contribution to Value Added in Indiana in 1994 in Millions of Dollars.

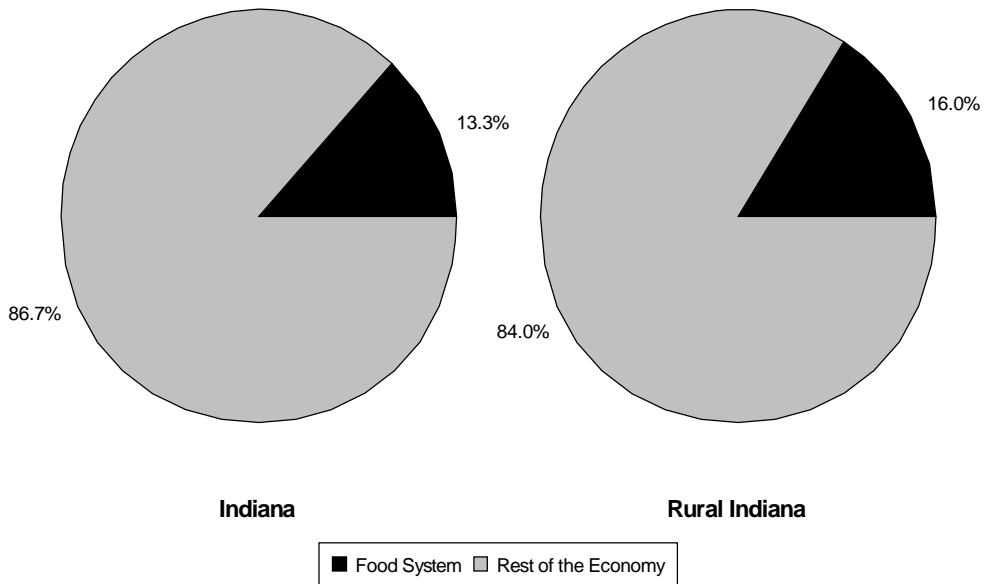


Table 1: Value Added (in millions of 1992 dollars) and Employment Effects for Indiana.

Sector Number	Sector	Direct Effects		Indirect Effects		Induced Effects		Total Effects	
		Value Added	Number of Jobs	Value Added	Number of Jobs	Value Added	Number of Jobs	Value Added	Number of Jobs
1	Dairy Farms	32	1,208	13	401	25	739	70	2,347
2	Poultry And Eggs	80	706	20	481	31	545	131	1,732
3	Cattle	17	4,269	9	485	37	2,233	62	6,988
4	Hogs, Pigs, and Swine	38	5,264	22	992	62	2,939	122	9,196
5	Other Livestock	1	122	0	54	1	11	2	188
6	Food Grains	21	1,223	10	293	20	712	51	2,228
7	Feed Grains	551	16,165	115	2,672	325	8,849	991	27,686
8	Oil Bearing Crops	319	12,422	70	1,796	225	6,680	614	20,898
9	Other Crops	42	1,672	4	123	29	843	75	2,637
10	Processed Meat and Eggs	38	2,008	25	831	39	1,303	102	4,143
11	Dairy Processing	55	705	24	474	27	541	106	1,720
12	Grain and Flour Milling	114	557	91	1,121	57	770	262	2,448
13	Fats and Oils Processing	29	148	25	324	15	201	68	672
14	Soft Drinks and Liquor	456	1,441	97	1,238	91	1,229	644	3,908
15	Misc. Food Processing	498	5,870	149	2,899	199	4,026	846	12,795
16	Food Stores	880	52,989	57	1,902	777	25,785	1,715	80,676
17	Eating & Drinking Places	819	94,490	135	5,528	1,116	46,981	2,070	146,998
18	Ag., Forest, and Fishing Serv's	0	7	33	2,359	0	36	33	2,402
19	Farm Inputs and Machinery	0	1	37	394	5	57	43	452
20	Horticultural and Nursery	0	11	5	242	14	640	20	893
21	Forest Products	0	1	0	1	0	1	0	2
22	Mining	0	0	2	27	2	24	5	51
23	Construction	0	0	115	2,984	128	3,331	243	6,315
24	Fabric Mills and Leather	0	1	0	4	1	31	1	37
25	Misc. Manufacturing	6	145	65	1,611	115	2,828	186	4,584
26	Wood and Paper Processing	0	8	57	1,312	15	354	72	1,675
27	Petroleum and Chemicals	4	47	48	558	233	2,693	286	3,298
28	Glass, Stone, and Clay	0	3	30	585	7	135	37	723
29	Metal Industries	0	4	19	311	11	185	31	499
30	Machinery and Equipment	1	13	20	350	22	391	43	754
31	High Technology Industries	1	18	4	70	66	1,086	71	1,174
32	Transportation Equipment	4	54	6	80	43	609	52	743
33	Transportation and Comm.	6	122	251	5,273	283	5,942	541	11,338
34	Utility Services and Generation	4	24	144	898	233	1,449	381	2,370
35	Wholesale and Retail Trade	25	789	340	10,677	1,363	42,742	1,729	54,208
36	Finance and Real Estate	35	417	307	3,633	1,620	19,166	1,962	23,216
37	Misc. Services	14	630	197	8,775	814	36,170	1,025	45,575
38	Recreation and Amusement	2	124	13	719	98	5,481	113	6,324
39	Health Services	28	745	12	332	1,391	37,110	1,432	38,187
40	Education	3	129	7	276	194	7,660	204	8,065
41	Government	3	97	55	1,839	185	622	243	8,156
Total		4,128	204,652	2,634	64,923	9,923	278,723	16,685	548,299
Percent Attributable to the Food System								13.3%	17.3%

Table 2: Value Added (in millions of 1992 dollars) and Employment Effects for Rural Indiana.

Sector Number	Sector	Direct Effects		Indirect Effects		Induced Effects		Total Effects	
		Value Added	Number of Jobs	Value Added	Number of Jobs	Value Added	Number of Jobs	Value Added	Number of Jobs
1	Dairy Farms	10	943	7	296	12	503	30	1,741
2	Poultry And Eggs	44	2,043	13	537	34	1,047	91	3,626
3	Cattle	231	1,816	8	302	23	860	54	2,978
4	Hogs, Pigs, and Swine	521	3,090	20	654	44	1,519	116	5,263
5	Other Livestock	19	42	0	4	1	19	1	65
6	Food Grains	289	619	7	151	12	312	47	1,082
7	Feed Grains	2709	4,384	50	1,048	94	2,204	414	7,636
8	Oil Bearing Crops	6081	9,557	67	1,389	189	4,441	864	15,387
9	Other Crops	246	384	5	148	10	216	39	748
10	Processed Meat and Eggs	215	1,573	13	483	20	782	54	2,837
11	Dairy Processing	254	339	9	195	9	203	44	736
12	Grain and Flour Milling	83	64	4	69	3	54	15	188
13	Fats and Oils Processing	185	75	11	141	6	82	35	297
14	Soft Drinks and Liquor	0	0	0	0	0	0	0	0
15	Misc. Food Processing	2928	3,303	77	1,581	97	1,982	465	6,865
16	Food Stores	3289	18,604	17	543	241	7,912	586	27,059
17	Eating & Drinking Places	2778	31,387	37	1,466	326	13,575	641	46,428
18	Ag., Forest, and Fishing Serv's	0	6	21	1,430	0	12	21	1,448
19	Farm Inputs and Machinery	0	1	7	145	1	10	8	155
20	Horticultural and Nursery	0	18	7	613	10	865	17	1,496
21	Forest Products	0	1	0	0	0	0	0	1
22	Mining	0	0	1	12	1	17	2	29
23	Construction	0	0	50	1,253	42	1,057	92	2,310
24	Fabric Mills and Leather	0	1	0	2	0	12	0	15
25	Misc. Manufacturing	5	111	22	532	53	1,281	79	1,924
26	Wood and Paper Processing	0	7	21	498	6	151	28	656
27	Petroleum and Chemicals	3	54	9	159	29	510	41	723
28	Glass, Stone, and Clay	0	3	8	151	3	68	11	222
29	Metal Industries	0	5	6	112	5	95	11	213
30	Machinery and Equipment	1	10	11	172	9	141	20	323
31	High Technology Industries	1	18	2	39	28	494	31	551
32	Transportation Equipment	3	47	3	41	13	190	18	278
33	Transportation and Comm.	5	104	107	2,334	100	2,171	212	4,608
34	Utility Services and Generation	3	18	49	287	94	553	146	859
35	Wholesale and Retail Trade	199	646	99	3,384	423	14,483	541	18,513
36	Finance and Real Estate	333	295	108	972	539	4,864	679	6,131
37	Misc. Services	114	496	60	2,677	258	11,410	329	14,583
38	Recreation and Amusement	2	103	3	178	39	2,168	44	2,449
39	Health Services	228	591	11	291	435	11,699	468	12,581
40	Education	3	111	2	100	63	2,776	68	2,988
41	Government	3	101	21	852	63	2,540	87	3,492
Total		2,1421	80,967	974	25,241	3,334	93,279	6,450	199,486
Percent Attributable to the Food System								16.0%	19.5%