

Agriculture's Bounty

The Economic Contribution of Agriculture

Research conducted by

Indiana Business Research Center, Kelley School of Business, Indiana University



KELLEY SCHOOL OF BUSINESS

INDIANA UNIVERSITY

Indiana Business Research Center

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Executive Summary

It is hard to miss the importance of Indiana agriculture. Take a short drive in any direction from any of Indiana's cities, and farms and forests dominate the view. Not only are the fields, barns and trees nice to look at, but they also contribute mightily to Indiana's economy.

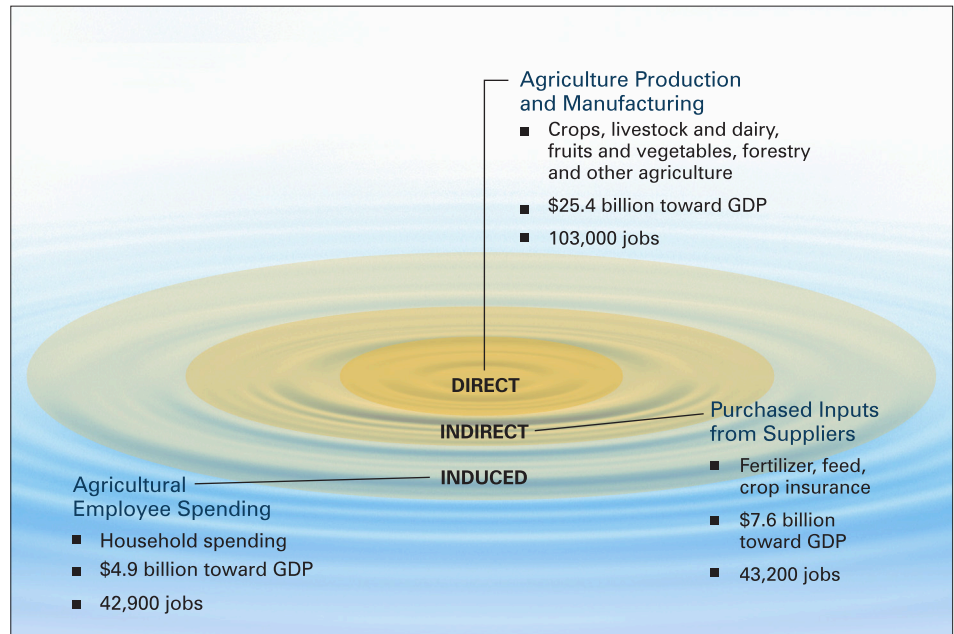
The agriculture industries, broadly defined to include the production of crops, livestock and wood—as well as the manufacture of processed agricultural goods—contributed \$25.4 billion to the Hoosier economy in 2011. (All values are in 2011 dollars or 2011 dollar equivalents.) Slightly more than half of that contribution was captured by processed and manufactured agricultural goods, with primary agricultural production of crops, livestock and wood accounting for the balance.

The ripple effects from Indiana's primary agricultural production and processing activity accounted for another \$12.5 billion in economic output. More specifically, the agricultural industries spurred an estimated \$7.6 billion in additional economic activity in the state through the purchase of inputs from Indiana-based suppliers. The paychecks linked to the households of agriculture-related employees supported another \$4.9 billion in economic output.

The combined \$37.9 billion in total economic output also supported nearly 190,000 Hoosier jobs.

Approximately 103,000 jobs were directly related to agricultural (including forestry-related) production and processing. The purchase of production inputs from Indiana-based suppliers supported an estimated 43,200 additional jobs in the state, while the household spending of direct and indirect

Figure 1: Economic Ripple Effect of Agriculture in Indiana



Source: IBRC, using WISER Trade and ERS data from the USDA

workers accounted for another 42,900 jobs.

Indiana, known for quality hardwoods, can boast that more than 35,500 workers were attached to sawmills and furniture production establishments scattered around the state.

By industry, grain and oilseed farming accounted for more than half of all workers in Indiana agriculture industries—more than 84,000 jobs. Grain farming alone accounted for better than one-third of the state's direct agriculture employment, and the ripple effects of Indiana's grain production supported an estimated 17,680 additional jobs around the state.

Grain production also dominated agriculture's contribution to Indiana GDP (or value added). The combined effects of grain production totaled an estimated \$3.2 billion in value added,

which accounted for one-quarter of the agricultural total and represented 1.2 percent of Indiana GDP. The direct and ripple effects of oilseed farming in the state totaled \$2.1 billion, while wet corn milling ranked third with nearly \$1.3 billion in value added.

After grain and oilseed farming, hog (and other animal) production had the next largest total employment impact with 16,930 jobs. Wet corn milling accounted for another 13,150 jobs.

The economic activity related to Indiana agriculture and forestry generated an estimated \$970 million in state and local revenue and nearly \$1.5 billion in federal collections. ■

Agriculture Industry's Production Trends

Indiana has a rich heritage of farmland and forestry production. Agriculture—defined to include both farm and forest production—plays an integral part in the state's economy. Agriculture utilizes a vast amount of Indiana's territory: approximately 83 percent of Indiana's acres are devoted to either farms (14.7 million acres) or forests (4.7 million acres). This report tells the tale of Indiana's agriculture production trends and the changing dynamics of the agriculture industry.

Agricultural data are collected and disseminated by the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS). Indiana Business Research Center (IBRC) analysts used these data to determine the levels of production, quantity sold or marketed, and the value of crop and livestock output. NASS, like the Census Bureau and other federal statistical agencies that collect potentially sensitive data, suppresses some statistics to maintain the confidentiality of producers if reporting production numbers could reveal competitive information. IBRC analysts captured as comprehensive a picture of agricultural goods as the data allowed. That said, public data were not available for all commodities (e.g., ducks, maple syrup and snap peas). Data on forest production—i.e., logging quantities—were obtained from the U.S. Forest Service. The analysts used logging values, also referred to as stumpage, from the Purdue University Department of Forestry and Natural Resources' annual analysis of the prices and trends of Indiana's forest product.

Defining Agriculture

What constitutes agriculture may seem straightforward, but, in practice, defining agriculture can

be complicated. Because many agricultural outputs serve as inputs to other products both within and outside of primary agricultural production (crops and livestock), the analysis can get complicated. Take, for example, a farmer in Washington County who raises corn, beans and hay in addition to feeder steers bought from a local cow/calf operation. A portion of the corn crop will feed the feeder steers, as will most of the hay. The remainder of the row crop will be sold to the local grain elevator and could end up being used in ethanol production, consumer food products, feed for other animals in the region or even exported out of the country. As a primary agricultural commodity becomes more processed on its way to becoming an eventual final product for consumption, a question emerges: what industry sectors should be included under the agriculture industry umbrella?

The IBRC analysts reviewed other similar studies¹ to glean insights and devise a master list of appropriate industries that can, without too many mental contortions, be considered related to agriculture. The appendix presents a detailed explanation, but, in general terms, one could measure the economic impact value of a state's agriculture industry by including primary commodity agriculture (crop and livestock production), core processing (manufacturing industries

¹ See Terance J. Rephann, "The Economic Impact of Agriculture and Forestry on the Commonwealth of Virginia," Weldon Cooper Center for Public Service, September 2008, www.dof.virginia.gov/info/resources/2008-09_Econ-Impact-Agriculture-Forestry.pdf and Sharon P. Kane and John C. McKissick, "Economic Importance of Food and Fiber in the Georgia Economy, 2008," Center for Agribusiness and Economic Development and College of Agricultural and Environmental Sciences, Center Report: CR-10-02, February 2010, <http://athenaeum.libs.uga.edu/bitstream/handle/10724/18659/CR-10-02.pdf?sequence=1>.

“Approximately 83 percent of Indiana's acres are devoted to either farms (14.7 million acres) or forests (4.7 million acres).”

heavily dependent on Indiana's primary agriculture or forestry outputs), extended processing (manufacturing industries less dependent upon agriculture and forestry outputs sourced in Indiana) and distribution (warehousing and wholesaling industries). IBRC analysts were interested in including those industries that had a material primary agricultural content. Due to the small amount of Indiana agricultural inputs used by the extended processing and distribution industries, the analysts chose primary and core processing agriculture and forestry industries for this report.

Value of Raw Agricultural Commodities

Raw, unprocessed, agricultural commodities such as corn, soybeans, timber and calves are homogenous products that are graded to indicate quality. Quality, in turn, affects the prices received by the producer for the commodities. Agricultural commodities are typically reported by production quantities (e.g., bushels, head, pounds, board feet). This is done to provide consistency in comparison efforts, as even within a given year prices for these

Market Prices

The prices received from producers varied considerably between 2003 and the end of 2012, with especially volatile price swings occurring after 2007. Row crops have seen the largest gains in prices and at a quicker rate than for livestock products, which may be attributed to increased demand for corn for ethanol in addition to fulfilling international market's demand for grains and oilseeds. Since January 2003, the prices received for all crops has increased by 123.5 percent, by 75 percent for livestock products and by 103 percent for all agricultural products.

commodities can vary considerably. This has been particularly true the past five to six years as producers have witnessed large swings in the market (see sidebar). Analysts used market prices to calculate the value of Indiana's agricultural production and estimate the economic impact of agricultural output.

Agricultural Commodities

Indiana's fertile soils are a critical component in the state's ability to produce large quantities of grains and oilseeds on its farm lands. The ag-friendly state has also encouraged livestock production, resulting in the presence of large dairy, hog and expanding aquaculture (fish farm) operations. The output of primary agricultural commodities varies each year due to weather patterns, forecasted demand, input costs (mostly feed for livestock) and producers' crop rotation practices.

Table 1 outlines the various agricultural production sectors and their output and value for 2011 to the extent that data were available. Production is the measure for volume. Value reflects both per unit prices and output volume. The data reflected represent what was available as of December 2012.

Table 1: Indiana Agricultural Production and Value, 2011

Agriculture Production Industries	Production Volume (thousands of units)	Value of Production (thousands \$)
Crops		
Grains (bushels) Includes oats, wheat and non-silage corn	864,727	\$13,872,230
Oilseeds (bushels)	238,050	\$2,761,380
All Other Crops (pounds) Includes peppermint and spearmint	734	\$19,292
Livestock and Dairy		
Pigs and Hogs (pounds)	1,755,434	\$1,093,908
Poultry and Eggs (head/eggs) ¹	6,514,413	\$1,000,731
Dairy Milk Production (pounds)	3,539,000	\$743,190
Cattle and Calves (pounds)	202,294	\$204,738
Other Animal Production (pounds) ^{2,3} Includes sheep and aquaculture	5,750	\$6,607
Fruits and Vegetables		
Fruits (pounds) ⁴ Includes cantaloupe, watermelon, blueberries, apples and peaches	381,200	\$58,012
Vegetables (pounds) ⁵ Includes sweet corn, tomatoes, cucumbers, snap peas	498,900	\$48,329
Forestry and Other Agriculture		
Logging (cubic feet)	85,916	\$400,540
Greenhouse, Nursery and Floriculture (operations) ⁶	568	n/a

¹ Production volume is predominantly egg (99.5 percent), yet eggs only comprise 42.2 percent of the total value.

² Excludes goats and horses due to lack of production data. Only inventory data were available.

³ Aquaculture production and value numbers for 2011 were estimated from available sources (2007 Census of Agriculture and news reports). 2011 estimated figures were compared against the 2002 figures (2002 Census of Agriculture).

⁴ 2011 peaches' figures were suppressed.

⁵ 2011 snap peas' figures were suppressed.

⁶ 2007 data (most recent data) and the figure represents 568 operations, not 568,000 operations.

Source: IBRC, using data from USDA and NASS

2010 and 2011: A Note about the Data

The IBRC analysts used the most recent comprehensive data for agriculture production volume and market prices by commodity, both of which are for the year 2011 (by NASS). For employment and inter-industry relationship detail, however, analysts used 2010 data embedded in the IMPLAN data and modeling software, the most recent available at the time of the analysis. While there is a one-year disparity in the NASS data and the internal IMPLAN data, there would be no material difference from 2010 to 2011 in terms of the production functions, employment requirements and inter-industry relationships that are used to estimate the economic impact of primary agricultural commodity output and secondary industry processing of agriculturally-related goods. This is because, in the absence of profound changes in production technology from one year to the next, economic impacts for agriculture—the most important being jobs and GDP—are more dependent on physical production volume rather than on market prices that are subject to vagaries of weather, fuel mandates, subsidies and other policies. In short, when this report presents data for 2010, these data are not expected to be materially different from data for 2011. Therefore, the data in the report should be considered as 2011 equivalents.

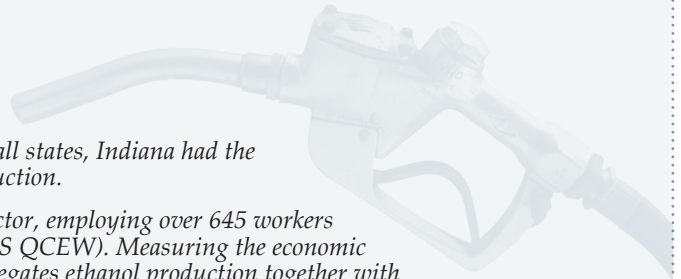
Ethanol Production

In 2011, 13.6 billion gallons of ethanol were produced in the United States from 209 biorefineries. Within Indiana, 13 ethanol-producing plants churned out approximately 1.1 billion gallons of ethanol. Among all states, Indiana had the fourth-largest operating capacity and ranked fifth in actual ethanol production.

Ethanol production plays an important role in the state's agricultural sector, employing over 645 workers in the state in 2011 with an average annual wage exceeding \$55,000 (BLS QCEW). Measuring the economic impact of ethanol using IMPLAN is complicated because IMPLAN aggregates ethanol production together with miscellaneous organic chemical production.

Informa Economics[§] conducted a study that reports the ethanol industry created 3,575 jobs within the state and generated approximately \$3.4 billion annually in economic activity from ethanol and its interlinked industries. For each direct ethanol industry job, 4.9 additional jobs were created within Indiana, meaning that the total employment multiplier effect (direct, indirect and induced) was 5.9. The industry contributes a net \$520 million toward the state's gross state product annually with \$257 million in household income, including farmer income. In addition, ethanol production and related economic activity generates an additional \$47 million in state and local taxes. Ethanol production also creates valuable by-products like distillers dried grain with solubles (DDGS) which can be fed to livestock as an economical feed ingredient alternative.

[§] Informa Economics, "Economic Impact of the Ethanol Industry on Indiana's Economy," Indiana Corn Marketing Council, 2012.



In 2011, the commodity with the greatest amount of output was eggs (approximately 6.5 billion) followed by milk (3.5 billion pounds). However, the commodities that had the highest total production value were grains, namely non-silage corn, followed by soybeans (oilseeds). Indiana produces more agricultural goods than what is displayed in **Table 1**, but data are not publicly available for all production. As a result, the production values and volume are not reported for ducks, broilers, aquaculture, horses, sheep, goats, snap peas, peaches and other miscellaneous vegetable production such as pumpkins.

Forest Land: Logging of Timber

Indiana is known for quality hardwoods, and sawmills and furniture production establishments throughout the state employ more than 35,500 workers. The Indiana Department of Natural Resources estimated that nearly 88 percent of logs processed in Indiana in 2010 were also harvested in the state.² Moreover, despite increasing

population and development, the quantity of forest land has increased over the years, allowing Indiana to continue its timber harvesting without sacrificing forest land growth. Eighty-four percent of Indiana's forest land is privately owned and is heavily populated with oaks and hickories (71.7 percent) and elm, ash and other cottonwood trees (13.6 percent). In 2011, approximately 85 billion board feet were harvested from Indiana's forests despite the slump in prices witnessed in the past few years.³ ■

“In 2011, the commodities that had the highest total production value were grains, namely non-silage corn, followed by soybeans (oilseeds).”

² William L. Hoover and Jeffrey Settle, "Indiana's Hardwood Industry: Its Economic Impact," December 2010, www.in.gov/dnr/forestry/files/foHrdwd_Imp_2010.pdf.

³ P.D. Miles, "Forest Inventory EVALIDator web-application version 4.01 beta," St. Paul, MN; U.S. Department of Agriculture, Forest Service, Northern Research Station, <http://apps.fs.fed.us/fido/index.html>.

Economic Contributions of Agriculture and Forestry

The economic contribution of Indiana agriculture extends beyond the commodities produced on farms and in forests. A Hoosier grain farmer, for instance, buys a range of production inputs from other Indiana businesses. From fertilizers and fuels to trucking and accounting services, the economic ripple effects from these supply chain purchases cascade through the state economy. Furthermore, Indiana agriculture production provides the inputs for a host of processing and manufacturing industries.

The IBRC analysts used the IMPLAN economic modeling software to estimate the total economic effects of Indiana agriculture, broadly defined. The IMPLAN model draws from a variety of secondary data sources to provide a detailed account of the Indiana economy. For example, the model indicates that Indiana sawmills purchase nearly 40 percent of their production inputs from other Hoosier establishments. The estimated economic effects of these supply chain purchases are reported in the “indirect effects” columns in the following tables. Additionally, workers in agriculture production and processing industries—as well as employees at supplier firms—spend their earnings on food, housing, health care, entertainment, etc. The estimated ripple effects from this household spending are presented in the “induced effects” columns.⁴

For this analysis, the research team considered two types of activities—primary agricultural production and processing (or

⁴ See the appendix for a more detailed explanation of the key terms used in this report.

Table 2: The 2011 Economic Contributions of Agriculture and Forestry to Indiana’s Economy

	Direct Effects	Indirect Effects	Induced Effects	Total	Multiplier
Total Output (\$ million)					
All Agriculture and Forestry	\$25,401	\$7,581	\$4,911	\$37,893	1.49
Production	\$12,247	\$4,293	\$3,002	\$19,542	1.60
Processing and Manufacturing	\$13,154	\$3,288	\$1,909	\$18,351	1.40
Value Added (\$ million)					
All Agriculture and Forestry	\$5,661	\$4,189	\$2,987	\$12,837	2.27
Production	\$3,935	\$2,243	\$1,827	\$8,005	2.03
Processing and Manufacturing	\$1,725	\$1,947	\$1,160	\$4,832	2.80
Employment					
All Agriculture and Forestry	102,700	43,200	42,900	188,800	1.84
Production	82,000	20,100	24,800	126,900	1.55
Processing and Manufacturing	20,700	23,100	18,100	61,900	2.99

Source: IBRC, using data from the USDA and the IMPLAN economic modeling software

manufacturing). Primary production refers to the activities that typically come to mind when one thinks of agriculture, such as growing crops, raising livestock, logging, etc. Within the North American Industry Classification System (NAICS), agricultural production activities refer to any industry classified in sector 11, with the exception of fishing, hunting and trapping. The processing and manufacturing activities are those that use primary agricultural commodities as inputs. These industries are classified under NAICS sectors 31 or 32. Examples of these industries include grain milling, milk and butter manufacturing, and veneer and plywood manufacturing.

Summary of Economic Contributions

As a group, Indiana’s agriculture and forestry-related industries of both primary commodity and processing

activities generated an estimated \$25.4 billion in direct economic output in 2011, as presented in the first section of **Table 2**.⁵ This level of direct economic output, which is analogous to the value of farm production together with the sales of manufactured goods, is split about evenly between farm and forest production (48 percent of the total) and processing and manufacturing (52 percent).

Indiana’s agricultural industries spurred an estimated \$7.6 billion in additional economic activity in the state through the purchase of inputs from Indiana-based suppliers. The paychecks linked to the households of agriculture-related employees supported another \$4.9 billion in economic output. All told, the total

⁵ Please see the sidebar on page 3 for a discussion on the reasons for the change in the year reported from 2011 to 2010 in terms of economic effects.

economic footprint of Indiana’s agriculture and forestry industries was \$37.9 billion.

The concept of the economic multiplier offers a useful way to interpret these ripple effects. The ratio of total effects (that include all the ripple effects) to direct output yields a multiplier of 1.49, meaning that each dollar of output generated by Indiana’s agriculture and forestry establishments, both primary and manufacturing, stimulates another \$0.49 in economic activity in the state.

While the economic output measure is useful in that it provides an approximate tally of all industry-related sales, this metric can result in an inflated estimate of the industry’s contribution to the economy. The potential for double counting becomes manifest if the sales of multiple industries that are inter-related are aggregated. The cases of agricultural commodity processing and primary commodity

production—for example, corn production and corn milling industries—are particularly problematic. Milling operations buy a portion of Indiana’s corn production, which they use as an input to produce oils, sweeteners, starches, etc. The value of the corn is counted twice if the final sales of these industries are added together. The sale of raw corn is counted as a final good, but then is included as an input in the sale of a processed good like livestock feed or tortillas. These types of supply linkages are present throughout agriculture and forestry.

The IBRC analysts adjusted the IMPLAN model to eliminate these intra-agriculture relationships within Indiana and, thus, avoid the double counting that would otherwise be reported in the indirect and induced effects. However, these adjustments solve the *modeling* problem in generating robust estimates for value added and employment

(which removes the value of “double counted” production inputs), but do not remove the double counting *reported* in direct output. As a result, the value added and employment numbers offer the better measures of the industry’s contributions to the Indiana economy.

In contrast to the concept of output, value added in the IMPLAN framework is the same as the official measure of gross domestic product at the national or state level. As shown in the second section of **Table 2**, Indiana’s agriculture and forestry-related establishments combined to generate an estimated \$5.7 billion in direct value added. This level of activity sparked an additional \$7.2 billion in indirect and induced effects throughout the state to bring the industry’s total value added impact to nearly \$13 billion. The state’s total value added (GDP) was roughly \$267 billion, which means that the combined effects of agriculture

Table 3: Agriculture and Forestry’s Contribution to Indiana Employment, Top 15 Industries

	Direct Effects	Ripple Effects*	Total	Multiplier
Grain Farming	37,170	17,680	54,850	1.48
Oilseed Farming	17,190	12,110	29,300	1.70
Hogs and Other Animal Production#	13,730	3,200	16,930	1.23
Wet Corn Milling	1,270	11,880	13,150	10.35
Animal Processing (Except Poultry)	5,910	7,040	12,950	2.19
Support Services for Agriculture and Forestry	6,780	2,340	9,120	1.35
Poultry Processing	3,080	2,370	5,450	1.77
All Other Food Manufacturing	2,040	2,940	4,980	2.44
Soybean and Other Oilseed Processing	630	4,030	4,660	7.40
Fluid Milk and Butter Manufacturing	1,610	2,850	4,460	2.77
Poultry and Egg Production	910	3,060	3,970	4.36
Dairy Cattle and Milk Production	2,200	1,560	3,760	1.71
Flour and Corn Meal Milling and Malt Manufacturing^	590	3,150	3,740	6.34
Veneer and Plywood Manufacturing	1,770	1,150	2,920	1.65
Sawmills and Wood Preservation	1,620	1,240	2,860	1.77
All Other Industries	6,260	9,550	15,810	2.53
Total	102,760	86,130	188,890	1.84

* Ripple effects refer to both indirect and induced effects.

“Other animal production” refers to sheep, goats, aquaculture, etc. Cattle and poultry production are separate industries.

^ A large percentage of dry corn milling is used for corn starch manufacturing, not for ethanol production.

Source: IBRC, using data from the USDA and the IMPLAN economic modeling software

Table 4: Agriculture and Forestry’s Contribution to Indiana Value Added, Top 15 Industries

	Direct Effects (\$ million)	Ripple Effects* (\$ million)	Total (\$ million)	Multiplier
Grain Farming	\$1,182	\$2,030	\$3,212	2.72
Oilseed Farming	\$1,184	\$920	\$2,104	1.78
Wet Corn Milling	\$ 314	\$942	\$1,257	4.00
Hogs and Other Animal Production [#]	\$537	\$245	\$782	1.46
Animal Processing (Except Poultry)	\$269	\$494	\$763	2.84
Poultry and Egg Production	\$187	\$257	\$443	2.38
Soybean and Other Oilseed Processing	\$121	\$317	\$439	3.62
Dairy Cattle and Milk Production	\$272	\$163	\$435	1.60
All Other Food Manufacturing	\$205	\$210	\$415	2.03
Support Services for Agriculture and Forestry	\$248	\$154	\$402	1.62
Fluid Milk and Butter Manufacturing	\$171	\$203	\$374	2.19
Flour and Corn Meal Milling and Malt Manufacturing	\$81	\$266	\$348	4.28
Poultry Processing	\$133	\$165	\$298	2.25
Paperboard Mills	\$139	\$151	\$290	2.09
Logging	\$134	\$106	\$240	1.79
All Other Industries	\$484	\$551	\$1,035	2.14
Total	\$5,661	\$7,176	\$12,837	2.27

* Ripple effects refer to both indirect and induced effects.

[#] “Other animal production” refers to sheep, goats, aquaculture, etc. Cattle and poultry production are separate industries.

Source: IBRC, using data from the USDA and the IMPLAN economic modeling software

and forestry accounted for nearly 5 percent of Indiana’s GDP.

As for employment, there were nearly 103,000 jobs in Indiana directly related to agricultural production and processing. The purchase of production inputs from Indiana-based suppliers supported an estimated 43,200 additional jobs in the state while the household spending of direct and indirect workers accounted for another 42,900 jobs. In all, the total employment footprint of agriculture and forestry-related industries in the state was nearly 189,000 jobs. The ratio of total employment effects to direct employment gives a multiplier of 1.84. In other words, every 100 jobs directly related to Indiana agriculture and forestry industries support an additional 84 jobs in the state.

Economic Contributions by Industry

More than half of all Indiana agriculture and forestry workers were engaged in grain or oilseed farming (see **Table 3**). Grain farming alone accounts for better than one-third of the state’s direct agriculture employment. The ripple effects of Indiana’s grain production supported an estimated 17,680 additional jobs around the state while oilseed farming sustained an estimated 12,110 additional jobs in other non-agriculture industries. In total, these two industries were responsible for more than 84,000 jobs. Among other agriculture industries, hog (and other animal) production had the next largest total employment impact (16,930 jobs) followed by wet corn milling (13,150), non-poultry animal

processing (12,950) and agricultural support services (9,120).⁶

Several agricultural processing industries have the largest employment ripple effects. Wet corn milling, for instance, has an employment multiplier above 10, while soybean processing and flour milling are not far behind at 7.4 and 6.3, respectively. These industries, along with others in agriculture processing, are among Indiana’s most production-input-intensive industries, meaning that they have long supply chains but produce their output with relatively few direct employees.

Grain and oilseed production also dominate agriculture’s contribution to Indiana value added, as shown in **Table 4**. The combined effects of

⁶ See the appendix for a listing of total economic and employment contributions for each industry considered in this analysis.

grain production totaled an estimated \$3.2 billion in value added, which accounts for one-quarter of the agricultural total and represents 1.2 percent of Indiana GDP. The direct and ripple effects of oilseed farming in the state were \$2.1 billion, while wet corn milling ranked third with nearly \$1.3 billion in combined value added.

Contributions to Government Revenues

The economic activity generated by Indiana’s agriculture and forestry industries also produces revenue streams for federal, state and local governments. The IMPLAN model estimates the tax revenues from corporate profits, indirect business taxes (e.g., sales, property and excise taxes), personal taxes (e.g., income and property taxes), and employer and employee contributions to social insurance. The largest share of federal revenue comes from contributions to social insurance. At the state and local level, indirect business taxes are the largest source of government revenue. As **Table 5** shows, the economic activity related to Indiana agriculture and forestry generated an estimated \$970 million in state and local revenue and nearly \$1.5 billion in federal collections.

Conclusion

It is hard to miss the importance of Indiana agriculture. Within a short drive in any direction from Indiana’s cities, farms and forests dominate the view. It is pretty, but there is also significant economic value in those fields and trees. This report has attempted to establish the economic connection between what is grown from the soil and livestock raised in barns to everyday products—food, clothes, fuel, household furnishings—and Hoosier livelihoods.

The value of Indiana’s agricultural production in the past decade has increased substantially for most primary commodities. This has been caused by increased domestic and worldwide demand for agricultural products and byproducts, leading to sustained high prices. Attempts to increase output, however, have often been hampered by the weather (for crops), high input prices (for livestock), soft demand or increased competition (for furniture). As the

world’s population grows and the fortunes of developing countries improve, there will be still greater pressure to increase production even as resources and territory become scarcer.

It is understandable why Indiana’s agricultural industries have been encouraged to expand in the past decade. Hoosier agricultural industries contributed \$25.4 billion to the economy, of which 51.8 percent was captured by processed and manufactured agricultural goods and the remainder by primary agricultural production. The ripple effects from Indiana’s agricultural production and processing activity are notable. The combined effects of these activities generated \$37.9 billion in economic output in 2011.

The pastoral scenes along Indiana highways are more than just fields of corn and soybeans or barns of hogs and chickens. Those scenes represent the livelihoods of some 190,000 Hoosiers. ■

Table 5: Tax Effects of Indiana’s Agricultural and Forestry, 2011 (\$ Million)

	Direct Effects	Indirect Effects	Induced Effects	Total
State and Local	\$277.7	\$392.4	\$299.5	\$969.6
Federal	\$610.1	\$500.7	\$369.4	\$1,480.3

Source: IBRC, using data from the USDA and the IMPLAN economic modeling software

Appendix

Data Sources

Every five years, the USDA conducts an agriculture census (currently in years ending in two or seven), which includes a wealth of data on the nation's agriculture industry. NASS is the primary vehicle for disseminating these surveys and is also responsible for annual producer surveys to maintain current data on the agriculture industry in between census years. The data collected represents raw production data and does not include processed agricultural products. For direct employment data, the research team relied on the employment numbers for each industry in the 2010 IMPLAN model for Indiana. IMPLAN derives these numbers primarily from Bureau of Economic Analysis and USDA data, and they cover both wage and salary workers and the self-employed.

Defining Agriculture and Forestry

One challenge in this analysis was deciding which collection of industries properly defines agriculture and forestry. The selection of production industries is straightforward; the research team simply included all industries in sector 11 of the NAICS industry classification scheme with the exception of fishing, hunting and trapping (subsector 114). The NAICS subsectors for production included in this study are crop production, animal production, forestry and logging, and support activities for agriculture and forestry.

The selection of processing and manufacturing industries was trickier. There have been several studies similar to this one conducted in other states. Some have used very broad definitions of agriculture that include nearly all types of food, fabric

and wood product manufacturing, while others have attempted to focus their analysis on processing industries that are most closely tied to the farm or forest. The IBRC research team selected the latter approach so as not to inflate the impact estimates with industries that have little direct link to Indiana agriculture.

The research team used the IMPLAN model to help distinguish which industries it considered primary agricultural processing and manufacturing. The IMPLAN model features production functions for each industry, which are akin to a recipe of the production inputs that each industry needs to produce its output. These production functions also include regional purchase coefficients (RPCs), which are estimates of the share of each production input that is supplied by other Indiana firms. The research team used the RPCs to calculate for each industry the share of production inputs that are sourced from Indiana. A large share of the inputs for Indiana's cheese makers, for instance, come from Indiana-based agriculture production, while only a tiny share of the inputs for local tortilla makers come directly from state agriculture production.

The research team settled on a 7 percent threshold, meaning that a processing or manufacturing industry is considered part of agriculture and forestry if at least 7 percent of its production inputs come directly from Hoosier farms or forests. We chose this threshold for two reasons: there was a large break in the values of the ranked list of industries at this point and it began to make intuitive sense to exclude the industries just below this level. The first industries excluded were snack food manufacturing, seasoning and dressing manufacturing, and paper

mills. **Table 6** lists each industry that was included in this analysis along with each industry's total contribution to Indiana output, value added and employment (total effects = direct + indirect + induced effects).

Adjustments to the IMPLAN Model

As mentioned in the body of the report, the research team adjusted the IMPLAN model to eliminate double counting in the estimates of indirect and induced effects. Without adjustments, the economic activity and employment related agricultural industries would be double counted when these industries supply production inputs to one another. Researchers followed the procedures outlined by MIG, Inc. to avoid double counting when conducting multi-industry contribution analysis. These adjustment procedures are online at "Estimating the Contribution of a Current Industry Using IMPLAN Version 3.0" (https://implan.com/v4/index.php?option=com_multicategories&view=article&id=660:660&Itemid=14). Note that there is still some double counting when the direct output of multiple industries are added together because the value of production inputs are embedded in the output figures.

Key Terms

- **Direct Effects:** Refers to the increase in final demand or employment in Indiana that can be attributed specifically to agriculture or forestry.
- **Indirect Effects:** A measure of the change in dollars or employment caused when agricultural producers increase their purchases of goods and services from suppliers and, in turn, those suppliers purchase more inputs and so

Table 6: Total Economic and Employment Contributions of Each Agriculture and Forestry Industry

Description	Total Output (\$ million)	Total Value Added (\$ million)	Total Employment
Oilseed Farming	\$4,321	\$2,104	29,290
Grain Farming	\$8,879	\$3,212	54,850
Vegetable and Melon Farming	\$181	\$101	1,180
Fruit Farming	\$21	\$12	280
Tree Nut Farming	n/a	n/a	n/a
Greenhouse, Nursery and Floriculture Production	\$258	\$162	1,800
Tobacco Farming	n/a	n/a	n/a
Cotton Farming	n/a	n/a	n/a
Sugarcane and Sugar Beet Farming	n/a	n/a	n/a
All Other Crop Farming	\$34	\$15	2,300
Cattle Ranching and Farming	\$364	\$97	1,810
Dairy Cattle and Milk Production	\$1,116	\$435	3,770
Poultry and Egg Production	\$1,650	\$443	3,970
Hogs and Other Animal Production	\$1,568	\$782	16,930
Forest Nurseries, Forest Products and Timber Tracts	n/a	n/a	n/a
Logging	\$574	\$240	1,670
Support Activities for Agriculture and Forestry	\$579	\$402	9,120
Flour Milling and Malt Manufacturing	\$1,147	\$348	3,740
Wet Corn Milling	\$4,431	\$1,257	13,140
Soybean and Other Oilseed Processing	\$3,104	\$439	4,670
Fluid Milk and Butter Manufacturing	\$1,333	\$374	4,460
Cheese Manufacturing	\$188	\$36	540
Dry, Condensed, and Evaporated Dairy Product Manufacturing	\$379	\$89	980
Ice Cream and Frozen Dessert Manufacturing	\$611	\$203	2,500
Animal (Except Poultry) Slaughtering, Rendering and Processing	\$3,432	\$763	12,940
Poultry Processing	\$1,006	\$298	5,440
Seafood Product Preparation and Packaging	\$0	\$0	0
All Other Food Manufacturing	\$1,064	\$415	4,980
Sawmills and Wood Preservation	\$478	\$151	2,860
Veneer and Plywood Manufacturing	\$406	\$166	2,920
Reconstituted Wood Product Manufacturing	\$9	\$4	40
Paperboard Mills	\$763	\$290	2,720
Total	\$37,893	\$12,837	188,890

Note: n/a indicates that there was no production in these industries in 2010.
 Source: IBRC, using data from the USDA and the IMPLAN economic modeling software

on throughout the economy. A corn milling operation, for instance, will buy inputs from a supplier. Those suppliers buy electricity to power their plants, buy material inputs for their products, and employ people to run the equipment. These

transactions are the indirect ripple effects associated with the corn milling operation’s purchases.

- **Induced Effects:** These reflect the changes—whether in dollars or employment—that result from the household spending

of agricultural employees and their suppliers. Induced spending will increase or decrease as output changes along the economic supply chain. For example, as a farm’s production and sales increase, the output of its supply chain

increases correspondingly. Those output changes also result in changes in household income and spending of suppliers' employees. Induced effects represent the change in overall economic output and employment resulting from such household spending changes.

- **Total Effects:** The total of all economic effects is the size of the economic impact and is the sum of the direct, indirect and induced effects.
- **Tax Effects:** The IMPLAN model tracks the tax effects associated with all the transactions and economic activity associated with the direct and ripple effects. For example, household spending at retailers generates state sales tax. In addition, those retailers pay property taxes to local governments. As a result, this analysis was also able to estimate the federal, state and local government tax flows.
- **Multiplier:** The multiplier is the magnitude of the economic response in a particular geographic area associated with a change—either an increase or a decrease—in the direct effects. For example, multiply every dollar of agricultural and forestry output by 1.49 to find an estimate of the total contribution of this activity to Indiana's economy. Another way to look at it is that every dollar of output supports \$0.49 in additional economic activity in the state.
- **Output:** The value of an industry's total production. Output includes both the price of production inputs and the value added of the industry.
- **Value Added:** Also known as gross domestic product (GDP), value added is the difference between an industry's total output and the cost of its

production inputs. Value added consists of four components: employee compensation, proprietor income, other property income and indirect business tax.

About IMPLAN Economic Impact Modeling Software

MIG, Inc. (formerly the Minnesota IMPLAN Group) is the company responsible for developing IMPLAN data and software. Using classic input-output analysis, IMPLAN can be used to measure the economic effects of an economic event, such as a factory closing or a new plant opening, or the size of the economic footprint of an economic entity like a production facility, headquarters or university.

The Economic Theory Behind IMPLAN

IMPLAN is built on a mathematical input-output (I-O) model that expresses relationships between sectors of the economy in a chosen geographic location. In expressing the flow of dollars through a regional economy, the input-output model assumes fixed relationships between producers and their suppliers based on demand. It also omits any dollars spent outside of the regional economy—say, by producers who import raw goods from another area or by employees who commute and do their household spending elsewhere.

The idea behind input-output modeling is that the inter-industry relationships within a region largely determine how that economy will respond to economic changes. In an I-O model, the increase in demand for a certain product or service causes a multiplier effect, layers of effect that come in a chain reaction. Increased demand for a product affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and so on, ultimately generating a

total effect in the economy that is greater than the initial change in demand. Say demand for Andersen Windows' wood window products increases. Sales grow, so Andersen has to hire more people, and the company may buy more from local vendors, and those vendors in turn have to hire more people ... who in turn buy more groceries. The ratio of that overall effect to the initial change is called a regional multiplier and can be expressed like this:

$$\frac{(\text{Direct Effect} + \text{Indirect Effects} + \text{Induced Effects})}{(\text{Direct Effect})} = \text{Multiplier}$$

Multipliers are industry and region specific. Each industry has a unique output multiplier, because each industry has a different pattern of purchases from firms inside and outside of the regional economy. (The output multiplier is in turn used to calculate income and employment multipliers.)

Estimating a multiplier is not the end goal of IMPLAN users. Most wish to estimate other numbers and get the answers to the following questions: How many jobs will this new firm produce? How much will the local economy be affected by this plant closing? What will the effects be of an increase in product demand? Based on those user choices, IMPLAN software constructs "social accounts" to measure the flow of dollars from purchasers to producers within the region. The data in those social accounts will set up the precise equations needed to finally answer those questions users have—about the impact of a new company, a plant closing or greater product demand—and yield the answers.

IMPLAN constructs its input-output model using aggregated production, employment, and trade data from local, regional, and national sources, such as the U.S. Census Bureau's annual *County Business Patterns* report, and the U.S. Bureau of Labor Statistics' annual report

called *Covered Employment and Wages*. In addition to gathering enormous amounts of data from government sources, the company also estimates some data where they haven't been reported at the level of detail needed (county-level production data, for instance), or where detail is omitted in government reports to protect the confidentiality of individual companies whose data would be easily recognized due to a sparse population of businesses in the area.

IMPLAN's accessibility and ease of use also make it a target of criticism by some economists, who charge that in the wrong hands, the software—or any input-output model—will produce inflated results at best, and at worst, completely ridiculous projections. Anyone can point and click their way to an outcome without fully understanding the economics in which the tool is grounded and without knowing how to look at data sets with a nuanced

eye. The IBRC has two analysts that have attended advanced training in the use of the IMPLAN modeling software. The estimates that the IBRC analysts generate are pressure-tested and triple-checked to ensure that they are accurate and reflect the most trustworthy application of the modeling software. In all instances, the most conservative estimation assumptions and procedures are used to produce the IMPLAN results. ■

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