



Economic Contribution of the Agbioscience Industry: Central Minnesota

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

Authored by Brigid Tuck and Neil Linscheid



PROGRAM SPONSORS: AGRICULTURAL UTILIZATION RESEARCH INSTITUTE (AURI), NORTHWEST MINNESOTA FOUNDATION, WEST CENTRAL INITIATIVE, INITIATIVE FOUNDATION, SOUTHWEST INITIATIVE FOUNDATION, AND SOUTHERN MINNESOTA INITIATIVE FOUNDATION

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April 2015

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ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: CENTRAL MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Central Minnesota. Central Minnesota includes the 14 counties served by the Initiative Foundation. The study builds on the work of Battelle Technology Partnership Practice, which defines agbioscience and identifies four platforms for additional investment and development.

- *Composition of Agbioscience in Central Minnesota:* In 2013, agbioscience companies in Central Minnesota directly created an estimated \$2.0 billion of economic activity, which represents 4 percent of all regional output. Agbioscience in the region is based primarily on food production and wood and paper product manufacturing. Growth sectors (measured by employment) include fruit and vegetable canning, distilleries, and paper mills. Sectors with job losses include engineered wood member manufacturing, hardwood veneer and plywood manufacturing, and cheese manufacturing. Central Minnesota is responsible for 12 percent of Greater Minnesota's total agbioscience output.
- *Agbioscience Platforms:* Of the four agbioscience platforms identified by Battelle, the value-added food and health platform is the largest in the Central region. Businesses in the platform directly produced an estimated \$1.1 billion in output. In comparison, the biobased industrial products platform produced \$779.0 million, the resilient, efficient, and productive agricultural systems platform \$197.4 million, and the microbial agbioscience platform \$118.2 million. However, it was the microbial agbioscience platform that grew the fastest between 2003 and 2013, adding nearly 100 jobs, which is a 35 percent increase. Components of the agbioscience industry can be included in more than one platform.
- *Production Agriculture:* Production agriculture is not included in this study's definition of agbioscience; however, it is important to the success of the industry. In Central Minnesota, production agriculture created an estimated \$3.0 billion, or 6 percent, of output in the region. Together, production agriculture and agbioscience companies create 10 percent of output in the region.
- *Direct Effect of Agbioscience:* In 2013, agbioscience companies in Central Minnesota directly generated an estimated \$2.0 billion of output (sales). The companies employed 3,180 workers and paid an estimated \$246.6 million in salaries, wages, and benefits. The average annual compensation per agbioscience employee is approximately \$78,000.
- *Total Contribution of Agbioscience:* In 2013, the agbioscience industry in Central Minnesota supported an estimated \$2.8 billion of output across all industries in the region, including output from supplier industries and those that benefit from spending by agbioscience workers. Based on this broad measure, the industry supported an estimated 8,940 jobs and \$474.0 million of labor income.
- *Top Industries Impacted:* The contribution of the agbioscience industry in Central Minnesota is strongest in the industries of wholesale trade, grain farming, dairy cattle and milk production, and electric power.
- *Future Growth and Development:* During the past 10 years, employment in the agbioscience industry in Central Minnesota has grown by 13 percent. If the trend continues with a growth rate of 10 percent through 2016, the economic contribution of the agbioscience industry in the region will increase to an estimated \$3.1 billion in output, 9,840 jobs, and \$521.5 million in labor income. During the same time period, the total number of jobs across all industries in the Central region increased by 7 percent. Evidence indicates the region has nearly recovered from the Great Recession of 2008-2009.



INTRODUCTION

Agbioscience is “a broad continuum of activity in the development, production, and value-added use of plant and animal organisms for food, health, fuel, and industrial applications” (Battelle Technology Partnership Practice and BioDimensions, February 2013, p. 10). Minnesota has a long history of being a leader in the field of agriculture and science, leaving the state with a strong agbioscience industry. In fact, many of Minnesota’s most iconic firms are associated in some way with this industry, and all regions of Minnesota have firms and institutions participating in agbioscience.

The Agricultural Utilization Research Institute (AURI), along with the Minnesota Corn Research and Promotion Council and the Minnesota Soybean Research and Promotion Council, recognizes the importance of this industry and recently contracted with Battelle Technology Partnership Practice to capture the current status of the industry in Minnesota, as well as its potential for growth and opportunities for advancement. The findings were published in the 2013 Battelle report “Agbioscience as a Development Driver: Minnesota’s Agbioscience Strategy.” In the report, Battelle, in consultation with industry leaders in Minnesota, identified four platforms worthy of additional investment and development within the state. These platforms include the following: microbial agbioscience; resilient, efficient, and productive agricultural systems; biobased industrial products; and value-added food and health products.

The Battelle report is a useful tool for decision-making at the state level. However, translating its findings into meaningful knowledge at regional and local levels can be a challenge, especially when it pertains to how the agbioscience industry can be leveraged for economic development. Particularly, certain regions of the state may be poised to become leaders in particular platforms, based on the strengths of the individual region within the agbioscience industry.

Economic development is an interaction between communities and firms, so it’s important community and regional leaders understand the key regional effects of the agbioscience industry. This report is intended to begin bridging the gap between the statewide results of the Battelle report and the regional specifics that local and regional decision makers need about agbioscience. Aware of the economic contribution agbioscience brings to a region, decision makers are more equipped to take actions on the latent advantages of the region in agbioscience.

This report focuses on the economic contribution of the agbioscience industry in Central Minnesota. It explores the current economic contribution of the industry, past industry trends in employment, and the potential for future growth and development of agbioscience in the region. Additionally, the economic contribution of agbioscience by region and by platform is included in this analysis. In

supplement to this publication, other reports will be published examining the agbioscience industry individually in each of the six Initiative Foundation regions in Minnesota. A report examining the agbioscience in Greater Minnesota will also be available.

*Minnesota’s Four Agbioscience Platforms:
Microbial Agbioscience
Resilient, Efficient, and Productive Agricultural Systems
Biobased Industrial Products
Value-Added Food and Health Products*

Agbioscience in this report includes components of the manufacturing, wholesale trade, and professional and business services industries. The definition of agbioscience includes specific, well-

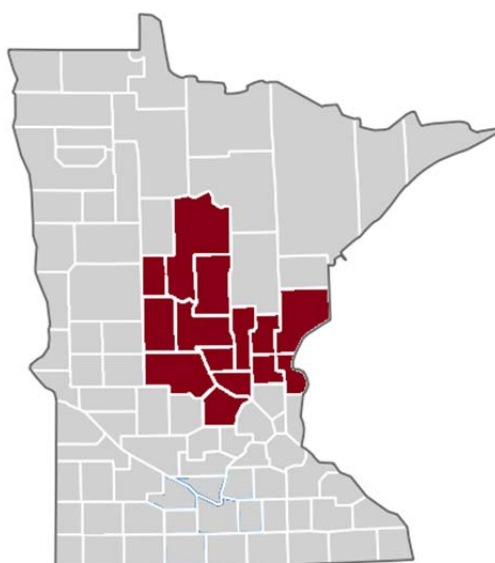
defined sectors within each of these industries. For example, manufacturing is an industry, and soybean processing is a sector within the manufacturing industry. More broadly, however, the definition of agbioscience includes components of food manufacturing, wood and paper product manufacturing, chemical manufacturing, farm supplies wholesalers, environmental consulting, and research and development in biotechnology. The only component of production agriculture included in this analysis is the sector of soil preparation, planting, and cultivation. By and large, this analysis *does not* focus on production agriculture. The definition of agbioscience used in this report is consistent with the definition of agbioscience used in the Battelle report.

This study was conducted as part of University of Minnesota Extension’s Economic Impact Analysis program. The study has two deliverables: a written report and a presentation with facilitated discussion of the results. The Agricultural Utilization Research Institute (AURI) provided guidance in the research. The project was funded by the Initiative Foundation, the Northwest Minnesota Foundation, West Central Initiative, Southwest Initiative Foundation, and the Southern Minnesota Initiative Foundation.

DEFINING THE CENTRAL REGION

The region in this analysis is Central Minnesota, as defined by the boundaries of the Initiative Foundation. Counties included in this analysis are Benton, Cass, Chisago, Crow Wing, Isanti, Kanabec, Mille Lacs, Morrison, Pine, Sherburne, Stearns, Todd, Wadena, and Wright.

Map 1: Central Region



ECONOMIC OVERVIEW AND THE AGBIOSCIENCE INDUSTRY IN CENTRAL MINNESOTA

Understanding the role of agbioscience in the Central region requires an understanding the broader economy. Several metrics exist for measuring economic activity. This analysis focuses on output and employment. Output is a measure of the total transactions in an economy. Most transactions occur as sales between businesses and between businesses and consumers.

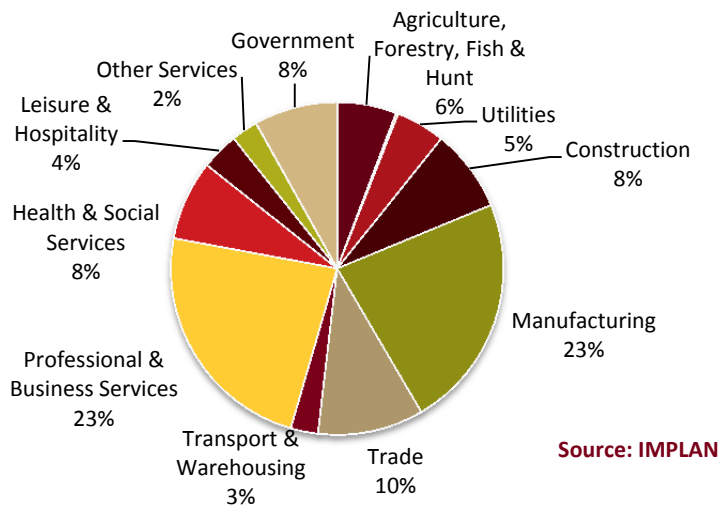
Output

In 2013, businesses and enterprises in the Central Minnesota economy produced \$52.0 billion of output. The professional and business services industry was the single largest contributor of output in the region, producing \$12.6 billion of sales in 2013 (chart 1). Real estate and rental businesses created 46 percent of all output in the industry. Real estate and rental businesses include those renting or leasing real estate. It also includes businesses that manage and appraise real estate assets. Rental of agricultural land would be included in this sector. Other sectors in this industry include finance and insurance; professional, scientific, and technical services; and information.

The manufacturing sector in the region produced \$11.9 billion of sales in 2013. Large manufacturing sectors in Central Minnesota include food production (23 percent of manufacturing output), transportation equipment manufacturing (13 percent), and fabricated metal production (12 percent).

Significant food product manufacturing sectors include meat processed from carcasses, poultry processing, and cheese manufacturing. Of these three sectors, only cheese manufacturing is included in the definition of agbioscience in this report.

Chart 1: Output by Industry, Central Minnesota



Trade is the third largest industry in the Central Minnesota region. Businesses in the trade industry (including both retail and wholesale trade) produced \$5.6 billion of output in 2013. Retail trade businesses produced \$3.3 billion of output while wholesale trade businesses produced \$2.3 billion of output. Farm supplies merchant wholesalers, which are included in the definition of agbioscience, are included in the wholesale trade sector.

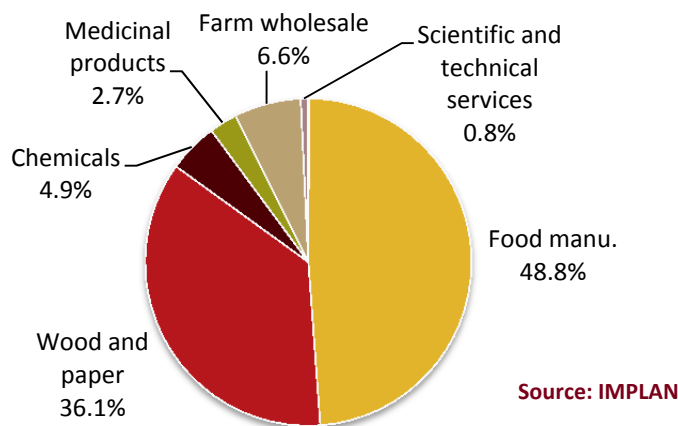
Agbioscience Output

In 2013, agbioscience businesses generated \$2.0 billion of output in the Central region. This represents approximately 4 percent of total output in the region.

Food manufacturers are one major contributor to the agbioscience industry in Central Minnesota (chart 2). In 2013, food manufacturers in the agbioscience industry made \$956.2 million of sales. Large food manufacturers in the agbioscience industry in the region include fruit and vegetable canning, cheese manufacturing, and distilleries.

Wood and paper product manufacturing created \$708.2 million of output in 2013. Wood and paper product manufacturing output, as related to agbioscience, includes paper mills, paperboard mills, and sawmills.

Chart 2: Agbioscience Output by Industry, Central Minnesota



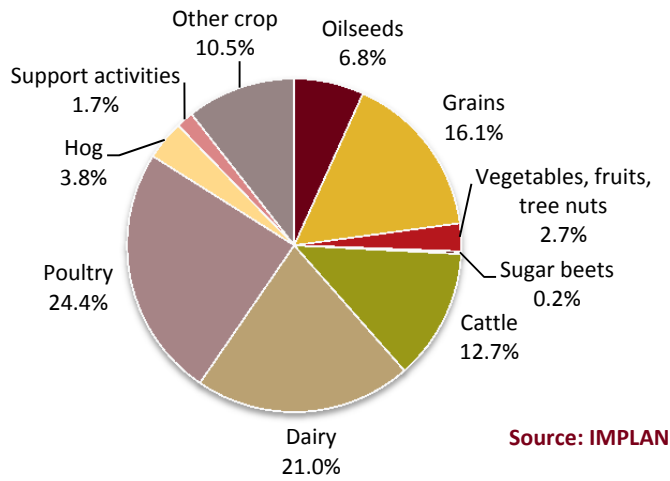
In comparison with other regions, the Central region is the fourth largest source of agbioscience output in Greater Minnesota. In 2013, the Central region accounted for 12 percent of Greater Minnesota's agbioscience output.

Production Agriculture Output

The definition of agbioscience in this report focuses on the value-added use of agricultural products. Production agriculture, while not directly included in this analysis as an agbioscience industry, is critical to the success of the agbioscience industry in Minnesota.

Production agriculture produced \$3.0 billion in economic activity in the Central region in 2013. Poultry production accounted for 24 percent of total output (chart 3), followed by dairy and milk production (21 percent), and grain production (16 percent).

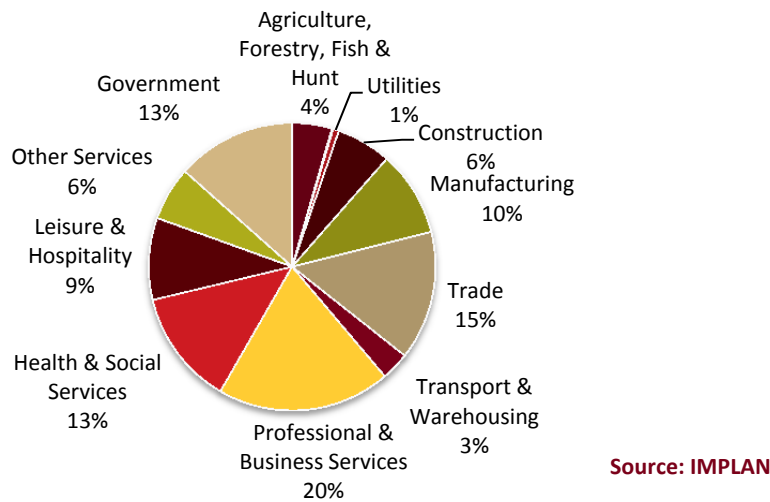
Chart 3: Production Agriculture Output by Sector, Central Minnesota



Employment

Output is one measure of economic activity; another is employment. According to IMPLAN, there are 374,390 jobs in the Central region. Employment is relatively diverse in the Central region. The professional and business services industry employs 20 percent of all workers in the region. The trade industry, including both retail and wholesale trade, employs 15 percent of workers. Health and social services and government each account for 13 percent.

Chart 4: Employment by Industry: Central Minnesota

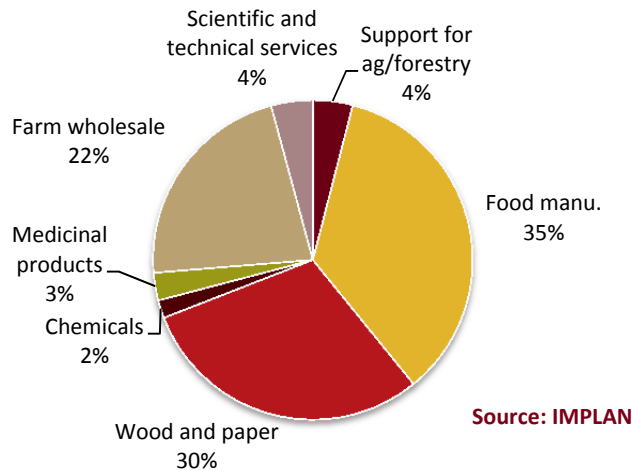


Agbioscience Employment

Agbioscience businesses in the Central region employ 3,180 workers or about 1 percent of the total workforce. Thirty-five percent of those employees are in food manufacturing (chart 5). Wood and paper product manufacturers employ 30 percent of all agbioscience employees in the region.

Share of employment versus share of output can vary because productivity per worker varies. For example, manufacturing employees can typically produce considerably more sales per worker than service industry employees.

Chart 5: Agbioscience Employment by Industry, Central Minnesota



Trends in Agbioscience Employment

Beyond understanding the current status of the industry, studying how the industry is changing also provides insights. Between 2003 and 2013, the number of jobs in the agbioscience industry in Central Minnesota grew by 13 percent. In comparison, the number of jobs in the agbioscience industry in Greater Minnesota declined by 3 percent. The Central region was one of three regions to post positive jobs gains in the period. The total number of jobs in the Central region (across all industries) grew by 7 percent in the period.

Shift-share analysis examines the drivers of growth and decline for a specific industry within a specific region by comparing to industry and national trends. The analysis provides an interesting interpretation of the changes in each industry (table 1). In this analysis, the primary focus is on the competitive effect. A strong positive competitive effect indicates particular characteristics of the local economy are driving growth in the region. A strong negative competitive effect can be interpreted as a warning that the local region may not be supporting the industry as well as it could.

Table 1: Shift-Share Analysis (Measured by Number of Jobs) for Growth and Decline Agbioscience Industries¹

Industry	Change 2003-2013	Industry Mix Effect	National Growth Effect	Competitive Effect
Top 3 Job Adding Industries				
Fruit and vegetable canning	134	-25	9	150
Distilleries	128	14	4	110
Paper mills (except newsprint)	105	-28	4	130
Top 3 Job Loss Industries				
Engineered wood member (except truss) manufacturing	-188	-78	9	-120
Hardwood veneer and plywood manufacturing	-60	-48	5	-18
Cheese manufacturing	-56	29	17	-101

Source: EMSI

Fruit and vegetable canning manufacturing added far more jobs than anticipated, given industry and national trends. The overall economy expanded during this time period, so jobs would have been added (national growth effect). However, the fruit and vegetable canning sector at the national level shed jobs; therefore, job losses would have been expected in the region (industry mix effect). The industry in Central Minnesota added jobs, however, thus making Central Minnesota competitive in this sector.

As highlighted in the table, distilleries and paper mills in the region also outperformed national and industry trends. Distilleries added 110 more jobs than expected, given trends. Paper mills added 130 more jobs than expected, based on national and industry trends.

The engineered wood member (except truss) manufacturing sector lost the highest number of jobs within the agbioscience industry in the Central region. While the industry did not fare well at the national level (industry mix effect), it appears the Central region lost more jobs than would have been anticipated given these trends. In other words, the sector was not as competitive as it could have been.

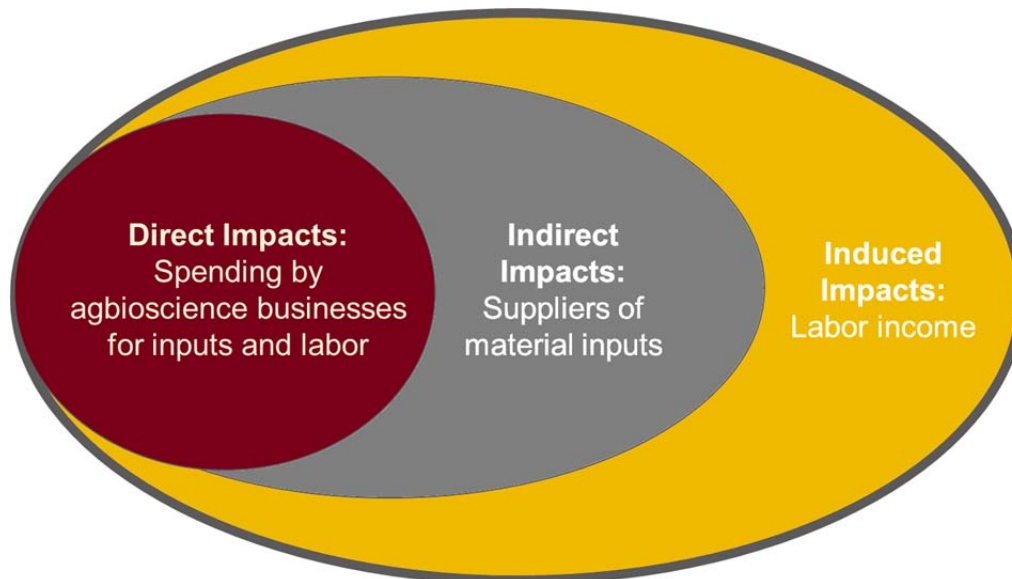
As highlighted in the table, hardwood veneer and plywood and cheese manufacturing experienced the second and third highest number of job losses in the region during the period. Both industries were less competitive than they could have been, given national industry trends and posted negative competitive effects.

¹ For an explanation of shift-share analysis, please see the methodology section. Note: figures in the table may not sum due to rounding.

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN CENTRAL MINNESOTA

Total economic contribution is comprised of three parts - direct, indirect, and induced effects. This section of the report explains each of these components and how they were calculated.

Chart 6: Economic Impact Analysis Diagram



Direct Effect

Direct effect is equal to output and employment generated by businesses in the agbioscience industry in the Central region. The Battelle Technology Partnership Practice grouped 51 sectors in Minnesota into an agbioscience industry. The first step of this research was to determine the total number of jobs in these sectors in the region. The Economic Modeling Specialist Inc. (EMSI) database contains county-level data on employment by sector. The primary data in the database is Quarterly Census of Employment and Wages (QCEW) for the years between 2003 and 2013. The second step of this research was to quantify the output related to the number of jobs in each of the sectors. The IMPLAN (MIG, Inc) database estimates the amount of output created per employee in a sector.²

In 2013, agbioscience companies in Central Minnesota employed 3,180 people (table 2). The highest shares of jobs were in the sectors of farm supplies wholesalers, paper mills, and fruit and vegetable canning. Both paper mills and fruit and vegetable canning were among the sectors within the agbioscience industry in the region to add the most jobs between 2003 and 2013.

Companies in the Central region's agbioscience industry created \$2.0 billion of output (sales). Output is led by paper mills, cheese manufacturing, and distilleries. As mentioned above, the paper

² For more on EMSI, please see www.economicmodeling.com. For more on IMPLAN, see implan.com. To learn about the types of companies classified in each agbioscience sector, visit <http://www.naics.com/search>.

mills and distilleries sectors are growing in the region (as measured by employment). Cheese manufacturing, however, has been declining (in employment).

Table 2: Direct Effect of Agbioscience Industry in Central Minnesota

Industry Name	Employment	Output (millions)
Farm supplies merchant wholesalers	702	\$130.2
Paper mills and newsprint mills	595	\$538.8
Fruit and vegetable canning, pickling, and drying	322	\$167.2
Cheese manufacturing	297	\$303.6
Distilleries	203	\$207.8
Sawmills and wood preservation	160	\$44.5
Breweries	139	\$116.3
Soil preparation, planting, and cultivating	128	\$1.2
Paperboard mills	120	\$105.4
In-vitro diagnostic substance manufacturing	89	\$53.8
Testing laboratories	67	\$5.8
Veneer and plywood manufacturing	53	\$14.8
Fluid milk and butter manufacturing	49	\$60.6
Breakfast cereal manufacturing	48	\$40.8
Ethyl alcohol manufacturing (ethanol)	33	\$57.1
Research and development in biotechnology	28	\$3.7
Pesticide and other agricultural chemical manufacturing	25	\$39.4
Wood windows and doors and millwork manufacturing	24	\$4.7
Flour milling and malt manufacturing	22	\$29.1
Wineries	22	\$7.4
Remediation services	20	\$4.2
Environmental consulting services	19	\$1.0

Wet corn milling	5	\$11.7
Soybean and other oilseed processing	5	\$10.0
Frozen food manufacturing	5	\$1.7
Total	3,180	\$1,960.8

Sources: EMSI and IMPLAN

Indirect and Induced Effects

Using estimated direct effects, the data was entered into an input-output model. Input-output models trace the flow of dollars throughout a local economy and capture the indirect and induced, or ripple, effects of an economic activity. The IMPLAN input-output model was used in this analysis. The indirect and induced effects measured are the result of spending in the Central region. In other words, purchases made outside of the Central region will not trigger ripple effects.

Indirect effects are those associated with a change in economic activity due to spending for goods and services directly tied to the industry. In this case, these are the changes in the local economy occurring because agbioscience companies purchase goods (soybeans and grains, for example) and related services (accounting and insurance, for example). As the agbioscience industry makes purchases, this creates an increase in purchases across the supply chain, as those suppliers make needed purchases of their own to produce output for the agbioscience industry. Indirect effects are the summary of these changes across an economy.

Induced effects are those associated with a change in economic activity due to spending by the employees of businesses (labor) and by households. Primarily, in this study, these are economic changes related to spending by employees of agbioscience companies. It also includes household spending related to indirect effects. As employees of the agbioscience industry make purchases locally, this triggers increases in economic activity.³

The indirect and induced effects of the agbioscience industry are shown in table 3, along with a discussion of the total contribution.

Total Effect

In 2013, the agbioscience industry contributed an estimated \$2.8 billion dollars in economic activity to the Central region of Minnesota from all effects – direct, indirect, and induced (table 3). The industry’s presence in the Central region supported an estimated 8,940 jobs. These employees received an estimated \$474.0 million in wages, salaries, and benefits.

The agbioscience industry directly created \$2.0 billion in economic activity in the region, as detailed above. Agbioscience companies directly employed 3,180 residents of the region and spent \$246.6 million in compensation to those workers. The average annual compensation per agbioscience employee is approximately \$78,000.

When agbioscience companies make purchases from businesses in the region, this generates additional economic activity (indirect effects). From these indirect effects, agbioscience companies

³ For further definitions of direct, indirect, and induced effects, please see appendix 1.

generated an estimated \$623.4 million in activity at regional businesses and supported jobs for 3,760 individuals.

When employees of agbioscience companies spend their wages and salaries in the Central region, this creates economic activity at businesses in the region (induced effects). Employee spending generated an estimated \$229.1 million in economic activity in 2013 and supported employment for 2,000 workers.

Table 3: Total Economic Contribution of Agbioscience in Central Minnesota, 2013

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$1,960.8	3,180	\$246.6
Indirect	\$623.4	3,760	\$159.6
Induced	\$229.1	2,000	\$67.8
Total	\$2,813.3	8,940	\$474.0

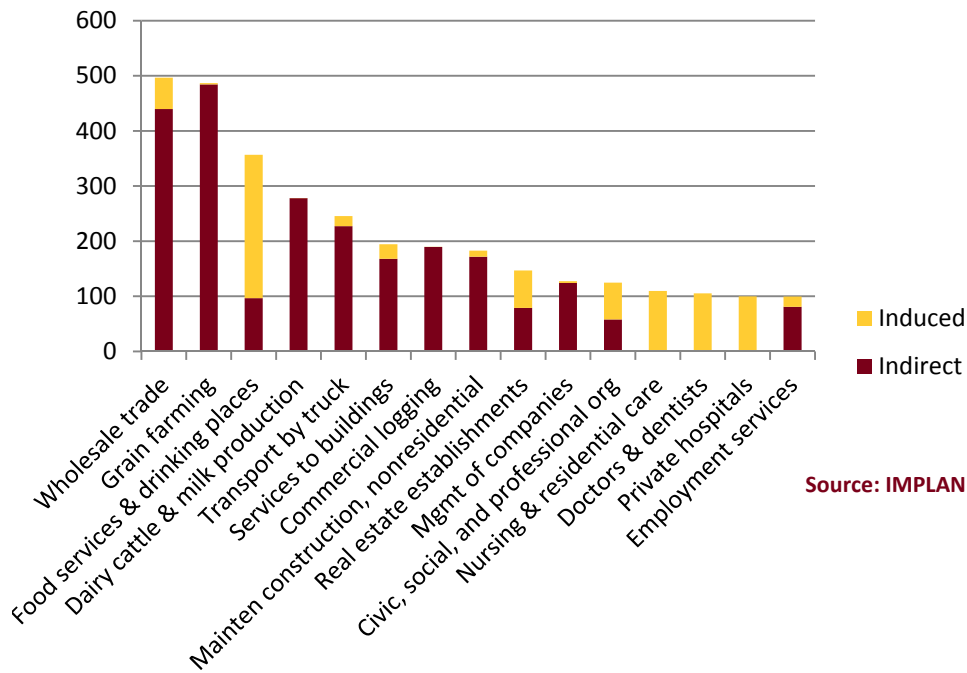
Estimates by University of Minnesota Extension

Top Industries Affected

Agbioscience companies support employment for an estimated 8,940 people in Central Minnesota. Of these jobs, 3,180 are with the agbioscience industry itself. Thus, the agbioscience industry supports 5,760 jobs in other businesses in the region. Chart 7 illustrates the top 15 sectors with jobs supported by the agbioscience industry. These impacts are driven by local expenditures and vary depending on the types of local purchases. Indirect effects are those created through agbioscience companies' expenditures for goods and services. Local supply chain purchases by the agbioscience industry highly influence the grain farming, wholesale trade, and dairy cattle and milk production sectors. Induced effects are generated because employees of agbioscience companies spend wages and salaries in the local economy. Health care is a major expenditure for most households; therefore, it is not surprising to see high induced impacts in the sectors affiliated with the health care industry. Induced effects are also noted in food services and drinking establishments sector.

Many economic impact studies show relatively high employment impacts on the food services and drinking establishments sector. Since employment in this industry is often part-time, and in the model, one job is one job (regardless of full or part-time status), employment impacts tend to be higher in this particular industry.

Chart 7: Top Industries Affected, Sorted by Employment, Central Minnesota

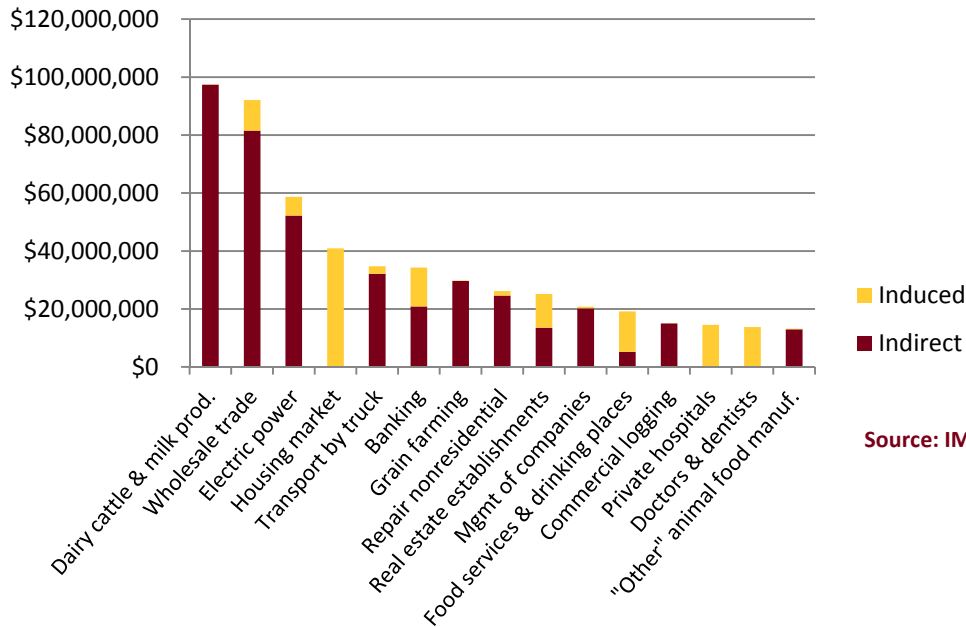


Source: IMPLAN

Examining the sectors most affected in terms of employment is one lens through which to examine economic contribution. As mentioned, one job is one job in the model, therefore employment effects are often weighted towards industries that employ more part-time workers and have lower levels of output per worker. Therefore, it is also instructive to view the sectors with the highest output impacts. Reviewing results both by employment and output gives a fuller picture of how the agbioscience industry affects the economy.

Chart 8 shows the top sectors affected, but sorted by output. Agbioscience companies contribute an estimated \$2.8 billion in economic activity to the Central region. Agbioscience companies directly spend \$2.0 billion in the region. The remainder, approximately \$0.8 billion, is activity at other businesses in the region. Activities by agbioscience companies in the region contribute most strongly to the dairy cattle and milk production, wholesale trade, and electric power sectors.

Chart 8: Top Industries Affected, Sorted by Output, Central Minnesota



Source: IMPLAN

Contribution of Agbioscience by Region of Greater Minnesota

Agbioscience businesses exist in all regions of Minnesota (table 4).⁴ Agbioscience economic activity is highest in the southern portion of the state, as the highest levels of output and employment are in the Southeast and Southwest regions of the state. Together, the two regions produce more than 65 percent of agbioscience output in Greater Minnesota.

⁴ Regions are defined by the boundaries of the Minnesota Initiative Foundations. For more on the counties included in each region, please see <http://www.greatermnnesota.net/>.

Table 4: Total Economic Contribution of Agbioscience by Region in Minnesota, 2013

	Output (millions)	Employment (rounded)	Labor Income (millions)	Total Regional Output (billions)	Agbioscience Output Percent of Total Regional Output
Central	\$2,813.3	8,940	\$474.0	\$52.0	5.7%
Northeast	\$2,807.3	7,580	\$478.5	\$28.5	10.2%
Northwest	\$1,230.3	4,870	\$234.8	\$15.6	8.2%
Southeast	\$11,737.1	29,220	\$1,719.6	\$75.6	15.5%
Southwest	\$3,590.6	9,440	\$554.5	\$31.6	11.1%
West Central	\$1,199.2	3,700	\$212.2	\$18.9	6.4%
Total	\$23,377.8	63,750	\$3,673.6	\$222.2	10.4%

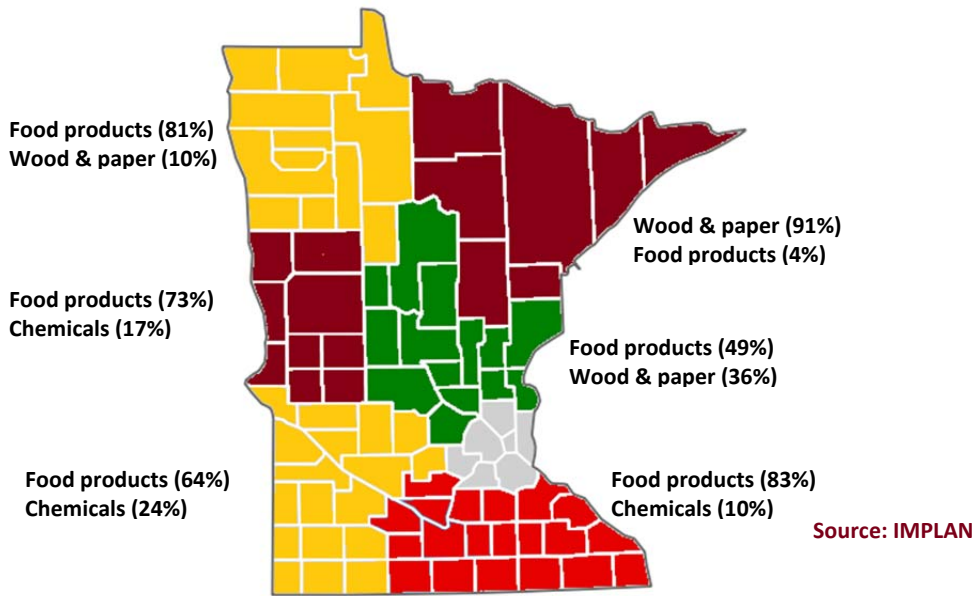
Estimates by University of Minnesota Extension

The Central region is responsible for 12 percent of Greater Minnesota’s total agbioscience output. In comparison, the Central region is responsible for 23 percent of Greater Minnesota’s total output from all industries.

The composition of the direct effect of the agbioscience industry also varies by region (chart 9). Food manufacturing is a major component of the agbioscience industry in Minnesota. In Central Minnesota, food manufacturing produces 49 percent of all agbioscience output in the region. Food manufacturing composes a significant share of output in all regions, with the exception of the Northeast region. The flavor of the food manufacturing industry, however, is different by region. In the Northwest and West Central regions, beet sugar manufacturing is a significant sector, while in the Southeast and Southwest, cheese manufacturing is a significant sector.



Chart 9: Top Agbioscience Sectors by Region and Percent of Regional Agbioscience Output



Chemical manufacturing is a significant sector in the Southwest, Southeast, and West Central regions of the state. Chemical manufacturing includes ethanol production and fertilizer production.

Wood and paper product manufacturing, including wood preservation, paper mills, pulp mills, and sawmills, is a significant sector in the Northeast, Central, and Northwest regions. In the Northeast region, the wood and paper manufacturing sector produces the largest share of agbioscience output in the region. In the Central region, wood and paper product manufacturing accounts for 36 percent of agbioscience output.

For more on the composition of agbioscience by region, please see appendix 3.

Future Growth and Development of Agbioscience

The agbioscience industry in Central Minnesota is not a stagnant industry; it is expanding, contracting, and changing. Between 2003 and 2013, the total number of jobs in agbioscience in the region grew by 13 percent, despite the Great Recession in 2008-2009. The 2013 Battelle Technology Partnership Practice report identified potential growth in the industry through to 2016. Growth rates varied across the industry from a low of 5.9 percent projected growth in business related to agricultural systems to 10.7 percent projected growth in business related to microbials. To estimate the potential for the industry in Central Minnesota, Extension modeled a conservative 5 percent growth rate across the industry and then a more optimistic growth rate of 10 percent across the industry. These two growth rates are estimates based on historical growth rates in the industry and estimates by Battelle. The growth rates are presented here for illustrative purposes.

If employment in the agbioscience industry in Central Minnesota was to grow at a rate of 5 percent between 2014 and 2016, the total economic contribution of the industry would increase to support an estimated \$3.0 billion in output, an estimated 9,390 jobs, and an estimated \$497.7 million in labor income (table 5).

Table 5: Total Economic Contribution of Agbioscience Central Minnesota, 5 Percent Growth Rate

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,058.8	3,340	\$258.9
Indirect	\$654.6	3,950	\$167.6
Induced	\$240.6	2,100	\$71.2
Total	\$2,954.0	9,390	\$497.7

Estimates by University of Minnesota Extension

If employment in the agbioscience industry in Central Minnesota was to grow at a rate of 10 percent between 2014 and 2016, the total economic contribution of the industry would increase to supporting an estimated \$3.1 billion in output, an estimated 9,840 jobs, and an estimated \$521.5 million in labor income (table 6). A 10 percent growth rate is consistent with the rate of growth in the region between 2003 and 2013.

Table 6: Total Economic Contribution of Agbioscience Central Minnesota, 10 Percent Growth Rate

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,156.9	3,500	\$271.3
Indirect	\$685.7	4,140	\$175.6
Induced	\$252.0	2,200	\$74.6
Total	\$3,094.6	9,840	\$521.5

Estimates by University of Minnesota Extension

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN CENTRAL MINNESOTA BY PLATFORM

The Battelle report identified four agbioscience platforms in Minnesota for future targeted investment and growth. These platforms were identified based on Minnesota's relative strengths. Agbioscience sectors can be included in multiple platforms (i.e. soybean processing is included in microbial agbioscience, biobased industrial products, and value-added food and health products). Therefore, the individual platforms will not add to the total agbioscience contribution in Central Minnesota.

In terms of total impacts, the largest platform in the Central region is the value-added food and health products platform. In 2013, the platform supported \$1.6 billion of output in the Central region (table 7). The platform also supported employment for 5,230 workers and paid \$253.8 million in wages, salaries, and benefits. The Central region also has relatively high output impacts in the biobased industrial products platform.



Table 7: Total Economic Contribution of Agbioscience in Central Minnesota by Platform, 2013*(Note, as industries within the platforms overlap, platform totals will not equal agbioscience total)*

	Output (Millions)	Employment	Labor Income (Millions)
Microbial agbioscience	\$169.9	765	\$41.6
Resilient, efficient, & productive agricultural systems	\$277.9	1,590	\$76.4
Biobased industrial products	\$1,088.1	3,180	\$187.6
Value-added food and health products	\$1,613.3	5,230	\$253.8

Estimates by University of Minnesota Extension

While the value-added food and health products platform is the largest platform in the region, the microbial agbioscience platform was the fastest growing between 2003 and 2013 (table 8).

Businesses in the platform added nearly 100 jobs, increasing the number of jobs in the platform by 35 percent. The increase was driven by the growth in soil preparation, planting, and cultivating, in-vitro diagnostic substance manufacturing, and pesticide manufacturing.

The number of jobs in three of the four platforms increased between 2003 and 2013. The resilient, efficient, and productive agricultural systems platform increased employment by 11 percent and the value-added food and health products platform increased by 25 percent. The number of jobs in the biobased industrial products platform, however, declined by a modest 4 percent or 48 jobs.

Meanwhile, between 2003 and 2013, the number of jobs across all industries in Central Minnesota grew by 7 percent.

Table 8: Change in Number of Jobs by Agbioscience Platform in Central Minnesota, 2003-2013*(Note, as industries within the platforms overlap, platform totals will not equal agbioscience total)*

	2003 Jobs	2013 Jobs	Percent Growth Rate
Microbial agbioscience	266	360	35%
Resilient, efficient, & productive agricultural systems	841	930	11%
Biobased industrial products	1,068	1,020	-4%
Value-added food and health products	1,485	1,850	25%

Source: EMSI

Microbial Agbioscience

The microbial agbioscience platform is based on Minnesota's expertise in the areas related to microbiology, genomics, ecological sciences, infectious disease, and biosecurity. It involves using this expertise to ensure adequate food supply and food production. Battelle identified this platform as a strength for Minnesota, due in part to Minnesota's breadth and depth in the advancing field of microbiology, coupled with its traditional strengths in the agricultural sciences. Included in the definition of the microbial agbioscience platform are medicinal, botanical, and related

manufacturing, testing laboratories, research and development, pulp mills, and food processing related to microbial agbioscience.⁵

In 2013, the microbial agbioscience platform supported an estimated \$169.9 million of output in Central Minnesota. The platform also supported an estimated 765 jobs, with those jobs paying an estimated \$41.6 million of labor income (table 9).

Table 9: Total Economic Contribution of the Microbial Agbioscience Platform in Central Minnesota, 2013

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$118.2	360	\$26.4
Indirect	\$31.7	230	\$9.3
Induced	\$20.0	175	\$5.9
Total	\$169.9	765	\$41.6

Estimates by University of Minnesota Extension

The Central region is one of the smallest of Greater Minnesota’s regions in the production of microbial agbioscience output. Within the microbial agbioscience platform in the Central region, the largest sectors, measured by output, are in-vitro diagnostic substance manufacturing, pesticide manufacturing, and soybean and oil processing. The highest ripple effects are in wholesale trade, the housing market, and management of companies and enterprises.

According to the Battelle report, the total global market for microbes and microbial products is projected to grow by a 10.7 percent projected compound annual growth rate (CAGR). “Most of this market consists of products, such as biopharmaceuticals and biofuels, made using yeasts, bacteria, and other microbes. Healthcare is the largest end-user market for microbes and microbial products at \$90.5 billion in 2010, increasing to \$100.4 billion in 2011 and \$169 billion in 2016” (Battelle Technology Partnership Practice, November 2013, p. 33).

Given these projections, the total economic contribution of the microbial agbioscience platform would be expected to increase. Assuming a 10 percent growth rate between 2013 and 2016, the total economic contribution in Central Minnesota would increase to an estimated \$186.9 million, including an estimated 840 jobs, and an estimated \$45.8 million in labor income.⁶

Resilient, Efficient, and Productive Agricultural Systems

The resilient, efficient, and productive agricultural systems platform is based on Minnesota’s expertise in areas related to agriculture, ecology, bio-engineering, and the environment. It involves using this expertise to develop sustainable agricultural production, environmental protection, and remediation. Included in the definition of agricultural systems are ethanol and basic organic chemical manufacturing, fertilizer manufacturing, environmental consulting, research and development in biotechnology, and remediation services.

⁵ For an exact definition of what is included in the microbial agbioscience platform, please see appendix 2.

⁶ The 10 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on Battelle’s projected growth rate (10.7 percent).

In 2013, the resilient, efficient, and productive agricultural systems platform supported an estimated \$277.9 million of output in Central Minnesota. The platform also supported an estimated 1,590 jobs, with those jobs paying an estimated \$76.4 million of labor income (table 10).

Table 10: Total Economic Contribution of the Resilient, Efficient, and Productive Agricultural Systems Platform in Central Minnesota, 2013

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$197.4	930	\$52.4
Indirect	\$43.7	340	\$13.1
Induced	\$36.8	320	\$10.9
Total	\$277.9	1,590	\$76.4

Estimates by University of Minnesota Extension

Compared to other regions, the Central region has a modest percentage of total output in the resilient, efficient, and productive agricultural systems platform. Within the Central region, the largest sectors in the agricultural systems platform (measured by output) are farm suppliers wholesalers and ethanol manufacturing. The largest ripple effects are in the housing market, wholesale trade, and banking.

According to the Battelle report, the resilient, efficient, and productive agricultural systems platform in North America, the “market is forecasted to grow at a compound annual growth rate of 7.7 percent” (Battelle Technology Partnership Practice, November 2013, p. 42). Markets in the rest of the world are expected to grow by a compound growth rate of 10 percent.

If the forecasted 10 percent growth rate occurs, the economic contribution of the resilient, efficient, and productive agricultural systems platform would increase to an estimated \$305.7 million of output, including 1,750 jobs and \$84.0 million in labor income.⁷

Biobased Industrial Products

This platform is based on Minnesota’s history of engaging in research and development related to bioproducts, particularly the expertise in examining the economics and market feasibility of agricultural and forestry products. It involves using this expertise to expand the ability of Minnesota companies to add value to agricultural and forestry products including biofuels, biobased materials and chemicals, and forestry co-products. Included in the definition of biobased industrial products are food processing (especially around fats and oils), wood product manufacturing (i.e. wood products, paper mills), chemical manufacturing (especially around ethanol), and fertilizer manufacturing.

In 2013, the biobased industrial products platform supported \$1.1 billion of output in Central Minnesota. The platform also supported 3,180 jobs, with those jobs paying \$187.6 million in labor income (table 11).

⁷ The 10 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on Battelle’s projected growth rates (7.7 to 10 percent).

Table 11: Total Economic Contribution of the Biobased Industrial Products Platform in Central Minnesota, 2013

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$779.0	1,020	\$95.6
Indirect	\$218.2	1,370	\$65.1
Induced	\$90.9	790	\$26.9
Total	\$1,088.1	3,180	\$187.6

Estimates by University of Minnesota Extension

The Central, Northeast, and Southwest regions all have significant levels of output in the platform (more than \$1 billion in each region), but the Southeast region is the largest source of output. In the Central region, paper mills and paperboard mills are major sources within the biobased industrial products platform. The largest ripple effects are in electric power and wholesale trade.

The Battelle report identifies two primary market components of the biobased industrial products platform, biomaterials and biofuels. The biomaterials market has been growing in the United States, and demand for biomaterial is expected to post a yearly growth of 6.9 percent, according to Battelle. As noted, the biofuels market suffered during the Great Recession. The Battelle analysis indicates overall demand will increase by approximately 3 percent, but the market value is expected to decline. Given the forecasts provided by Battelle and the overall decline in the number of jobs in the platform, a growth rate of 5 percent between 2013 and 2016 appears to be reasonable.

If the rate of growth of 5 percent occurs, the economic contribution of the biobased industrial products platform would increase to \$1.14 billion of output, including 3,340 jobs and \$197.0 million in labor income.⁸

Value-Added Food and Health Products

This platform is based on Minnesota's strength in agricultural value-added, particularly around food. Minnesota is a strong competitor in the food processing manufacturing industry. It involves expanding the historic core competencies of food manufacturing in Minnesota to new markets focused on health and nutrition, including nutritional supplements. Included in the definition of value-added food and health products are major food manufacturing industries (flour, rice, corn milling, soybeans and oilseeds, breakfast cereal, beets, vegetables and fruits, cheese and butter, spices and extracts, and wineries and breweries), along with some medicinal and botanical manufacturing, and research and development in biotechnology.

In 2013, the value-added food and health products platform supported an estimated \$1.6 billion in output in Central Minnesota, including an estimated \$253.8 million in labor income and 5,230 jobs (table 12).

⁸ The 5 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on Battelle's projected growth rate (3 to 6.9 percent).

Table 12: Total Economic Contribution of the Value-Added Food and Health Products Platform in Central Minnesota, 2013

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$1,100.2	1,850	\$126.9
Indirect	\$390.7	2,310	\$90.7
Induced	\$122.4	1,070	\$36.2
Total	\$1,613.3	5,230	\$253.8

Estimates by University of Minnesota Extension

In the value-added food and health products platform, the Southeast region produces the highest amount of output and employment. However, all regions, with the exception of the Northeast, produce more than \$1 billion of output. In the Central region, large sectors in the value-added food and health products platform include cheese manufacturing, distilleries, and fruit and vegetable canning. The largest ripple effects in the Central region include dairy cattle and milk production, wholesale trade, and grain farming.

Although the food and health manufacturing industry is strong in Minnesota, the focus of this platform is on the value-added food and health product market, which currently accounts for less than 10 percent of the market (Battelle Technology Partnership Practice, November 2013). Market forces are strong, however, for traditional food and health companies to move into the value-added market.

The Battelle report states, “Overall, the U.S. is leading the global nutraceuticals market with more than 33.1 percent of the market share in 2010, and this market is anticipated to grow at a 6.5 percent compound annual growth rate (CAGR) from 2011 to 2016” (p. 61). As noted above, employment in the platform increased by 4 percent across Greater Minnesota between 2003 and 2013. Therefore, University of Minnesota Extension estimated a 5 percent rate of growth in the platform.

If the forecasted rate of growth of 5 percent occurs, the economic contribution of the value-added food and health products platform would increase to an estimated \$1.7 billion of output, including an estimated 5,490 jobs and an estimated \$266.5 million in labor income.⁹

Contribution of Agbioscience Platforms by Region of Greater Minnesota

In comparison to the other regions, the Central region has a higher share of total economic contribution in the biobased industrial products and value-added food and health platforms (table 13). The Central region has the third highest share of output contribution in the biobased industrial products platform (following the Southeast and Southwest regions). The Central region also has the third highest share of output contribution in the value-added food and health platform.

As a note, the size and scale of the agbioscience industry also depends on the size and scale of the economy in the region. In 2013, businesses and industries in the Central region produced \$52.0 billion of output. In comparison, the Southeast region produced \$75.6 billion and the Southwest

⁹ The 5 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on Battelle’s projected growth rate for the nutraceuticals market (6.5 percent).

region produced \$31.6 billion.

Table 13: Total Economic Contribution of Minnesota’s Agbioscience Platforms by Region, 2013

Note: Individual platforms will not sum to total economic contribution of agbioscience since sectors can be classified in more than on platform.

Millions of Output	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Microbial agbioscience	\$787.9	\$169.9	\$88.7	\$857.5	\$452.1	\$2,583.4	\$4,939.5
Resilient, efficient, and productive agricultural systems	\$82.6	\$277.9	\$125.7	\$1,111.8	\$288.0	\$1,246.9	\$3,132.9
Biobased industrial products	\$116.2	\$1,088.1	\$2,660.6	\$1,068.3	\$191.1	\$3,443.5	\$8,567.8
Value-added food and health products	\$1,092.2	\$1,613.3	\$108.4	\$2,709.7	\$1,004.2	\$10,502.2	\$17,030.0

Estimates by University of Minnesota Extension Center for Community Vitality

In addition to variation in the size of the platforms, the rate of growth of each platform also varies. The Central region was the fastest growing region in the value-added food and health products platform, with the number of jobs in the platform increasing by 25 percent between 2003 and 2013. The region was the second fastest growing in the microbial agbioscience platform, increasing by 35 percent.

Table 14: Growth Rate, Measured in Jobs, by Region and by Agbioscience Platform from 2003-2013

	Northwest	Central	Northeast	Southwest	West Central	Southeast
Microbial agbioscience	7%	35%	16%	26%	6%	37%
Value-added food and health products	-17%	25%	-47%	14%	-5%	1%
Biobased industrial products	-57%	-4%	-34%	352%	27%	-5%
Resilient, efficient, and productive agricultural systems	-20%	11%	-38%	37%	18%	-16%

Source: EMSI

SUMMARY

Given Minnesota’s long tradition in agriculture and science, the state is positioned with a strong agbioscience industry. The industry is a broad continuum that includes many agricultural, scientific, and research activities. The Agricultural Utilization Research Institute (AURI) recognizes agbioscience’s importance in the state’s economy. In 2013, AURI partnered, along with the



Minnesota Corn Research and Promotion Council and the Minnesota Soybean Research and Promotion Council, with Battelle Technology Partnership Practice (Battelle) to explore the agbioscience industry in Minnesota. Battelle identified four platforms of Minnesota's agbioscience industry for further development and investment. While the Battelle report defines agbioscience and focuses on the four platforms, the analysis was on a statewide level. AURI then contracted with University of Minnesota Extension to explore the economic contribution of the industry and the four platforms in each of the six regions. The goal of this analysis is to help regional stakeholders and decision makers understand their region's role in the industry. The project was funded by the Initiative Foundation, the Northwest Minnesota Foundation, West Central Initiative, Southwest Initiative Foundation, and the Southern Minnesota Initiative Foundation. This report focuses on the Central region of Minnesota, as defined by the boundaries of the Initiative Foundation region.

The agbioscience industry contributes significantly to the economy of Central Minnesota. In 2013, the total economic contribution of the agbioscience industry was an estimated \$2.8 billion in Central Minnesota. Through its impacts across all industries, agbioscience supported an estimated 8,940 jobs that paid \$474.0 million in income to workers in the region.

In Central Minnesota, the agbioscience industry is dominated by food processing and wood and paper product manufacturing. Large sectors within the food processing industry include cheese manufacturing, distilleries, and fruit and vegetable canning. Wood and paper product manufacturing, primarily paper mills and paperboard mills, is also a significant portion of the agbioscience industry in the region. Growing agbioscience sectors in the region include fruit and vegetable canning, distilleries, and paper mills. These sectors have added jobs in the past 10 years and have done so at rates faster than expected, given national and industry trends. Engineered wood member (except truss) manufacturing, hardwood veneer and plywood manufacturing, and cheese manufacturing are agbioscience sectors that shed jobs between 2003 and 2013.

Directly, agbioscience companies in the Central region employ 3,180 individuals. The companies produce \$2.0 billion in economic activity, including compensation to workers of \$246.6 million. The average annual compensation per agbioscience employee is approximately \$78,000.

The \$2.0 billion of output represents approximately 4 percent of all economic activity in the region. In addition to the sales from agbioscience industries, production agriculture also generates output in the region. Production agriculture, which falls outside the agbioscience category, recorded sales of \$3.0 billion or about 6 percent of all sales in the region. The Central region is responsible for 12 percent of Greater Minnesota's agbioscience output.

Indirectly, industries with strong ties to agriculture and manufacturing are most affected by the agbioscience industry in Central Minnesota. The related industries benefiting most from include wholesale trade, grain farming, dairy cattle and milk production, and electric power.

During the past 10 years, the agbioscience industry in Central Minnesota has grown by 13 percent. If that trend continues with a 10 percent increase between 2013 and 2016, the economic contribution of the agbioscience industry in the region will increase to an estimated \$3.1 billion in output, an estimated 9,840 jobs, and an estimated \$521.5 million in labor income.

Of the four platforms, the value-added food and health products platform is largest in the Central region. In 2013, the platform supported an estimated \$1.6 billion of economic activity, including an estimated 5,230 jobs. This platform is based on Minnesota's strength in agricultural value-added, particularly around food. The platform involves expanding on historic core competencies of food manufacturing in Minnesota to new markets focused on health and nutrition, including nutritional supplements.

The fastest growing platform in the Central region was the microbial agbioscience platform, which grew by 35 percent between 2003 and 2013. The microbial agbioscience platform supported an estimated \$169.9 million of output in Central Minnesota in 2013. The platform also supported an estimated 765 jobs. The microbial agbioscience platform is based on Minnesota's expertise in the areas related to microbiology, genomics, ecological sciences, infectious disease, and biosecurity. It involves using this expertise to ensure adequate food supply and food production.

In conclusion, the Central region is one component of the agbioscience industry in Greater Minnesota. It is currently strongest in the value-added food and health platform and the biobased industrial products platform. The region clearly will be important in the future growth and development of the industry, particularly in the realm of microbial agbioscience. The region has a strong base of wood and paper product manufacturing and food manufacturing on which to grow.

APPENDIX 1: METHODOLOGY

Input-Output Models

Special models, called input-output models, exist to conduct economic impact analysis. There are several input-output models available. IMPLAN (Impact Analysis for PLANning from the Minnesota IMPLAN Group)¹⁰ is one such model. Many economists use IMPLAN for economic contribution analysis because it can measure output and employment impacts, is available on a county-by-county basis, and is flexible for the user. IMPLAN has some limitations and qualifications, but it is one of the best tools available to economists for input-output modeling. Understanding the IMPLAN tool, its capabilities, and its limitations will help ensure the best results from the model.

One of the most critical aspects of understanding economic impact analysis is the distinction between the "local" and "non-local" economy. The local economy is identified as part of the model-building process. Either the group requesting the study or the analyst defines the local area. Typically, the study area (the local economy) is a county or a group of counties that share economic linkages.

A few definitions are essential in order to properly read the results of an IMPLAN analysis. The terms and their definitions are provided below.

- **Output:** Output is measured in dollars and is equivalent to total sales. The output measure can include significant "double counting." Think of corn, for example. The value of the corn is counted when it is sold to the mill, again when it is sold to the dairy farmer, again as part of the price of fluid milk, and yet again when it is sold as cheese. The value of corn is built into the price of each of these items, and then the sale of each of item is added to get total sales (or output).
- **Employment:** Employment includes full and part-time workers and is measured in annual average jobs, not full-time equivalents (FTEs). IMPLAN includes total wage and salaried employees, as well as the self-employed in employment estimates. Because employment is measured in jobs and not in dollar values, it tends to be a very stable metric.
- **Labor Income:** Labor income measures the value added to the product by the labor component. So in the corn example, when the corn is sold to the mill, a certain percentage of the sale goes to the farmer for his/her labor. Then when the mill sells the corn as feed to dairy farmers, it includes some markup for its labor costs in the price. When dairy farmers sell the milk to the cheese manufacturer, they include a value for their labor. These

¹⁰ IMPLAN Version 3.0 was used in this analysis. The trade flows model with SAM multipliers was implemented.

individual value increments for labor can be measured, which amounts to labor income. Labor income does *not* include double counting.

- **Direct Impact:** Direct impact is equivalent to the initial activity in the economy. In this study, it is employment and output of agbioscience companies in the central region of Minnesota.
- **Indirect Impact:** The indirect impact is the summation of changes in the local economy that occur due to **spending for inputs** (goods and services) by the industry or industries directly impacted. For instance, if employment in a manufacturing plant increases by 100 jobs, this implies a corresponding increase in output by the plant. As the plant increases output, it must also purchase more inputs, such as electricity, steel, and equipment. As the plant increases purchases of these items, its suppliers must also increase production, and so forth. As these ripples move through the economy, they can be captured and measured. Ripples related to the purchase of goods and services are indirect impacts. In this study, indirect impacts are those associated with spending by agbioscience companies for their supplies and inputs.
- **Induced Impact:** The induced impact is the summation of changes in the local economy that occur due to **spending by labor**. For instance, if employment in a manufacturing plant increases by 100 jobs, the new employees will have more money to spend to purchase housing, buy groceries, and go out to dinner. As they spend their new income, more activity occurs in the local economy. Induced impacts also include spending by labor generated by indirect impacts. So, if the bio-based businesses purchase services from a local tax preparer, spending of the tax preparer's wages would also create induced impacts. Primarily, in this study, the induced impacts are those economic changes related to spending by employees of agbioscience companies in the region.
- **Total Impact:** The total impact is the summation of the direct, indirect, and induced impacts.

Quarterly Census of Employment and Wages (QCEW)

The Quarterly Census of Employment and Wages (QCEW) is a national dataset maintained by the Bureau of Labor Statistics. In Minnesota, the data is collected by the Department of Employment and Economic Development (DEED). Each quarter, businesses that are covered by the Unemployment Insurance Program are required to report their total payroll and the number of employees to DEED. The data is then aggregated by business classification code and geographic location. The QCEW database is one of the most robust and current sets of data available, covering about 97 percent of all workers in the state. The database, however, has drawbacks, including the fact that the self-employed are not included in the numbers. Agriculture is one group often under-represented in the data.

Shift-Share Analysis

The results of shift-share analysis are presented in this report. Shift-share analysis is a powerful tool for understanding the drivers of economic change in an industry. Shift-share analysis parses economic change (here employment changes) into three components: national growth, industrial mix, and competitive share.

- **National Growth:** National growth indicates how many jobs a local economy would have gained (or lost) as a result of the growth (or decline) of employment at the national level. For example, consider a local economy with 100,000 jobs at the beginning of the time period. If during the period under consideration, the number of jobs in the United States grew by a rate of 2 percent, then at the end of the time period under consideration, the local economy would be expected to have 102,000 jobs.
- **Industrial Mix:** Industrial mix indicates how many jobs a particular industry within the local economy would have gained (or lost) if the local industry grew (or declined) at a rate similar to the industry as a whole in the United States. For example, if 1,000 people were employed

in the finance industry in the local economy at the beginning of the period, and the finance industry as a whole in the U.S. grew at a rate of 10 percent, then at the end of the time period under consideration, the local finance industry would be expected to have 1,100 jobs.

- **Competitive Share:** Competitive share is the remainder of change in employment for the region examined. From our example, region’s employment should have grown by 2,100 jobs, looking at overall national growth and then growth in the finance industry itself. If the local economy actually grew by 3,100 jobs in the finance industry, then 1,000 jobs were added because the local economy grew faster than expected, given national and industry trends. Conversely, if the local economy grew by only 1,000 jobs, then the economy was not as competitive as it should have been, given national and industry trends.

APPENDIX 2: DEFINITION OF AGBIOSCIENCE WITH NAICS CODES

This section lists the sectors defined as the agbioscience industry, along with the definition of each of the platforms. The industries included in the definition are based on research by the Battelle Technology Partnership Practice. The findings were published in in the 2013 document “Agbioscience as a Development Driver: Minnesota’s Agbioscience Strategy.” Find the study here: <http://www.auri.org/assets/2013/12/Minnesotas+Agbioscience+Strategy+--+Final+Report-1.pdf>.

Table A1: All Agbioscience Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311313	Beet Sugar Manufacturing
311411	Frozen Fruit, Juice, and Vegetable Manufacturing
311421	Fruit and Vegetable Canning
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing
311513	Cheese Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311942	Spice and Extract Manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
321113	Sawmills
321114	Wood Preservation
321211	Hardwood Veneer and Plywood Manufacturing
321212	Softwood Veneer and Plywood Manufacturing
321213	Engineered Wood Member (except Truss) Manufacturing

321219	Reconstituted Wood Product Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
322110	Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
325191	Gum and Wood Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325212	Synthetic Rubber Manufacturing
325221	Cellulosic Organic Fiber Manufacturing
325222	Noncellulosic Organic Fiber Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325411	Medicinal and Botanical Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325620	Toilet Preparation Manufacturing
424910	Farm Supplies Merchant Wholesalers
541380	Testing Laboratories
541620	Environmental Consulting Services
541711	Research and Development in Biotechnology
562910	Remediation Services

Table A2: Microbial Agbioscience Platform Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311313	Beet Sugar Manufacturing
322110	Pulp Mills
325320	Pesticide and Other Agricultural Chemical Manufacturing
325411	Medicinal and Botanical Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
541380	Testing Laboratories
541711	Research and Development in Biotechnology
562910	Remediation Services

Table A3: Resilient, Efficient, and Productive Agricultural Systems Platform Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
424910	Farm Supplies Merchant Wholesalers
541620	Environmental Consulting Services
541711	Research and Development in Biotechnology
562910	Remediation Services

Table A4: Biobased Industrial Products Platform Sectors and NAICS Codes

311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
321113	Sawmills
321114	Wood Preservation
321211	Hardwood Veneer and Plywood Manufacturing
321212	Softwood Veneer and Plywood Manufacturing
321213	Engineered Wood Member (except Truss) Manufacturing
321219	Reconstituted Wood Product Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
322110	Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
325191	Gum and Wood Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325212	Synthetic Rubber Manufacturing
325221	Cellulosic Organic Fiber Manufacturing
325222	Noncellulosic Organic Fiber Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
541711	Research and Development in Biotechnology

Table A5: Value-Added Food and Health Platform Sectors and NAICS Codes

311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling

- 311222 Soybean Processing
- 311223 Other Oilseed Processing
- 311225 Fats and Oils Refining and Blending
- 311230 Breakfast Cereal Manufacturing
- 311313 Beet Sugar Manufacturing
- 311411 Frozen Fruit, Juice, and Vegetable Manufacturing
- 311421 Fruit and Vegetable Canning
- 311511 Fluid Milk Manufacturing
- 311512 Creamery Butter Manufacturing
- 311513 Cheese Manufacturing
- 311930 Flavoring Syrup and Concentrate Manufacturing
- 311942 Spice and Extract Manufacturing
- 312120 Breweries
- 312130 Wineries
- 312140 Distilleries
- 325411 Medicinal and Botanical Manufacturing
- 325620 Toilet Preparation Manufacturing
- 424910 Farm Supplies Merchant Wholesalers
- 541711 Research and Development in Biotechnology

APPENDIX 3: COMPOSITION OF AGBIOSCIENCE OUTPUT BY REGION

Chart A1: Agbioscience Output by Industry, Central Minnesota

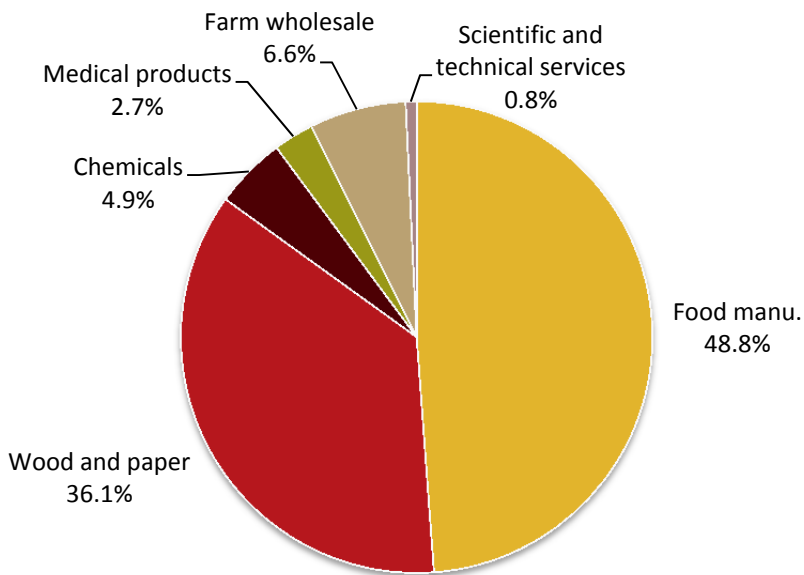


Chart A2: Agbioscience Output by Industry, Northeast Minnesota

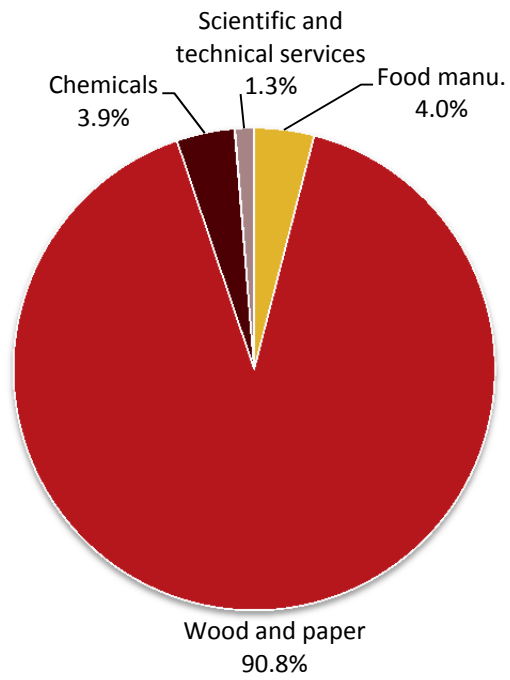


Chart A3: Agbioscience Output by Industry, Northwest Minnesota

Source: IMPLAN

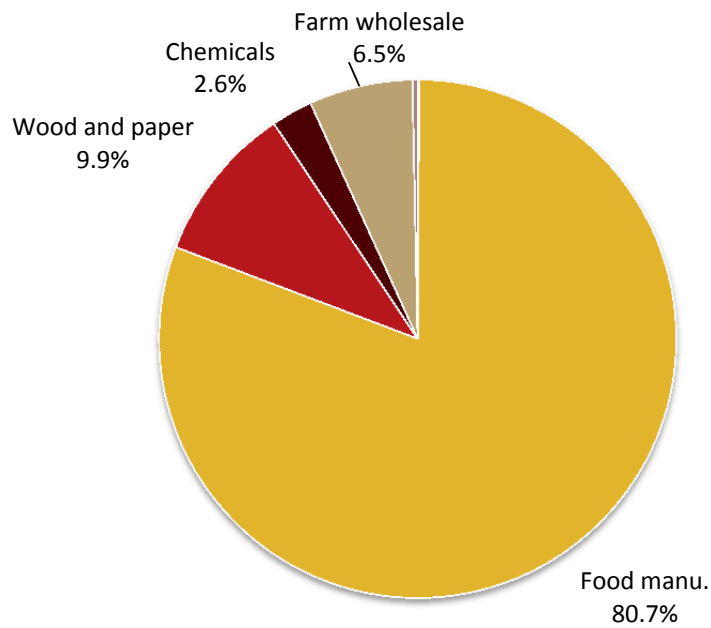
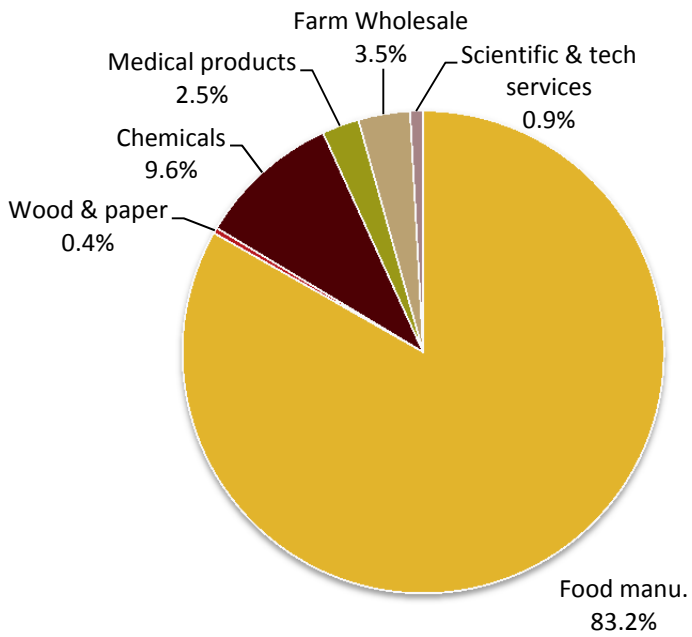


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

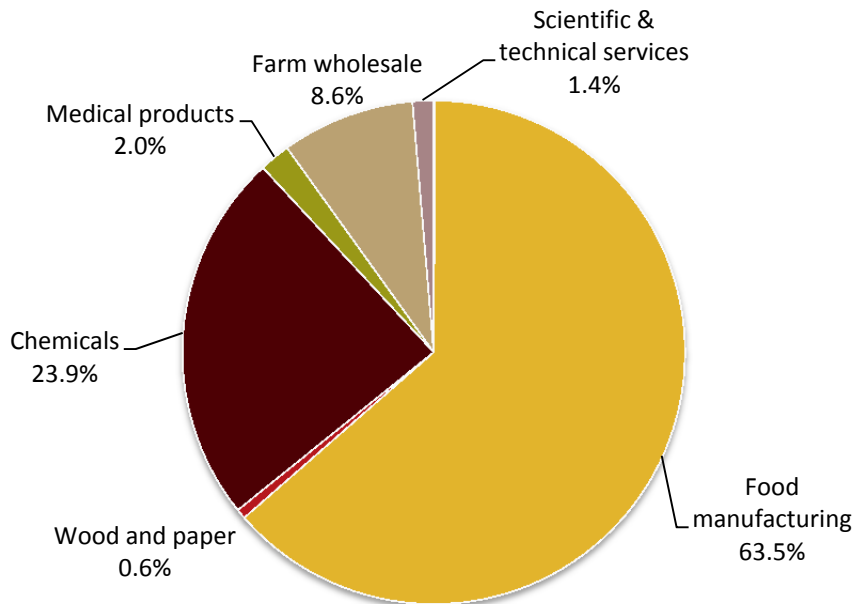
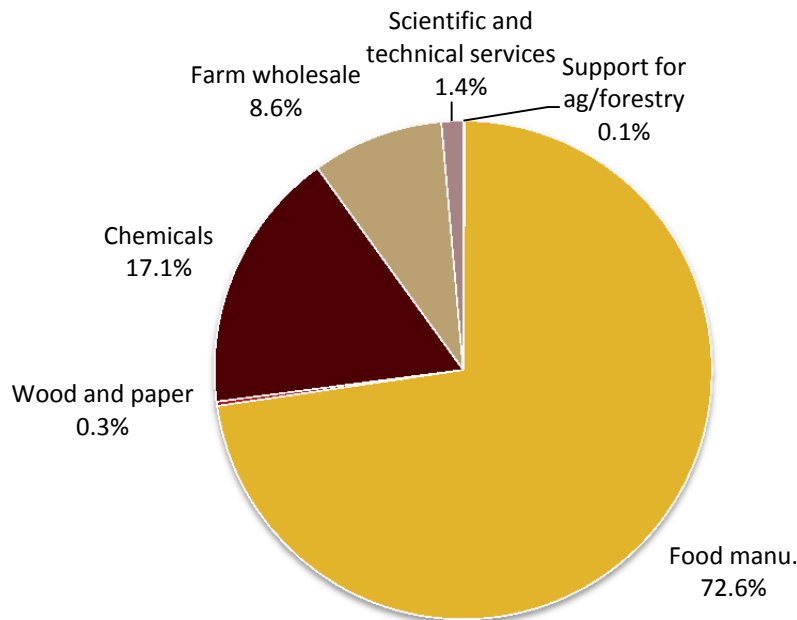


Chart A6: Agbioscience Output by Industry, West Central Minnesota



Source: IMPLAN

APPENDIX 4: REFERENCES

Battelle Technology Partnership Practice (November 2013). *Agbioscience as a development driver: Minnesota's agbioscience strategy*. Retrieved from:

<http://www.auri.org/assets/2013/12/Minnesotas+Agbioscience+Strategy+-+Final+Report-1.pdf>.

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APPENDIX 5: AGBIOSCIENCE JOBS AND CHANGE BY SECTOR, 2003-2013

Table A6 lists all the agbioscience sectors with jobs in 2003 or 2013 and the change during the period. Agbioscience sectors with no employment in 2003 or 2013 are not listed in the table.

To learn more about the types of companies classified in each agbioscience sector, please visit <http://www.naics.com/search/>.

Table A6: Agbioscience Jobs in Central Minnesota, 2003 and 2013

Description	2003 Jobs	2013 Jobs	2003- 2013 Change	2003- 2013 % Change
Farm Supplies Merchant Wholesalers	667	702	35	5%
Paper mills and newsprint mills	511	595	84	16%
Fruit and Vegetable Canning	187	322	135	72%
Cheese Manufacturing	353	297	-55	-16%
Distilleries	75	203	128	169%
Breweries	61	139	78	129%
Soil Preparation, Planting, and Cultivating	70	128	58	82%
Paperboard Mills	116	120	4	3%
Sawmills	96	100	4	4%
In-Vitro Diagnostic Substance Manufacturing	63	90	27	44%
Testing Laboratories	97	67	-30	-31%
Wood Preservation	5	60	55	1093%
Hardwood Veneer and Plywood Manufacturing	113	53	-60	-53%
Fluid Milk Manufacturing	84	49	-36	-42%
Breakfast Cereal Manufacturing	0	48	48	NA
Ethyl Alcohol Manufacturing	12	33	21	175%
Research and Development in Biotechnology	5	28	23	458%
Pesticide and Other Agricultural Chemical Manufacturing	0	25	25	NA
Cut Stock, Resawing Lumber, and Planing	5	24	19	382%
Wineries	0	22	22	NA
Remediation Services	34	20	-14	-41%
Environmental Consulting Services	33	19	-14	-43%
Flour Milling and Malt Manufacturing	0	22	22	NA
All Other Basic Organic Chemical Manufacturing	16	0	-16	-100%
Engineered Wood Member (except Truss) Manufacturing	188	0	-188	-100%
Soybean and Other Oilseed Processing	0	5	5	NA
Frozen Fruit, Juice, and Vegetable Manufacturing	0	5	5	NA
Wet Corn Milling	33	5	-28	-85%
Total	2,825	3,180	355	13%

Source: EMSI