Economic Impacts of Fall Commercial Nutrient Regulation

Daniel Otto
Economics Professor and Extension Economist, ISU
March, 2008

Introduction

Concern that nutrient (nitrogen (N) and phosphorus (P)) runoff are seriously contributing to hypoxia in the Gulf of Mexico has led some environmental groups to call for the banning of fall fertilizer applications; especially fall anhydrous ammonia. However, restricting fertilizer application to only the spring season has agronomic as well as economic implications for farmers in the Midwest.

Fall application can help improve the availability of nutrients like P and K because they generally move only short distances (a few mm to a few cm) from the depth of placement in silt loam to clay soils. A fall fertilizer application allows more time for surface-applied and incorporated, or shallow-placed P and K to penetrate into the root zone. Better nutrient availability and higher yield potential can result.

Fall fertilizer application can lighten the labor and equipment load at spring planting when time is precious. Trying to balance unpredictable weather with fertilization and other field chores has potential to complicate planting schedules. Also, fertilizer dealers often work closely with customers in developing long-term soil fertility strategies that can benefit from fall application. That way, dealers can plan operations and schedule personnel, equipment, and storage for improved efficiencies and utilization rates in their schedules.

Post-harvest (fall) application can minimize soil compaction. In wet conditions more typical in the spring, tractors, tillage and application equipment cause compaction in the fields. Packing the soil impairs its natural aeration and water-holding capacity. Fields are normally drier in the fall, so there is less risk of damaging the soil structure. If structure damage or soil compaction does occur near the soil surface (e.g. top 4-6 inches), the natural winter freezing and thawing cycle(s) can help “repair” the soil before the next crop season.

In addition to the agronomic arguments, there are economic benefits for fall fertilizing. Compressing all fertilizer applications into the spring season would require agri-businesses to expand capacities for fertilizer storage and application equipment. Additional fieldwork in the spring could also lead to significant planting delays for farmers resulting in lower yields and economic returns. Lower yields, in turn, result in lower nutrient uptake by the crop, leaving more residual nutrients to discharge in the environment.

Identifying and estimating the economic impact that a fall fertilizer ban would have on the agricultural economy and the Iowa state economy in general is the purpose of this study. Two areas of particular concern will be investigated:

1. The cost of additional storage facilitates, equipment and labor costs required to concentrate the application in the spring.
2. The economic loss to the farm sector of the potential reduction in yield.

A fall nutrient ban is most likely to focus on N. The current pattern of fertilizer application has many farmers applying NH_3 (anhydrous ammonia) in the fall. Proper fertilizer Best Management Practices (BMPs) for applications of NH_3 is include delaying application until soil temperatures at the 4 to 6-inch depth are consistently below the 50 degree F range. (Snyder et al.).[1] The ammonia applied at these temperatures reacts with the soil moisture to form ammonium, which is held on soil catrion exchange sites and slowly converts to nitrate (NO_3). Ammonium (NH_4) and nitrate (NO_3) are the two forms of N available for plant root uptake when soil temperatures rise in the spring. Given the high profile of corn in the current cropping patterns with its high fertilizer requirements, this ban would shift the fall fertilizer application to the spring and require additional storage capacity near the end use markets. The logistics of getting necessary fertilizer supplies in place for spring planting takes significant lead

---

[1] *Snyder, C.S., G.W. Randall, R.E. Lamond, and R.G. Hoeft, "Fall Nitrogen Management for Agronomic Response and Environmental Protection,"* *<u>Fall Fertilization Facts 2001: Opportunities and Considerations,</u>* *PPI, 2001*

time and would require investment in new facilities to store supplies near farms and additional distribution, handling, and application equipment so that the crop acres in Iowa and a number of other Midwestern states can be serviced in a timely manner. This strain on the infrastructure for fertilizer delivery could also hamper the spring supply, distribution, and application of fertilizer in regions where fall applications of P, K, and NH_3 are not as common.

State historical data show the three major commercial forms of N: NH_3 (anhydrous ammonia), urea (a dry material) and UAN (a urea ammonia nitrate liquid solution) represent 53%, 11% and 24 % of the annual N nutrient applications respectively. The N components in DAP (di-ammonium phosphate) and MAP (mono-ammonium phosphate) represent 8% and 2% of Iowa's annual N applications. Collectively, these three major N sources and the two phosphate sources represent 99% of the annually applied N derived from commercial fertilizer. When we look at fall applications, we find that NH_3, DAP and MAP account for the majority of fall applied N. Of the total N applied in the fall months within Iowa NH_3, DAP and MAP represent 75%, 15% and 4% respectively. Hence, these three fertilizers account for 94% of all fall applied commercial N and P. State data show that NH_3 represents 41% of the spring N applications while the dry urea and liquid UAN represent 16% and 35% of the spring N applications, respectively. A ban on fall applied commercial fertilizer specifically targeting N sources would include NH_3, DAP and MAP. Eliminating the fall applications of dry phosphate materials DAP and MAP would also indirectly impact the 62% of annual potassium (potash) that is typically applied in a simultaneous application with the phosphate. So, not only would a ban shift the fertilizing schedule to the spring, but the N source and timing of potash application also may change. Rather than NH_3, urea or liquid UAN may become the fertilizer of choice for spring-only applications. Due to their simultaneous application relationship potash applications would shift to the spring with the phosphate application.

To ensure adequate supplies of fertilizer are available in the spring would require additional storage facilities as well as inventory costs for holding supplies for up to 6 months. The bottom line on additional annual storage costs for space rental or amortizing of capital investments for new facilities, interest and insurance costs is in excess of \$75 million and could approach \$100 million using the current spring 2008 fertilizer prices (Table 1).

Concentrating fertilizer application in the spring will also strain the capacity of the distribution and application system as well. The expected annual costs for additional fertilizer holding and application capacity from a fall fertilizer ban are estimated as $322.34 million and are summarized in Table 1.

Table 1. Additional Storage, Handling, and Application Costs.

Storage Related Costs	$75,000,000	to $100,000,000
Handling Costs		
Inbound Costs	$47,467,711	(labor included)
Mixing/Blending	$6,412,160	(labor included)
Tendering	$61,984,211	(labor included)
Application	$206,476,269	(labor included)
Total Additional Costs	$322,340,351	
Total	**$397,340,351**	to $422,340,351

From the general economy's perspective, constructing new storage facilities is new economic activity with a stimulative effect. However, the expenditure is a cost for the sector bearing it. The $397.34+ million represents additional costs of production in agriculture that would be borne by farmers and rural communities.

These additional costs are likely to end up in the ag business and farm level as higher costs of production and lower returns. these costs are likely to be passed on to the famer as the agribusinesses recover their costs over time in the form of higher charges to farmers. By shifting the costs to the farmers, the result is higher costs of production which in turn leads to lower farm income. The bottom-line result is that the additional costs come out of farmer's profits, reducing net farm income for Iowa farmers and leaving fewer dollars to spend in the local rural and state economy. The secondary impacts to the Iowa economy resulting from this $397.3 million of lost farmer income are estimated using an Input-Output model of the Iowa economy.

Table 2 summarizes the estimated economic impacts in Iowa. These are annual economic losses that would result from the farm sector needing to absorb the additional costs of focusing fertilizer applications in the spring. Total negative impacts (including the initial $397.3

million) are $542.6 million of lost sales, $125.6 million of lost income, $237.3 million of losses to the gross state product, and 4,200 jobs. This means that because Iowa farmers are not able to spend the $397.3 million on farm and personal expenses, these secondary business owners also have less to spend. The estimate of the subsequent rounds of these transactions totals to $145.3 million.

Total lost spending is the sum of these two components, or $542.6 million in Iowa. Our model estimates that this level of spending would support 4,200 jobs with $125.6 million of earnings.

Table 2. Economic Impact of $397.3 Million of Additional Fertilizer Costs.

Sectors	Total Sales	Labor Income	Value Added to GDP	Jobs
Agriculture and Mining	$4,693,522	$664,882	$1,104,232	34
Utilities	$10,953,063	$2,788,978	$7,506,047	40
Manufacturing	$37,949,328	$5,650,926	$9,092,223	106
Transportation & Warehousing	$8,497,886	$3,666,288	$4,685,926	88
Wholesale & Retail Trade	$94,687,224	$38,296,296	$61,381,408	1,337
Finance, Insurance & Real Estate	$49,484,888	$12,610,399	$28,315,626	318
Professional Services	$97,492,976	$45,325,324	$54,211,924	1,251
Other	$238,870,376	$16,641,042	$71,028,824	1,027
Total	**$542,629,263**	**$125,644,135**	**$237,326,210**	**4,201**

Source: IMPLAN Model for Iowa.

Impacts of Less Timely Spring Planting

A major benefit of fall fertilizer application is saving precious field days in the spring when delays in planting can lead to significant yield reductions and losses in revenues. In the Iowa latitudes, May 10th is the critical last planting date for corn after which yields begin to decline. Field trials by Iowa State University (ISU) at several sites throughout central Iowa document this pattern (Figure 1). Planting delayed two weeks result in a 10% reduction in yields and a delay of 4 weeks would lead to a 25% yield reduction.

With this May 10 deadline in mind, farmers are anxious to use all suitable field days toward getting their crop planted. Using those suitable spring days for applying fertilizer reduces days available for planting. The expected outcome from the potential delays is a reduction in yields and income losses for Iowa farmers, which translate into large income losses to the state.

In the spring prior to May 10, farmers can typically expect 15 days suitable for field work. (Tables A1 and A2). The actual weather patterns are probabilistic. If 5 days are used with spring fertilizer applications, this leaves 10 days for planting. The potential impacts on yields can be illustrated for a representative farmer with 1,500 acres of corn and 1,500 acres of soybeans. Table 3 summarizes the impacts of this scenario. With a 12-row planter and a 12 hour day, this farmer can plant 138 acres per day. Eleven days would be needed to finish the corn planting on 1,500 acres. With a comparable number of soybean acres to be planted in this window of suitable days, delayed planting will occur for a portion of each crop or all of either crop would be delayed. If we assume both corn and soybean planting are delayed 10 days, corn yield losses are 1.2 bushels per day and soybean reductions are .46 bushels per acre per day. For this 3,000 acre corn-soybean farmer, a 10 day planting delay would result in a loss of 17,940 bushels of corn and 6,900 bushels of soybeans. At $5.00/bu corn and $12.00/bu bean prices, these losses would total $89,600 for corn and $75,900 for the bean crop for this farmer with 1,500 acres in each crop.

Applying these potential losses from late planting to the entire 14 million acres of corn and 8.8 million acres of soybean in Iowa add up to significant, large economic losses. If half these acres are subjected to planting delays, the costs are $42 million per day of planting delay for corn producers and $23.7 million per day of planting delay for soybean producers. If we assume a total of 10 days of planting delays, total losses in the Iowa ag sector sums to $657 million.

These losses come after all input costs are incurred so they translate directly into lower incomes for farmers. Lower incomes mean losses in spending on farm equipment, improvements and personal expenditures. These secondary impacts to the Iowa economy from the lost income can be estimated using an Input-Output model. Table 3 presents our estimate of the annual impacts of these losses to the Iowa economy. Under these assumptions, the total annual estimated losses include over $900 million of lost sales, $212.5 million of lost income, almost $400 million of lost gross state product, and over 7,000 fewer jobs. The initial $657 million of lost income and spending by Iowa farmers result in $353 million of lost secondary spending.

Table 3. Expected Iowa Economic Impact of $657 Million of Lowered Farm Income Associated with late planting, Caused by Potential Bans on Fall Fertilizer Application

Sectors	Total Sales	Labor Income	Value Added to GDP	Jobs
Agriculture and Mining	$7,800,096	$1,104,133	$1,834,334	56
Utilities	$18,312,316	$4,666,471	$12,544,333	68
Manufacturing	$63,145,794	$9,413,660	$15,142,586	177
Transportation & Warehousing	$14,237,644	$6,154,926	$7,864,062	147
Wholesale and Retail Trade	$164,695,237	$66,864,434	$106,669,736	2,306
Finance, Insurance & Real Estate	$82,624,528	$21,046,942	$47,312,076	531
Professional Services	$162,724,072	$75,599,970	$90,443,964	2,086
Other	$396,319,601	$27,689,470	$118,042,169	1,708
Total	**$909,859,289**	**$212,540,005**	**$399,853,261**	**7,079**

Source: IMPLAN Model for Iowa.

Farmers with smaller acres would have scaled-down equipment that would result in a similar potential of 1.2 bu per acre loss per each day of corn planting delay. There may be some distributional issues of these losses which would not be shared proportionally across all farmers in the state. Farmers may have different priorities for access to services.

If all states implemented this ban, the loss in yield and output would lead to some corn price increases that would help offset the output loss. However, if only Iowa institutes this fall nutrient ban, the price adjustment would be smaller resulting in a net effect of Iowa producers being at a production economic disadvantage to their neighboring state’s producers.

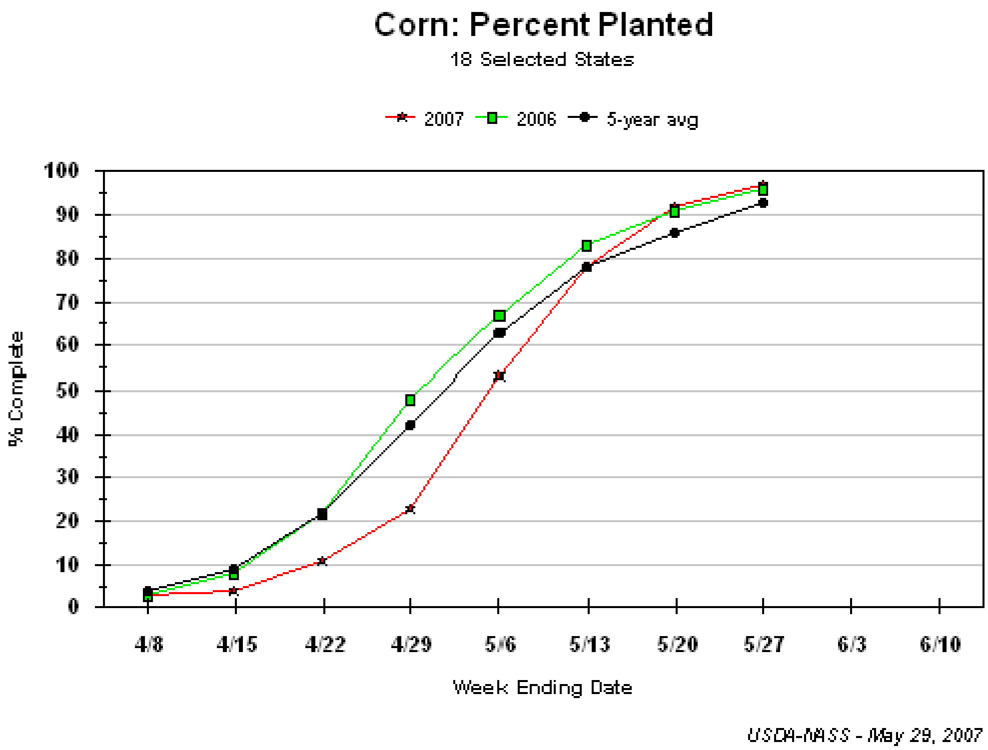

Figure 1.

Corn Yield Response to Planting Date-ISU

Date	Relative Yield Potential (%)
April 20-May 5	100
May 13-May 19	99
May 26-June 1	90
June 10-June 16	68
June 24-June 28	52
*Average of 3 locations: Nashua, Ames, and Lewis for 1998-2000.	

Summary

A ban on fall commercial fertilizer applications within the state of Iowa will have the effect of increasing production costs for Iowa farmers, lower expected corn and soybean yields and revenues. Removing the fall opportunity for fertilizer applications would concentrate all application in the spring, which would require additional storage, handling and application capacity. These annual costs are estimated at $397.3 million.

Concentrating the fertilizer application in the spring would shorten the number of expected field days available for spring work and lead to expected planting delays. Planting delays in Iowa past May 10 results in significant yield losses. Based on current prices and expected corn and soybean yield losses from planting delays, expected economic losses to farmers would total an additional $657 million.

These direct losses of $397 million of expanded capacity costs and $657 million of lost yield effects would result in fewer secondary benefits from dollars being spent in the rural economy. Including these projected secondary effects suggests that annually, a total of $1.45 billion worth of sales would be lost in the Iowa economy. This level of sales supports over 11,000 jobs and $338.1 million of labor income. Table 4 summarizes these findings.

Table 4. Economic Study – Summary Findings.

	Sales	Labor Income	Jobs
Additional Est. **COTS** for 100% Spring Application:			
Storage related costs	$75 million		
Handling/Equipment	$322 million		
Secondary Impact: Loss of sales, income, GDP, jobs	$146 million		
TOTAL	$543 million	$125 million	4,200
Potential **REVENUE LOSS** due to 100% Spring Application:			
Impact of Delayed Planting	$657 million		
Secondary Impact: Loss of sales, income, GDP, jobs	$252.8 million		
TOTAL	$909.8 million	$212.5 million	7,079
TOTAL Est. Economic ($) Sales Impact	**$1.453 billion**	**$337.5 million**	**11,079**

Appendix Table A1 Days Suitable for Fieldwork, Iowa.

Estimated Number of Days Suitable for Fieldwork in Iowa
Median Values, by Crop Reporting District
PM1874 ISU Ext. 2006

Week	NW	NC	NE	WC	C	EC	SW	SC	SE	State Avg
4/2-4/8	2.6	1.1	2	3.4	3.1	2.6	3.8	2.8	2.5	2.8
4/9-4/15	3.3	2.7	3	3.8	3.8	3.2	3.8	2.5	2.7	3.3
4/16-4/22	4.3	3.7	3.7	4.4	3.9	3.7	4.6	3.2	2.8	3.7
4/23-4/29	4.2	3.9	4.2	4.4	4	3.9	3.9	3.2	3.5	3.7
4/30-5/6	4.8	4.4	4.7	4.6	4.1	4.4	3.8	3.7	3.9	4.4
5/7-5/13	4.7	4.2	4.6	4.8	4.1	4.7	4.5	3.9	4.6	4.3
5/14-5/20	5	5.2	5.4	5.3	5.4	5.1	5.5	5	5	5.2
5/21-5/27	4.8	4.7	4.9	4.8	4.6	4.8	3.7	3.4	4.2	4.5
5/28-6/3	4.8	4.5	4.6	4.4	4.6	5.4	4.4	3.7	4.2	4.5
SUM	38.5	34.4	37.1	39.9	37.6	37.8	38	31.4	33.4	36.4
4/2-6/3	39.8	37.3	37.9	37.4	37.1	37.1	36.1	31.2	29.6	35.5

Counties in Iowa's Nine Crop Reporting Districts

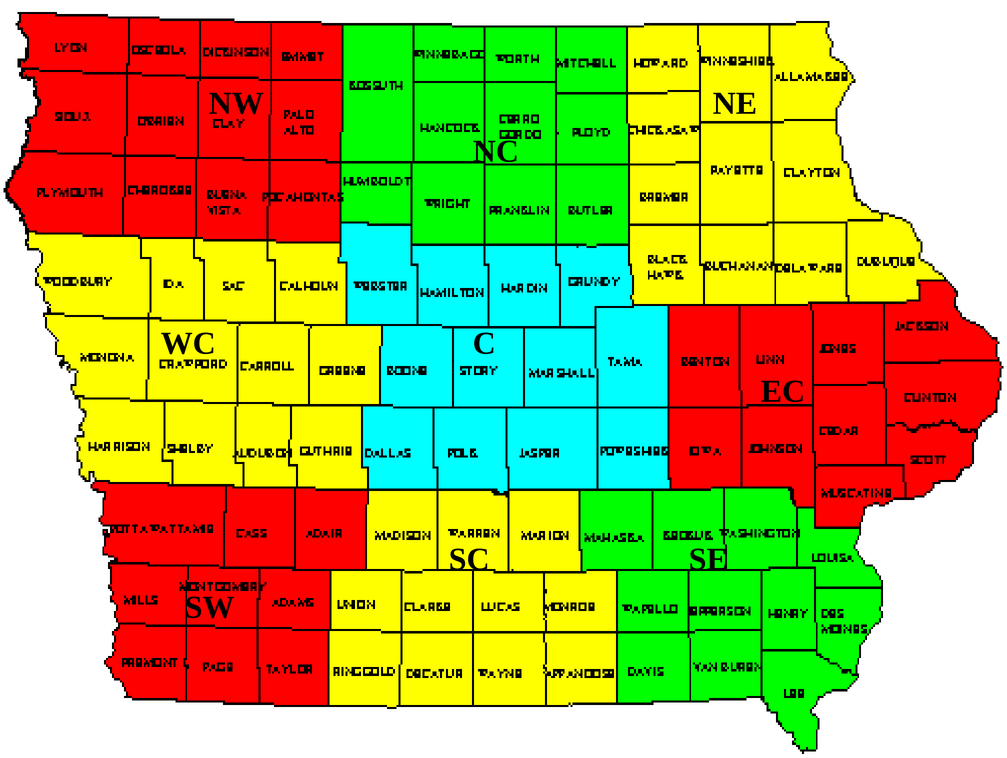

Table A2- Suitable Planting Days, Iowa.

	Crop	Planting Window	Total Acres	Suitable Days	Ac/Day	Ac/Hr	Hr/Day	Bu/Ac Loss	Price/Bu	Lost Income/Day
4/9-4/29	corn	21	1500	11	138	11.5	12	13	$ 5	$ 8,960
4/16-5/6	beans	22	1500	12	125	11.5	12	5	$ 12	$ 7,500

Week	WC	C	EC	SW	SC	SE	Avg
4/2-4/8	3.4	3.1	2.6	3.8	2.8	2.5	3.0
4/9-4/15	3.8	3.8	3.2	3.8	2.5	2.7	3.3
4/16-4/22	4.4	3.9	3.7	4.6	3.2	2.8	3.8
4/23-4/29	4.4	4.0	3.9	3.9	3.2	3.5	3.8
4/30-5/6	4.6	4.1	4.4	3.8	3.7	3.9	4.1
5/7-5/13	4.8	4.1	4.7	4.5	3.9	4.6	4.4
5/14-5/20	5.3	5.4	5.1	5.5	5.0	5.0	5.2
5/21-5/27	4.8	4.6	4.8	3.7	3.4	4.2	4.3
5/28-6/3	4.4	4.6	5.4	4.4	3.7	4.2	4.5
SUM	39.9	37.6	37.8	38.0	31.4	33.4	36.4

PM1874 ISU Ext. 2006

Appendix B - IMPLAN Input-Output Model Documentation

The traditional indicators which economists use for measuring the economic importance of an activity include the size of its workforce and payroll, its capital investment and its local purchase of goods and services. Economists call these the ’direct expenditures’ or ‘direct effects’.

Direct effects refer to the operational characteristics (employment, payroll, sales) of the sectors that we studied. Indirect effects measure the value of supplies and services that were purchased directly by the sector from businesses and firms within the region. Induced effects occurred when workers in the direct and indirect industries spent their earnings on goods and services from other vendors within the region. Induced effects are also often called ‘household effects’. The total economic impact effect is the aggregate of the direct, indirect, and induced effects. It is the total effect on the economy of transactions that are attributable to the direct economic activity of the sectors.

But the workers and the vendors who receive those direct expenditures don’t bury them in a mattress. They will spend some of the money, save some of it and thus begins the journey by which the dollars travel through many hands before they finally leave the economic region. Economists call this phenomenon the ‘multiplier effect’. The multiplier factor is calculated by dividing the sum of the direct, indirect and induced effects by the direct effect.

The multiplier effect for any economy or industry is examined using an ‘input-output analysis’. The tool was devised by the 1973 Nobel Prize winning economist Wassily Leontief. It uses a matrix that measures inter-industry relations in an economy, and shows how the output of one industry becomes the input for another. The most widely used regional input-output economic impact tool is the IMPLAN model developed and distributed by Minnesota IMPLAN Group, Inc. (MIG). According to MIG, the model is currently in use by more than 1,000 public and private institutions.

Mechanics of the Input-Output Model

An input-output 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.

The model is 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 or contribution to state gross domestic product is the measure of the economic product that an industry or collection of industries produce. It is simply the payments that are made to labor (wages and salaries), business owners (proprietors or simple partnerships), investors (paid as interest, dividends, or rents), and the indirect tax payments made to government that are part of production activity.

- Jobs, the fourth measure, represent the number of positions in the economy, not the number of employed persons.

We also get detailed breakdown of this data into direct, indirect, induced, and total economic effects. Direct effects refer to the operational characteristics of the firm that we are studying. Indirect effects measure the value of supplies and services that are provided to the direct firm by industries in the region. 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 that we are measuring.

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 businesses 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.

This study employed the latest version of the IMPLAN model, modified by staff at Iowa State University to calibrate the magnitude of these secondary impacts in Iowa.