



Economic Contribution of the Agbioscience Industry: Southeast Minnesota

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

Authored by Brigid Tuck and Neil Linscheid



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April 2015

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Editors and Reviewers:

Matt Kane, Program Leader, University of Minnesota Extension Center for Community Vitality
Elyse Paxton, Senior Editor, University of Minnesota Extension Center for Community Vitality

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ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: SOUTHEAST MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Southeast Minnesota. Southeast Minnesota includes the 20 counties served by the Southern Minnesota 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 Southeast Minnesota:* In 2013, agbioscience companies in the region directly created an estimated \$8.3 billion of economic activity, which represents 11 percent of regional output. Agbioscience in the region is primarily concentrated in food production. Growth sectors (measured by employment) include testing laboratories, fluid milk manufacturing, and breakfast cereal manufacturing. Sectors with job losses include cheese manufacturing, farm supplies wholesalers, and fats and oils refining and blending.
- *Agbioscience Platforms:* Of the four agbioscience platforms identified by Battelle, the value-added food and health products platform dominates in the Southeast region. Businesses in the platform produced \$7.4 billion in output. In comparison, the biobased industrial products platform produced \$2.6 billion, the microbial agbioscience platform \$1.8 billion, and the resilient, efficient, and productive agricultural systems platform \$0.9 billion. The microbial agbioscience platform grew the fastest between 2003 and 2013, adding 481 jobs, which is a 37 percent increase. In output, Southeast Minnesota is the largest region in all four platforms. 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 Southeast Minnesota, production agriculture created an estimated \$7.2 billion, or 10 percent of output in the region. Together, production agriculture and agbioscience companies created 21 percent of regional output in 2013.
- *Direct Effect of Agbioscience:* In 2013, agbioscience companies in Southeast Minnesota directly generated an estimated \$8.3 billion of output (sales). The companies employed 10,518 workers and paid an estimated \$747.3 million in salaries, wages, and benefits. The average annual compensation per agbioscience employee is approximately \$71,000.
- *Total Contribution of Agbioscience:* In 2013, the agbioscience industry in Southeast Minnesota supported an estimated \$11.7 billion of output across all industries in the region, including output from supplier industries and industries that benefit from spending by agbioscience workers. Based on this broad measure, the industry supported an estimated 29,218 jobs and \$1.7 billion of labor income.
- *Top Industries Impacted:* The contribution of the agbioscience industry in Southeast Minnesota is strongest in the industries of wholesale trade, transport by truck, production agriculture (especially oilseeds, dairy and milk production, and grain farming), and health care.
- *Future Growth and Development:* During the past 10 years, employment in the agbioscience industry in Southeast Minnesota has grown by 9 percent. If the trend continues with a 5 percent increase through 2016, the economic contribution of the agbioscience industry will increase to an estimated \$12.3 billion in output, 30,720 jobs, and \$1.8 billion in labor income. This growth is to be driven by demand from health care, potentially creating an interesting synergy for the Southeast region. During the same time period, the total number of jobs across all industries in the Southeast region increased by 4 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 the state 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 in 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 the field of agbioscience.

This report focuses on the current economic contribution of the agbioscience industry in Southeast Minnesota. It also explores past industry trends in employment and potential for future growth and development of the agbioscience industry in the region. Additionally, the economic contribution of agbioscience 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

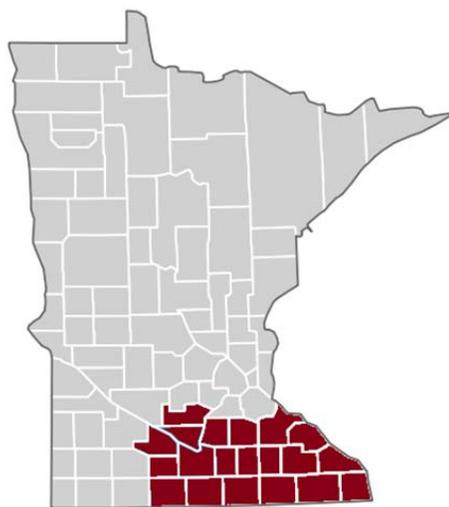
soybean processing is a sector within the manufacturing industry. More broadly, however, the definition of agbioscience includes components of food manufacturing; wood and paper product manufacturing; chemical manufacturing; farm supplies wholesalers; environmental consulting; and research and development 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 for 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 SOUTHEAST REGION

For this report, the region defined as Southeast Minnesota is composed of counties covered by the Southern Minnesota Initiative Foundation. Counties included in this analysis are Blue Earth, Brown, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Houston, Le Sueur, Martin, Mower, Nicollet, Olmsted, Rice, Sibley, Steele, Wabasha, Waseca, Watonwan, and Winona.

Map 1: Southeast Region



ECONOMIC OVERVIEW AND THE AGBIOSCIENCE INDUSTRY IN SOUTHEAST MINNESOTA

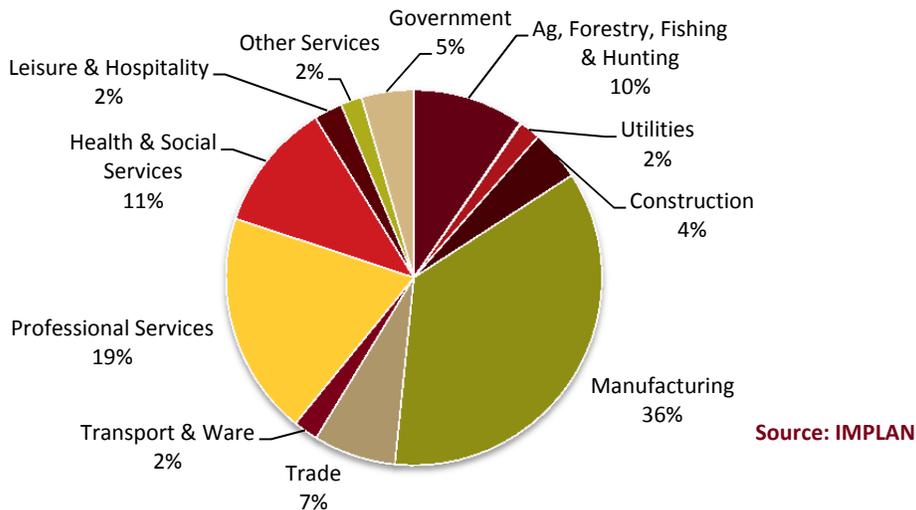
Understanding the role of agbioscience in the Southeast region requires an understanding of the broader economy of the region. Several metrics exist for measuring economic activity, but this analysis focuses on output and employment. Output is a measure of the total transactions in an economy. Most transactions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

Output

In 2013, businesses and enterprises in the Southeast Minnesota economy produced \$75.6 billion of output. Manufacturers were the single largest contributors of output in the region, producing \$27.1 billion of sales in 2013 (chart 1). The manufacturing sector in the region encompasses a broad range of activities. Large manufacturing sectors in Southeast Minnesota include food production (38 percent of manufacturing output), computers and electronics (21 percent), and machinery manufacturing (8 percent).

Significant food product manufacturing sectors include breakfast cereal manufacturing, fruit and vegetable processing, cheese manufacturing, and animal processing. Businesses in these manufacturing sectors each produce more than \$1 billion of output. These large manufacturing sectors (with the exception of animal processing) are included in the definition of agbioscience in this report.

Chart 1: Output by Industry, Southeast Minnesota



The professional and business services industry produced \$14.5 billion of output in 2013. Large sectors within the industry include real estate and rental, finance and insurance, and information. Research and development in biotechnology, and testing and environmental consulting, both included in the definition of agbioscience, are components of the professional and business services industry.

The health and social services industry produced \$8.4 billion in output in the region. Health and social services is dominated by the health care sector in Rochester, home to the Mayo Health System.

Testing laboratories included in the definition of agbioscience can provide services related to both health care and agbioscience. Interestingly, the region produces more supply in the testing laboratories sector than demanded by businesses in the region. In other words, testing laboratories in the Southeast region are conducting services for businesses located outside of the region.

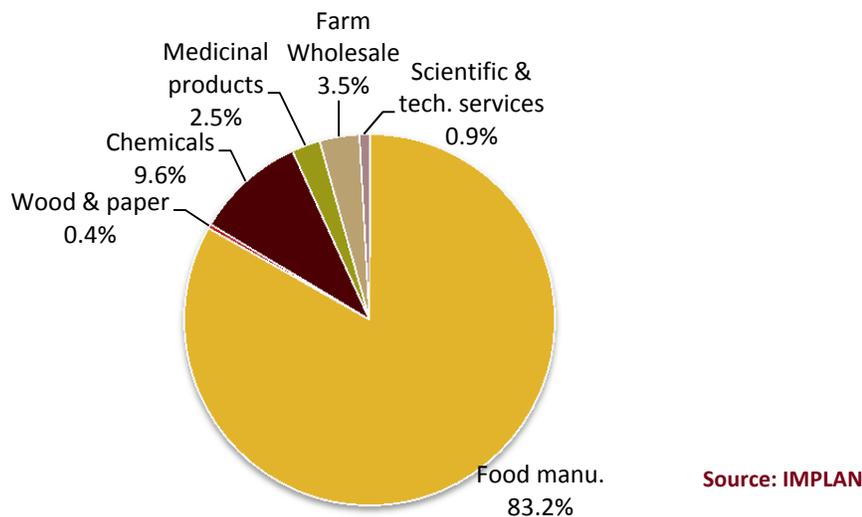
Agbioscience Output

In 2013, agbioscience businesses generated \$8.3 billion of output in the Southeast region. This represents 11 percent of total output across all industries in the region. If agbioscience were categorized as its own industry, it would be nearly equal to the health care and social services industry, in terms of output.

Food manufacturers are major contributors to the agbioscience industry in Southeast Minnesota (chart 2). In 2013, food manufacturers made \$6.9 billion of sales. As mentioned, large food manufacturers include breakfast cereal, fruit and vegetable processing, and cheese manufacturing.

Chemical product manufacturing created approximately \$800 million of output in 2013. Major chemical manufacturing sectors include ethyl alcohol (ethanol production) and fertilizer manufacturing.

Chart 2: Agbioscience Output by Industry, Southeast Minnesota



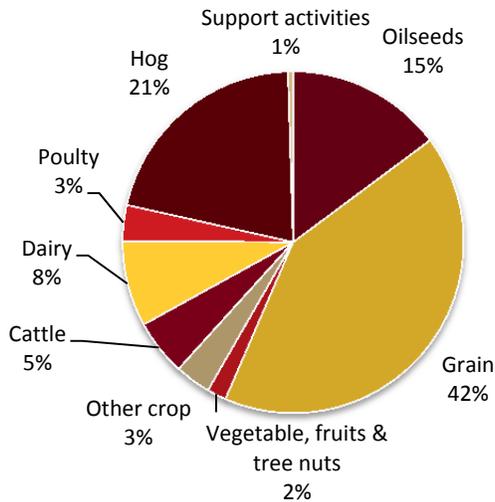
In comparison with other regions, the Southeast region is the largest source of agbioscience output in Greater Minnesota. In 2013, the Southeast region accounted for 50 percent of Greater Minnesota's agbioscience output. This is primarily due to food manufacturing. Southeast Minnesota accounted for 63 percent of all food manufacturing related to agbioscience in Greater Minnesota. The Southeast region is also a leader in chemical manufacturing.

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 \$7.2 billion in economic activity in the Southeast region in 2013. Grain production accounts for 42 percent of total output (chart 3), followed by hog production (21 percent) and oilseed production (15 percent).

Chart 3: Production Agriculture Output by Sector, Southeast Minnesota

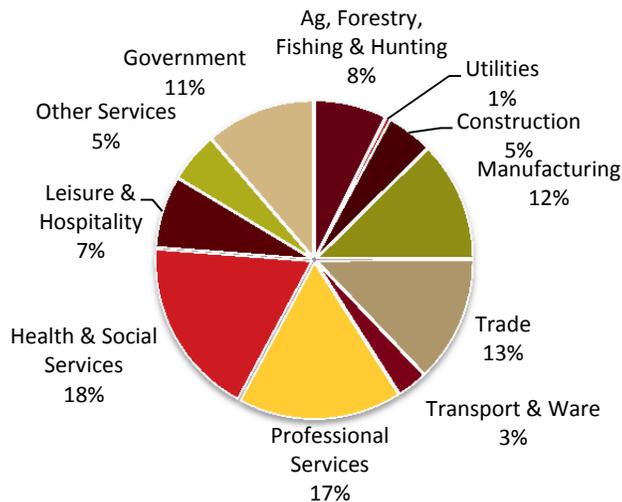


Source: IMPLAN

Employment

Output is one measure of economic activity; another is employment. According to IMPLAN, there are 454,500 jobs in the Southeast region. Eighteen percent are in the health and social services industry; 17 percent are in professional services; and 13 percent are in trade (chart 4).

Chart 4: Employment by Industry, Southeast Minnesota



Source: IMPLAN

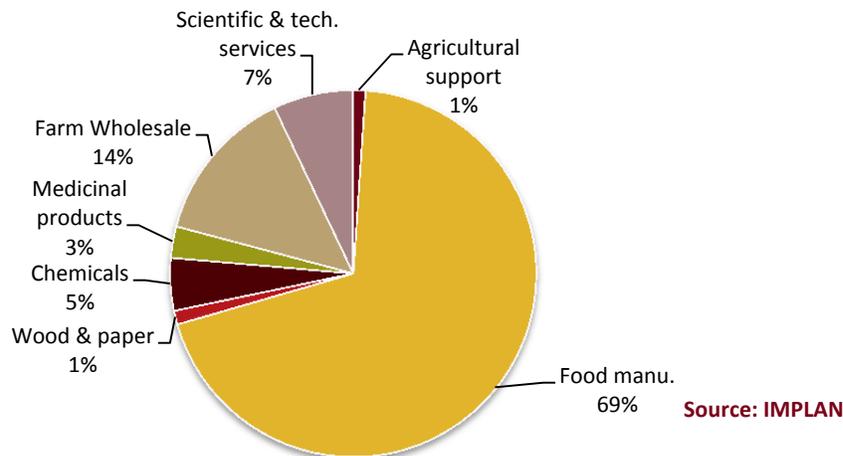
Agbioscience Employment

Agbioscience industries in the Southeast region employ an estimated 10,518 of the 454,500 workers in the region. More than two-thirds of those workers are in the food manufacturing sector. Farm

supply wholesalers employ 14 percent of workers and scientific and technical services employ 7 percent. 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.

In comparison to other regions in Greater Minnesota, the Southeast region comprises the largest share of agbioscience employment. There were 22,763 agbioscience jobs in Greater Minnesota; thus, the Southeast region accounts for approximately 46 percent of all agbioscience employment.

Chart 5: Agbioscience Employment by Industry, Southeast 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 Southeast Minnesota grew by 9 percent. In comparison, the number of jobs in the agbioscience industry in Greater Minnesota declined by 3 percent. The Southeast was one of three regions to post positive jobs gains during this time period in the agbioscience industry. During the same period, the total number of jobs in all industries in the Southeast region increased by 4 percent.

Shift-share analysis examines the drivers of growth and decline for a specific industry in 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				
Testing Laboratories	510	23	15	472
Breakfast Cereal Manufacturing	246	-83	51	278
Fluid Milk Manufacturing	227	-10	4	233
Top 3 Job Loss Industries				
Farm Supplies Merchant Wholesalers	-378	-30	87	-436
Cheese Manufacturing	-237	140	83	-460
Fats and Oils Refining and Blending	-137	10	14	-161

Source: EMSI

Testing laboratories added far more jobs than anticipated, given industry and national trends. The sector grew at the national level, so it is expected the sector in the Southeast would add jobs (industry mix effect). As the overall economy also expanded, jobs would also have been added (national growth effect). However, the testing laboratories sector in the Southeast region added even more jobs, indicating a specific strength in the region. While other regions in Minnesota added jobs in the testing laboratories sector, the Southeast region posted the highest number.

As highlighted in the table, fluid milk manufacturing and breakfast cereal manufacturing in the region also outperformed national and industry trends. Breakfast cereal manufacturing added 278 more jobs than expected. Fluid milk manufacturing added 233 more jobs than expected given trends, based on national and industry trends

The cheese manufacturing sector, on the other hand, created fewer jobs than anticipated, given national and industry trends. Had the industry grown at the rate predicted based on these trends, Southeast Minnesota would have 460 more jobs in this sector than it currently does. The cheese manufacturing sector has also seen a number of plant consolidations in recent years.² The farm supplies merchant wholesalers sector and the fats and oils refining and blending sector also posted negative competitive shares and job losses.

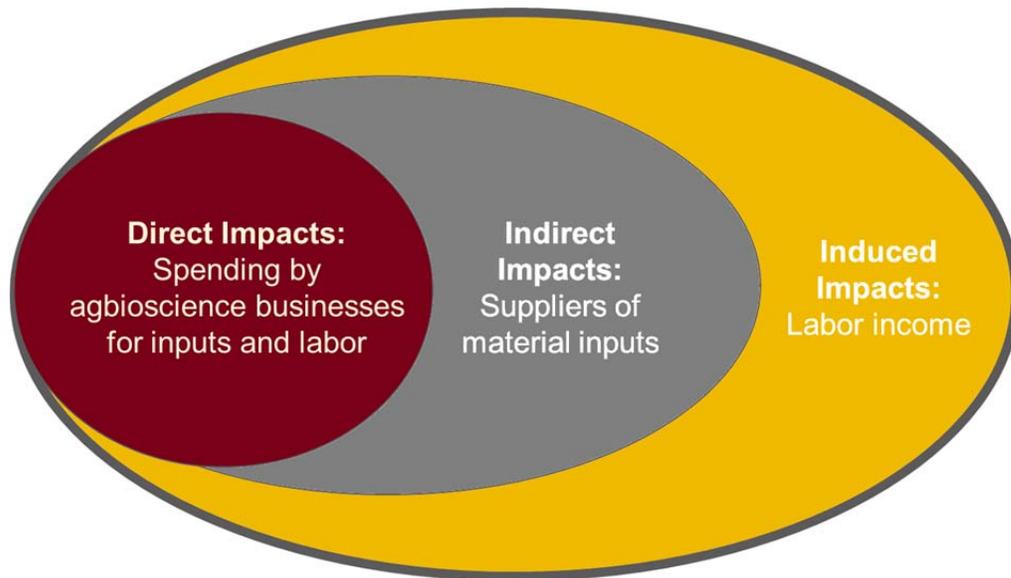
¹ For an explanation of shift-share analysis, please see the methodology section. Note: the table may not sum due to rounding.

² <http://tcbmag.com/News/Recent-News/2012/October/Kraft-to-Cut-90-Positions-in-New-Ulm,-Shift-Product> and <http://tcbmag.com/News/Recent-News/2012/November/MN-Dairy-Plant-Closure-to-Result-in-130-Layoffs>

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN SOUTHEAST 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 for this study.

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 Southeast 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 database estimates the amount of output created per employee in a sector.³

In 2013, agbioscience companies in Southeast Minnesota employed 10,518 people (table 2). The highest shares of jobs were in the sectors of fruit and vegetable canning, pickling, and drying; cheese manufacturing; and farm supplies wholesalers.

³ For more on EMSI, please see www.economicmodeling.com. For more on IMPLAN, please see implan.com. To learn more about the types of businesses classified in each agbioscience sector, visit <http://www.naics.com/search/>.

Companies in the agbioscience industry created \$8.3 billion of output (sales). Output is led by cheese manufacturing, breakfast cereal manufacturing, and soybean and other oilseed processing.

Table 2: Direct Effect of Agbioscience Industry in Southeast Minnesota

Industry Name	Employment	Output (millions)
Fruit and vegetable canning, pickling, and drying	1,906	\$991.6
Cheese manufacturing	1,478	\$1,501.6
Farm supplies wholesalers	1,434	\$295.2
Breakfast cereal manufacturing	1,301	\$1,111.0
Testing laboratories	824	\$76.5
Fluid milk and butter manufacturing	577	\$726.1
Soybean and other oilseed processing	492	\$1,013.6
Other basic organic chemical manufacturing (includes ethanol)	350	\$607.1
Flour milling and malt manufacturing	346	\$465.2
Frozen food manufacturing	305	\$105.4
Seasoning and dressing manufacturing	241	\$142.6
Toilet preparation manufacturing	169	\$126.9
Breweries	158	\$133.1
Fats and oils refining and blending	143	\$640.6
Wineries	126	\$41.3
Engineered wood member and truss manufacturing	114	\$29.3
Soil preparation, planting, and cultivating	108	\$1.4
Plastics material and resin manufacturing	86	\$138.5
In-vitro diagnostic substance manufacturing	66	\$43.8
Pulp mills	59	\$52.5
Remediation services	56	\$11.7
Sawmills and wood preservation	48	\$12.8
Environmental consulting services	43	\$3.2
Synthetic rubber manufacturing	36	\$43.4
Veneer and plywood manufacturing	20	\$5.7
Scientific research and development services in biotechnology	11	\$1.7

Fertilizer manufacturing	10	\$15.6
Wood windows and doors and millwork manufacturing	5	\$1.0
Medicinal and botanical manufacturing	5	\$3.2
Total	10,518	\$8,341.6

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 can 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 Southeast Minnesota. In other words, purchases made outside of the Southeast 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 (for example, soybeans and grains) and related services (accounting and insurance, for instance). 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 sum 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.⁴

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

Total Effect

In 2013, the agbioscience industry contributed an estimated \$11.7 billion dollars in economic activity to the Southeast region of Minnesota (table 3) from all effects – direct, indirect, and induced. The industry’s presence in the Southeast region supported an estimated 29,218 jobs. These employees receive an estimated \$1.7 billion in wages, salaries, and benefits.

The agbioscience industry directly created \$8.3 billion in economic activity in the region, as detailed above. Agbioscience companies directly employed 10,518 residents of the region and spent \$747.3 million in compensation for those workers. Each agbioscience employee earns approximately \$71,000 annually in wages, salaries, and benefits.

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

⁴ For further definitions of direct, indirect, and induced effects, please see appendix 1.

generated \$2.5 billion in activity in 2013 at regional businesses and supported jobs for 11,300 individuals in those businesses.

When employees of agbioscience companies spend their wages and salaries in the Southeast region, this creates economic activity at businesses in the region (induced effects). Employee spending generated \$875.0 million in economic activity in 2013 in the region and supported employment for 7,400 workers.

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$8,341.6	10,518	\$747.3
Indirect	\$2,520.5	11,300	\$686.8
Induced	\$875.0	7,400	\$285.5
Total	\$11,737.1	29,218	\$1,719.6

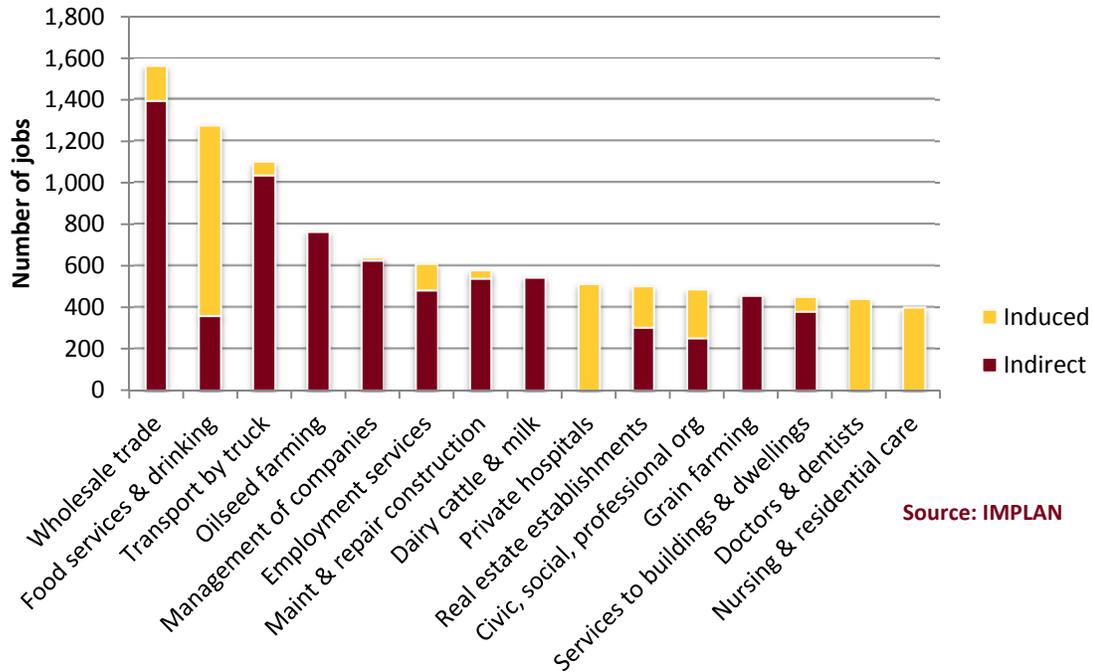
Estimates by University of Minnesota Extension

Top Industries Affected

Agbioscience companies support employment for 29,218 people in Southeast Minnesota. Of these, 10,518 jobs are with the agbioscience industry itself. Thus, the agbioscience industry supports 18,700 jobs in other businesses in the region. Chart 7 illustrates the top fifteen sectors with jobs supported by the agbioscience industry. These impacts are driven by the local expenditures and vary depending on the type 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 wholesale trade sector, transport by truck, and farming enterprises (oilseeds, dairy, and grain production). 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.

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 sector.

Chart 7: Top Sectors Affected, Sorted by Employment, Southeast Minnesota

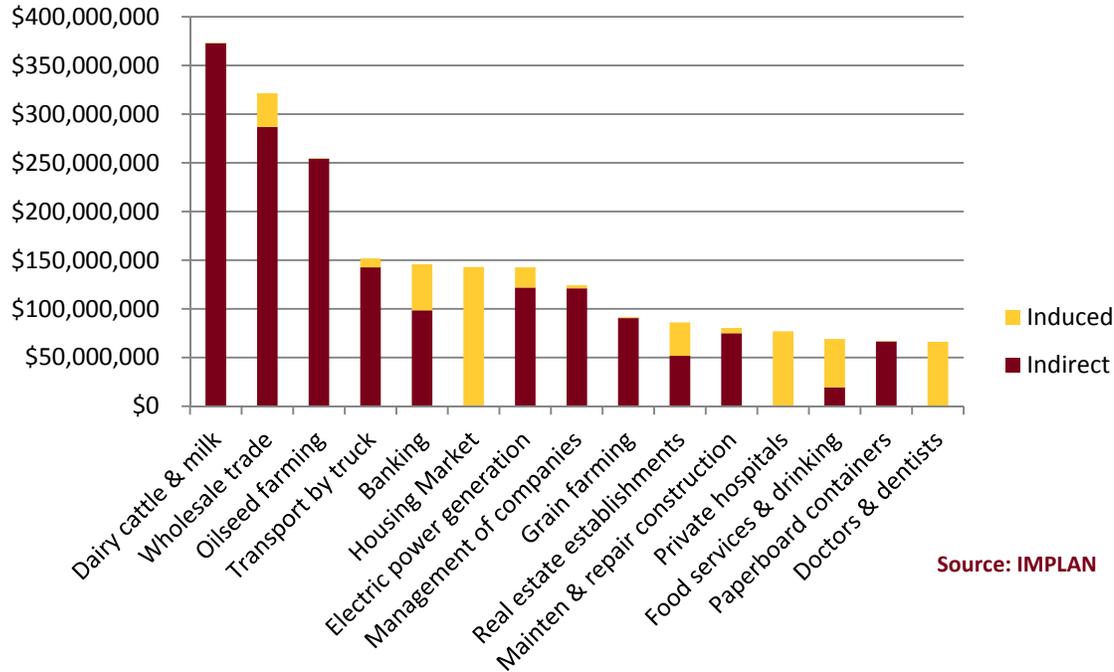


Source: IMPLAN

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 \$11.7 billion in economic activity to the Southeast region. Agbioscience companies directly spend \$8.3 billion in the region. The remainder, \$3.4 billion, is activity at other businesses in the region. Activities by agbioscience companies in the region contribute most strongly to the dairy and milk production sector, the wholesale trade sector, and the oilseed production sector.

Chart 8: Top Sectors Affected, Sorted by Output, Southeast Minnesota



Source: IMPLAN

Contribution of Agbioscience by Region of Greater Minnesota

Agbioscience businesses exist in all regions of Minnesota⁵ (table 4). Agbioscience economic activity is highest in the southern portion of the state. The highest levels of output and employment are in the Southeastern and Southwestern regions. Together, the two regions produce more than 65 percent of agbioscience output in Greater Minnesota.

The Southeast region alone is responsible for 50.2 percent of Greater Minnesota’s total agbioscience output. In contrast, the Southeast region is responsible for 35 percent of Greater Minnesota’s total output. Since the Southeast regional economy is the largest of the six economies, its share of total agbioscience output would be expected to be higher than the other regions. However, it is significantly higher than expected.

⁵ 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/>.

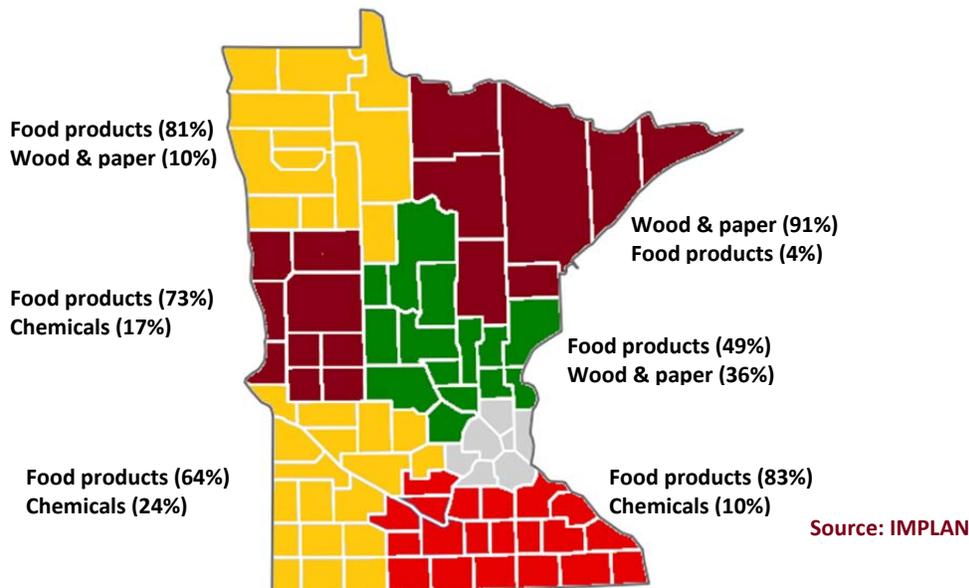
Table 4: Total Economic Contribution of Agbioscience by Region in Minnesota, 2013

	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 Center for Community Vitality

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 Southeast Minnesota, it produces 83 percent of all agbioscience output in the region. Food manufacturing composes a significant share of output in all of the 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 and includes ethanol production and fertilizer production.

Wood and paper production, 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 sector produces the largest share of agbioscience output in the region.

Future Growth and Development of Agbioscience

The agbioscience industry in Southeast 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 9 percent, despite the Great Recession in 2008-2009. The 2013 Battelle Technology Partnership Practice report identified potential growth in the industry out 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 Southeast 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 based on historical growth rates in the industry and estimates by Battelle. They are provided for illustrative purposes.

If employment in the agbioscience industry in Southeast 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 \$12.3 billion in output, an estimated 30,720 jobs, and an estimated \$1.8 billion in labor income (table 5).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$8,758.7	11,040	\$784.7
Indirect	\$2,646.6	11,900	\$721.1
Induced	\$918.8	7,780	\$299.8
Total	\$12,324.1	30,720	\$1,805.6

Estimates by University of Minnesota Extension

If employment in the agbioscience industry in Southeast 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 \$12.9 billion in output, an estimated 32,180 jobs, and an estimated \$1.9 billion in labor income (table 6).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$9,175.8	11,570	\$822.0
Indirect	\$2,722.6	12,460	\$755.4
Induced	\$962.5	8,150	\$314.1
Total	\$12,860.9	32,180	\$1,891.5

Estimates by University of Minnesota Extension

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

The Battelle report identified four agbioscience platforms in Minnesota. 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 Southeast Minnesota.

In terms of direct impacts, the largest platform in the Southeast region is the value-added food and health products platform. In 2013, the platform supported \$10.5 billion of output in the Southeast region (table 7). The platform also supported employment for 25,260 workers and paid \$1.5 billion in wages, salaries, and benefits.

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

	Output (Millions)	Employment (Rounded)	Labor Income (Millions)
Microbial agbioscience	\$2,583.4	5,890	\$360.2
Resilient, efficient, & productive agricultural systems	\$1,246.9	4,240	\$260.0
Biobased industrial products	\$3,443.5	6,240	\$401.2
Value-added food and health products	\$10,502.2	25,260	\$1,533.4

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 481 jobs, increasing the number of jobs in the platform by 37 percent. The number of jobs in the value-added food and health products platform remained steady. The number of jobs in both the agricultural systems and biobased industrial products platforms declined.

Table 8: Change in Number of Jobs by Agbioscience Platform in Southeast 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	1,283	1,764	37%
Resilient, efficient, & productive agricultural systems	2,398	2,017	-16%
Biobased industrial products	1,452	1,380	-5%
Value-added food and health products	8,589	8,692	1%

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 identifies 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.⁶

In 2013, the microbial agbioscience platform supported an estimated \$2.6 billion of output in Southeastern Minnesota. The platform also supported an estimated 5,894 jobs, with the jobs paying an estimated \$360.2 million of labor income (table 9).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$1,845.0	1,764	\$118.7
Indirect	\$555.7	2,580	\$181.9
Induced	\$182.7	1,550	\$59.6
Total	\$2,583.4	5,894	\$360.2

Estimates by University of Minnesota Extension

The Southeast region is the largest region in the platform in both output and employment. Within the platform in the Southeast region, the largest sectors measured by output are soybean processing; fats and oils refining and blending; and architectural, engineering and related services. The highest ripple effects are in oilseed farming, wholesale trade, and food services and drinking establishments.

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 the strong presence of the health care industry in the Southeast region, an interesting synergy may exist.

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 Southeast Minnesota would increase to an estimated \$2.9 billion, including an estimated 6,480 jobs, and an estimated \$396.2 million in labor income.⁷

⁶ For an exact definition of what is included in the microbial agbioscience platform, please see the appendix.

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 rate (10.7 percent).

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, and remediation services.

In 2013, the resilient, efficient, and productive agricultural systems platform supported an estimated \$1.2 billion of output in Southeast Minnesota. The platform also supported an estimated 4,237 jobs, with those jobs paying an estimated \$260.0 million of labor income (table 10).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$943.6	2,017	\$163.4
Indirect	\$170.6	1,100	\$53.3
Induced	\$132.7	1,120	\$43.3
Total	\$1,246.9	4,237	\$260.0

Estimates by University of Minnesota Extension

The Southeast region is the largest region in the platform for both output and employment. Within the Southeast region, the largest sectors in the platform (measured by output) are ethyl alcohol manufacturing and farm suppliers wholesalers. The largest ripple effects are in wholesale trade, the housing market, and electric power generation.

According to the Battelle report on the resilient, efficient, and productive agricultural systems platform, "the North American 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 rate of growth of 10 percent occurs, the economic contribution of the resilient, efficient, and productive agricultural systems platform would increase to \$1.4 billion of output, including 4,660 jobs and \$286.0 million in labor income.⁸

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 agricultural systems 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.

⁸ 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).

In 2013, the biobased industrial products platform supported \$3.4 billion of output in Southeast Minnesota. The platform also supported 6,240 jobs, with those jobs paying \$401.2 million in labor income (table 11).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,572.1	1,380	\$120.0
Indirect	\$667.5	3,130	\$214.7
Induced	\$203.9	1,730	\$66.5
Total	\$3,443.5	6,240	\$401.2

Estimates by University of Minnesota Extension

Within the platform, the Southeast region produces the highest levels of output and employment. The Northeast, Central, and Southwest regions also have significant levels of output in the platform (more than \$1 billion in each region). In the Southeast region, soybean and oilseed processing and ethyl alcohol manufacturing are major employers within the platform. The largest ripple effects are in the oilseed farming and wholesale trade businesses.

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 the 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 \$3.6 billion of output, including 6,550 jobs and \$421.3 million in labor income.⁹

Value-Added Food and Health Products

This platform is based on Minnesota’s strengths 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.

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 (3 to 6.9 percent).

In 2013, the value-added food and health products platform supported an estimated \$10.5 billion in output in Southeast Minnesota, including an estimated \$1.5 billion in labor income and 25,262 jobs (table 12).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$7,360.3	8,692	\$637.6
Indirect	\$2,360.2	10,100	\$641.3
Induced	\$781.7	6,470	\$254.5
Total	\$10,502.2	25,262	\$1,533.4

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 Southeast region, large employers in the platform include fruit and vegetable canning, cheese manufacturing, wholesale trade, and breakfast cereal manufacturing. In West Central, by contrast, major employers in the platform include beet sugar manufacturing, wholesale trade, and fluid milk and butter manufacturing. The largest ripple effects in the Southeast region include dairy cattle and milk production, oilseed farming, and transport by truck.

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 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. Based on the predicted growth rate in the nutraceuticals market (a sub-sector of the value-added food and health platform) and historical growth rates, University of Minnesota Extension modeled a 5 percent increase in the industry.

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 \$11.0 billion of output, including an estimated 26,530 jobs and an estimated \$1.6 billion in labor income.¹⁰

Contribution of Agbioscience Platforms by Region of Greater Minnesota

In comparison to the other regions, the Southeast region is the largest contributor to total economic contribution in each of the platforms (table 13). In certain platforms (value-added food and health

¹⁰ 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).

products and microbial agbioscience), the Southeast region is largest by a quite a margin. In other platforms (resilient, efficient, and productive agricultural systems and biobased industrial products), the Southeast is the largest, but there are several other regions of similar size.

As a note, the Southeast regional economy is also the largest of the regional economies. In 2012, businesses and enterprises in the Southeast region generated \$75.6 billion of output. In comparison, in the Central region (the second largest region), businesses and enterprises generated \$52.0 billion of output. In the smallest region, Northwest, businesses and enterprises generated \$15.6 billion of output.

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.

Output (millions)	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

While the Southeast region is the largest region in each platform, the rate of growth of each platform varies. The Southeast region was among the fastest growing regions in the microbial agbioscience platform, with the number of jobs in the platform increasing by 37 percent between 2003 and 2013. The number of jobs in the productive agricultural systems platform declined by 16 percent during the period.

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, Minnesota is positioned with a strong agbioscience industry. The agbioscience industry is a broad continuum that includes many agricultural, scientific, and research activities. The Agricultural Utilization Research Institute (AURI) recognizes the importance of agbioscience within the state's economy. In 2013, AURI, along with the Minnesota Corn Research and Promotion Council and the Minnesota Soybean Research and Promotion Council, partnered 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 provides focus 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 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 Southeast region.

The agbioscience industry contributes significantly to the economy of Southeast Minnesota. In 2013, the total economic contribution of the agbioscience industry was an estimated \$11.7 billion in the Southeast region. Through all of its impacts, the agbioscience industry supported an estimated 29,218 jobs that paid \$1.7 billion in income to workers in the region.

In Southeast Minnesota, the agbioscience industry is dominated by food processing. Cheese manufacturing, breakfast cereal manufacturing, and fruit, vegetable, canning, pickling, and drying directly create approximately \$1 billion of output each. Chemical manufacturing, including ethanol production, is also a significant portion of the agbioscience industry in the region. Growing agbioscience sectors in the region include: testing laboratories, fluid milk production, and breakfast cereal manufacturing. These sectors have added jobs in the past 10 years and have done so at rates faster than expected given national and industry trends. Cheese manufacturing, farm supplies wholesalers, and fats and oils refining and blending are agbioscience sectors that shed jobs between 2003 and 2013. These jobs losses exceeded expectations given national and industry trends.

Directly, agbioscience companies in the Southeast employ 10,518 individuals. The companies spent \$8.3 billion in 2013, including compensation to workers of \$747.3 million. Each agbioscience employee earns approximately \$71,000 annually in wages, salaries, and benefits. The \$8.3 billion of output represents approximately 11 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 \$7.2 billion or about 10 percent of all sales in the region.

Indirectly, industries with strong ties to agriculture and manufacturing are most affected by the agbioscience industry in Southeast Minnesota. The related industries benefiting most from employment impacts include wholesale trade, transport by truck, and production agriculture (oilseed, dairy, and grains). Spending by employees of agbioscience companies creates the highest impacts at food services and drinking establishments, hospitals, and offices of doctors and dentists.

During the past 10 years, the agbioscience industry in Southeast Minnesota has grown by 9 percent. If that trend continues with a 5 percent increase, the economic contribution of the agbioscience industry in the region will increase an estimated \$12.3 billion in output by 2016, including an estimated 30,720 jobs and \$1.8 billion in labor income.



Of the six regions included in the analysis, the Southeast regional economy is the largest with \$75.6 billion of output. The Southeast region is responsible for more than 50 percent of agbioscience's total economic contribution in Greater Minnesota, making it the largest of the regions.

Of the four platforms, the value-added food and health products platform is the largest in the Southeast region. In 2013, the platform supported an estimated \$10.5 billion of economic activity in the region, including an estimated 25,260 jobs. This platform is based on Minnesota's strengths 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 was the microbial agbioscience platform, which grew by 37 percent between 2003 and 2013. The microbial agbioscience platform supported an estimated \$2.6 billion of output in Southeastern Minnesota in 2013. The platform also supported an estimated 5,890 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 Southeast region is a major component of the agbioscience industry in Greater Minnesota. The region clearly will be important in the future growth and development of the industry, particularly in the realm of value-added food and health products. The region has a strong base of food production and manufacturing on which to grow. Given the region's strengths in health care, an interesting synergy may exist to move food manufacturers into the health food market. The microbial agbioscience platform also appears to hold opportunity. The number of jobs in the platform has been growing, particularly in areas related to health care. The number of testing laboratories jobs has also increased. Interestingly, the region's expertise in this area means the services of testing laboratories are being offered to customers outside of the region.

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)¹¹ 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.

¹¹ IMPLAN Version 3.0 was used in this analysis. The trade flows model with SAM multipliers was implemented.

- **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 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 the corn is built into the price of each of these items and then the sale of each 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 labor costs in the price. When dairy farmers sell the milk to the cheese manufacturer, they include a value for their labor. These 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 southeast 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 to DEED their total payroll and the number of employees. 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.
- **Percent Competitive Share:** This is the percent of total jobs that are sourced from competitive share. A competitive share of 80 percent would indicate that 80 percent of the jobs during the time period were derived from the competitive share, rather than from 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

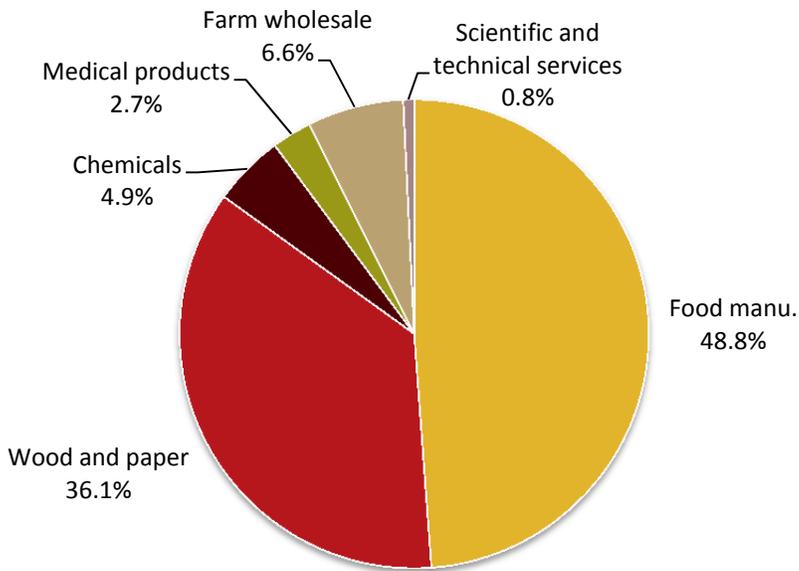
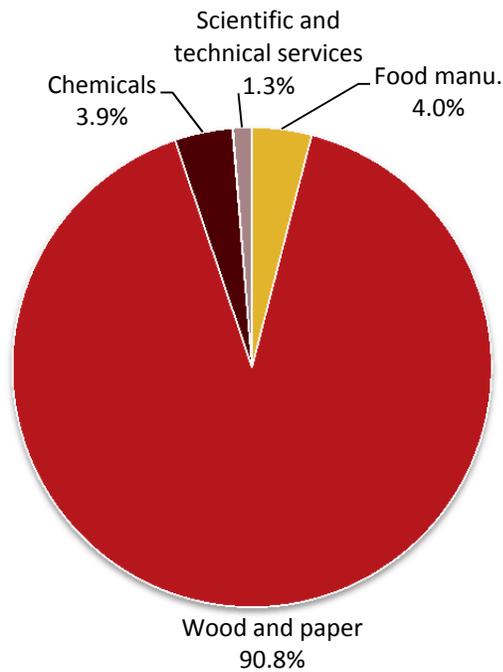


Chart A2: Agbioscience Output by Industry, Northeast Minnesota



Source: IMPLAN

Chart A3: Agbioscience Output by Industry, Northwest Minnesota

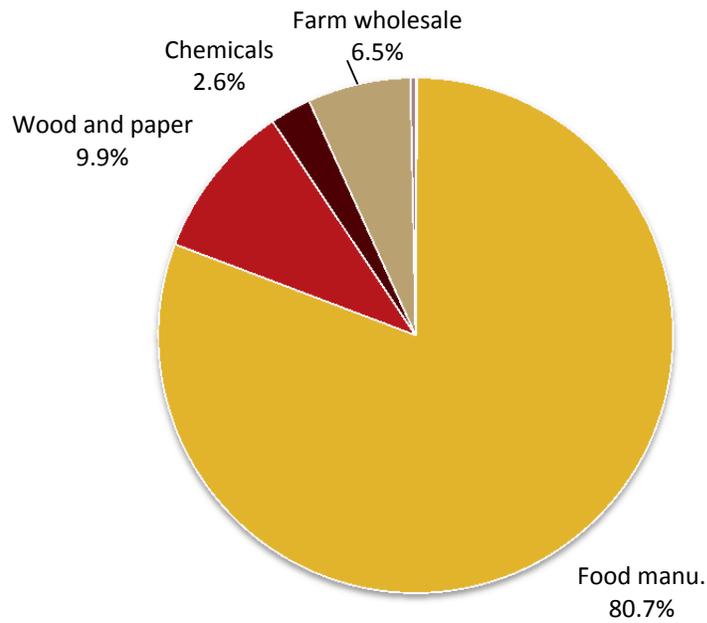
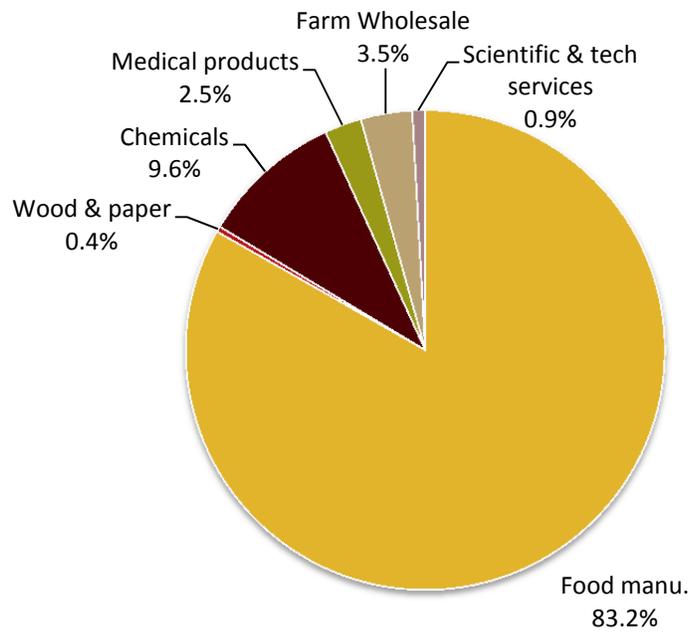


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

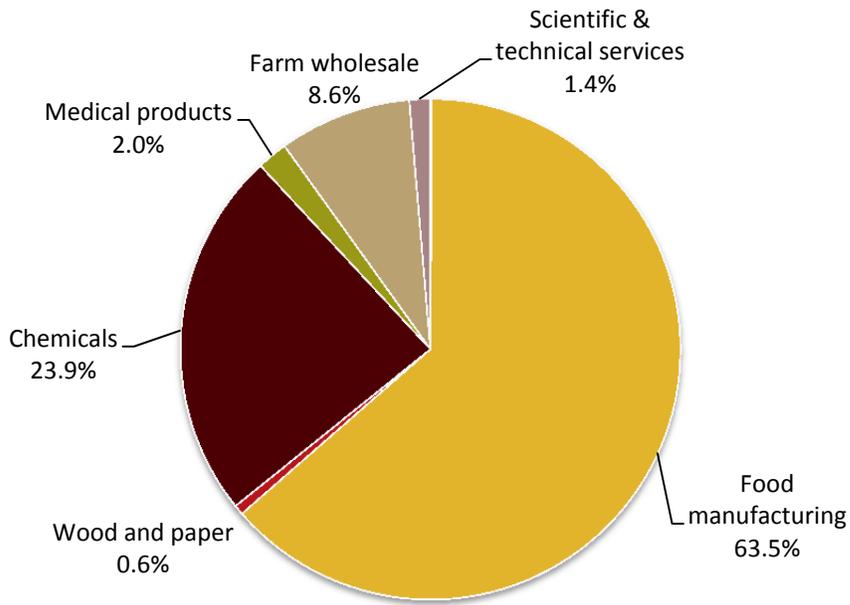
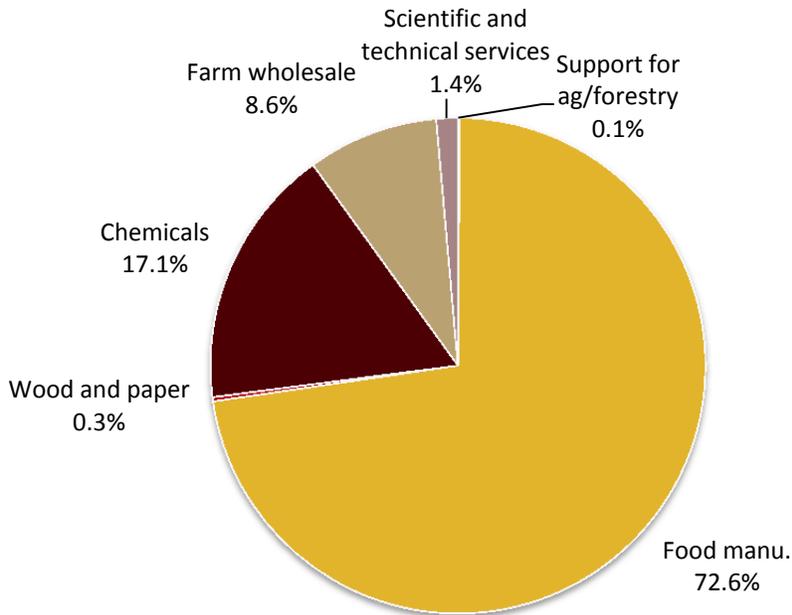


Chart A6: Agbioscience Output by Industry, West Central Minnesota



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>.

Battelle Technology Partnership Practice and BioDimensions (February 2013). *Impact and innovation: Agbioscience in the Southern United States*. Retrieved from: http://battelle.org/docs/energy-environment/battelle_agbioscience_southern_usa_3_13.pdf?sfvrsn=0.

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 Southeast Minnesota, 2003 and 2013

Industry Name	2003	2013	Change 2003-2013	Percent Change 2003-2013
Fruit and Vegetable Canning	1,953	1,906	-47	-2%
Cheese Manufacturing	1,715	1,478	-237	-14%
Farm Supplies Merchant Wholesalers	1,812	1,434	-378	-21%
Breakfast Cereal Manufacturing	1,055	1,301	246	23%
Testing Laboratories	314	824	510	162%
Soybean and Other Oilseed Processing	416	492	76	18%
Ethyl Alcohol Manufacturing	174	350	176	101%
Flour Milling	423	346	-77	-18%
Fluid Milk Manufacturing	86	313	227	264%
Frozen Fruit, Juice, and Vegetable Manufacturing	230	305	75	33%
Creamery Butter Manufacturing	69	264	195	281%
Spice and Extract Manufacturing	185	241	56	30%
Toilet Preparation Manufacturing	111	169	58	53%
Breweries	67	158	92	138%
Fats and Oils Refining and Blending	280	143	-137	-49%
Wineries	19	126	107	578%
Engineered Wood Member (except Truss) Manufacturing	100	114	14	14%
Soil Preparation, Planting, and Cultivating	95	108	14	15%
Plastics Material and Resin Manufacturing	130	86	-44	-34%
In-Vitro Diagnostic Substance Manufacturing	0	66	66	NA
Pulp Mills	0	59	59	NA
Remediation Services	62	56	-6	-9%
Sawmills	94	48	-46	-49%
Environmental Consulting Services	53	43	-10	-18%
Synthetic Rubber Manufacturing	13	36	22	165%
Hardwood Veneer and Plywood	5	20	15	308%



Manufacturing				
Research and Development in Biotechnology	91	11	-80	-88%
Fertilizer (Mixing Only) Manufacturing	45	10	-35	-78%
Cut Stock, Resawing Lumber, and Planing	0	5	5	NA
Medicinal and Botanical Manufacturing	25	5	-20	-80%
Malt Manufacturing	53	0	-53	-100%
Total	9,675	10,518	843	9%

Source: EMSI

