



Economic Contribution of the Agbioscience Industry: Northeast 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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ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: NORTHEAST MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Northeast Minnesota, which includes the seven counties served by the Northland 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 Northeast Minnesota:* In 2013, agbioscience companies in the region directly created an estimated \$2.1 billion of economic activity, which represents 7 percent of regional output. Agbioscience in the region is based primarily on wood and paper products manufacturing. Growth sectors (measured by employment) include testing laboratories and pulp mills. Sectors with job losses include paper mills, reconstituted wood product manufacturing, and sawmills. Northeast Minnesota is responsible for 13 percent of Greater Minnesota's total agbioscience output.
- *Agbioscience Platforms:* Of the four agbioscience platforms identified by Battelle, the biobased industrial products platform is the largest in the Northeast region. In 2013, businesses in the platform directly produced \$2.0 billion in output. In comparison, the resilient, efficient, and productive agricultural systems platform produced \$99.6 million, the value-added food and health products platform \$85.9 million, and the microbial agbioscience platform \$60.7 million. However, it was the microbial agbioscience platform that grew the fastest between 2003 and 2013, adding 30 jobs, which is a 16 percent increase. Components of the agbioscience industry can be included in more than one platform.
- *Production Agriculture and Commercial Forestry:* Production agriculture and commercial forestry are not included in this study's definition of agbioscience; however, the industry is important to the success of the agbioscience industry. In Northeast Minnesota, production agriculture and commercial forestry created an estimated \$250.5 million, or 1 percent, of output in the region. Together, production agriculture, commercial forestry, and agbioscience companies create 8 percent of output in the region.
- *Direct Effect of Agbioscience:* In 2013, agbioscience companies in Northeast Minnesota directly generated an estimated \$2.1 billion of output (sales). The companies employed 2,720 workers and paid an estimated \$259.6 million in salaries, wages, and benefits. The average annual compensation per agbioscience employee is approximately \$95,000.
- *Total Contribution of Agbioscience:* In 2013, the agbioscience industry in Northeast 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 7,580 jobs and \$478.5 million of labor income.
- *Top Industries Impacted:* The contribution of the agbioscience industry in Northeast Minnesota is strongest in the industries of commercial logging, wholesale trade, health care, electric power, and housing.
- *Future Growth and Development:* During the past 10 years, employment in the agbioscience industry in Northeast Minnesota declined by 33 percent. However, the Battelle report indicates the agbioscience industry is poised for growth. Markets for agbioscience products are expected to grow by 3 to 10 percent. Based on that, if the agbioscience industry in the Northeast were to grow by 5 percent by 2016, the economic contribution of the agbioscience industry in the region would increase to an estimated \$2.9 billion in output, 7,960 jobs, and \$502.4 million in labor income. During the same time period, the total number of jobs across all industries in the Northeast region increased by 2 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 specific 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 action on the latent advantages of the region within agbioscience.

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

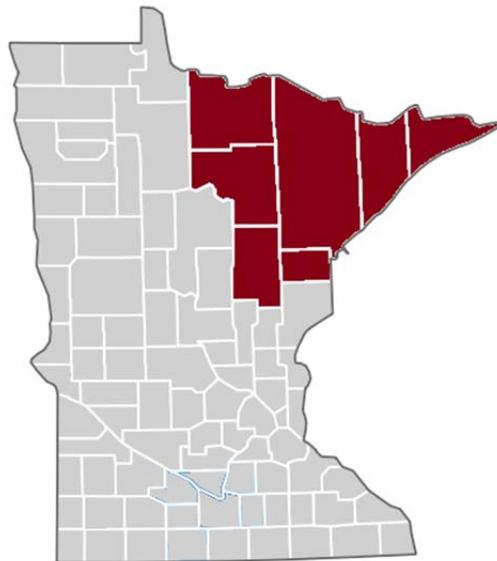
soybean processing is a sector within the manufacturing industry. More broadly, however, the definition of agbioscience includes components of food manufacturing, wood and paper product manufacturing, chemical manufacturing, farm supplies wholesalers, environmental consulting, and research and development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

The region in this analysis is Northeast Minnesota, as defined by the boundaries of the Northland Foundation. Counties included in this analysis are Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis.

Map 1: Northeast Region



ECONOMIC OVERVIEW AND THE AGBIOSCIENCE INDUSTRY IN NORTHEAST MINNESOTA

Understanding the role of agbioscience in the Northeast requires an understanding of the broader economy in the region. 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.

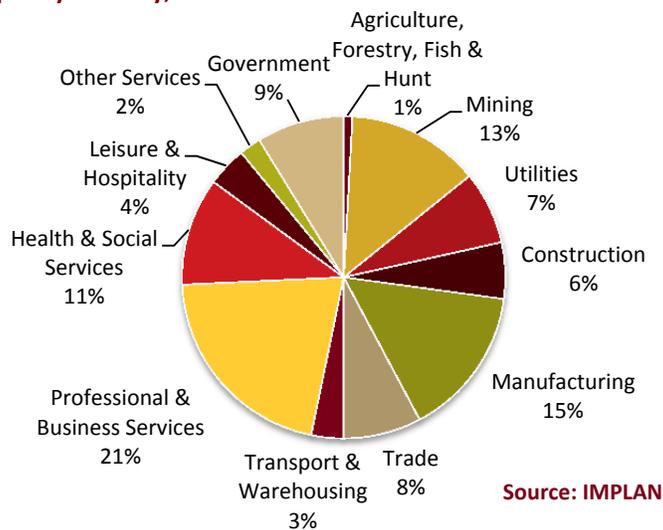
Output

In 2013, businesses and enterprises in the Northeast Minnesota economy produced \$28.5 billion of output. The professional and business services industry was the single largest contributor of output in the region, producing \$6.0 billion of sales in 2013 (chart 1). Real estate and rental businesses created 40 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. Other sectors in this industry include finance and insurance; professional, scientific, and technical services; and information.

The manufacturing sector in the region produced \$4.3 billion of sales in 2013. Large manufacturing sectors in Northeast Minnesota include paper manufacturing (26 percent of manufacturing output), machinery manufacturing (10 percent), and transportation equipment manufacturing (7 percent).

Significant paper manufacturing sectors include paper mills, pulp mills, and printing. Of these three sectors, paper mills and pulp mills are included in the definition of agbioscience used in this report.

Chart 1: Output by Industry, Northeast Minnesota



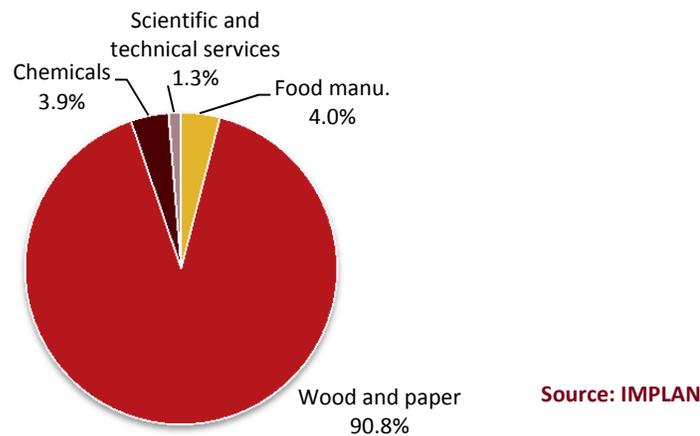
Mining is the third largest industry in the Northeast Minnesota region. Businesses in the mining industry (including iron ore, copper ore, and sand and gravel mining) produced \$3.8 billion of output in 2013.

Agbioscience Output

In 2013, agbioscience businesses generated \$2.1 billion of output in the Northeast region. This represents 7 percent of total output in the region.

Wood and paper manufacturers are the major contributors to the agbioscience industry in Northeast Minnesota (chart 2). In 2013, wood and paper manufacturers in the agbioscience industry made \$1.9 billion of sales. As mentioned, paper mills and pulp mills are the major sources of output in the wood and paper manufacturing industry.

Chart 2: Agbioscience Output by Industry, Northeast Minnesota



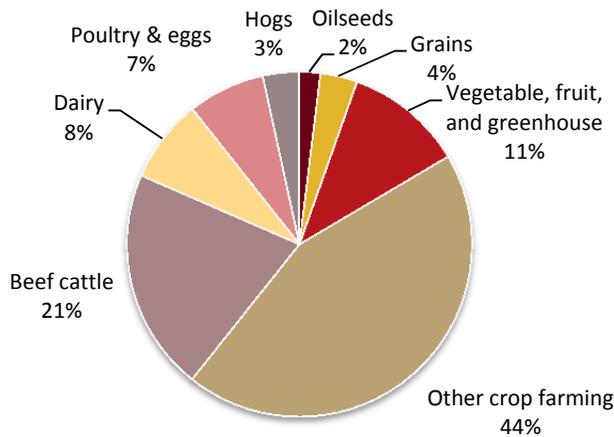
In comparison with other regions, the Northeast region is the third largest source of agbioscience output in Greater Minnesota. In 2013, the Northeast region accounted for 13 percent of Greater Minnesota's agbioscience output.

Production Agriculture and Forestry 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. In the Northeast region, given its reliance on wood and paper product manufacturing, forestry and logging are also key sectors in the region.

Production agriculture and forestry produced \$250.5 million in economic activity in the Northeast region in 2013. Production agriculture produced \$134.4 million of the industry's output. Other crop farming (or crops not otherwise categorized) produced 44 percent of agricultural output (chart 3). A major source of output in the other crop farming sector is greenhouse, nursery, and floriculture production. Forestry produced \$116.1 million of output in 2013. The majority of this (85 percent) was from commercial logging.

Chart 3: Production Agriculture Output by Sector, Northeast Minnesota

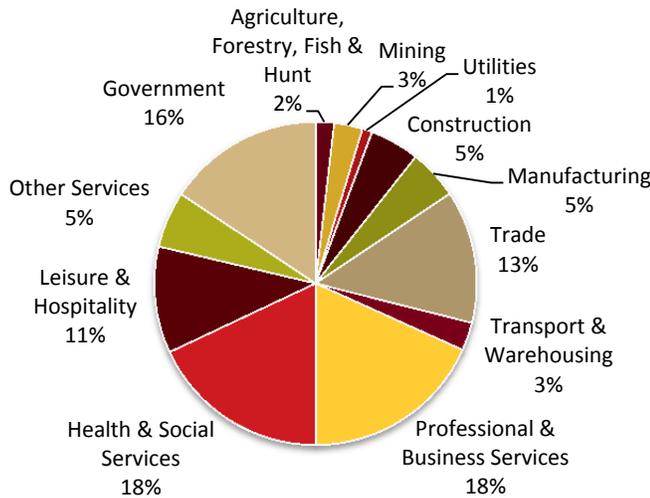


Source: IMPLAN

Employment

Output is one measure of economic activity, another measure is employment. According to IMPLAN, there are 186,020 jobs in the Northeast region. Employment is relative diverse in the region. Both the professional and business services industry and the health and social services industry employ 18 percent of all workers in the region. Government accounts for 16 percent. Government employment includes federal, state, local, and tribal employment.

Chart 4: Employment by Industry: Northeast Minnesota



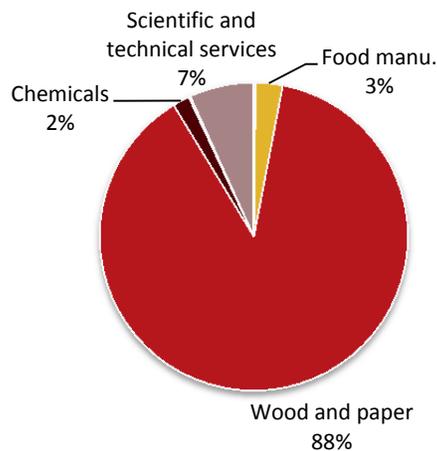
Source: IMPLAN

Agbioscience Employment

Agbioscience industries employ 2,720 workers of the 186,020 workers in the Northeast region. Eighty-eight percent of those employees are in the wood and paper products manufacturing sector. Scientific and technical services businesses employ 7 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, Northeast Minnesota



Source: IMPLAN

Trends in Agbioscience Employment

Beyond understanding the current status of the industry, studying how the industry is changing also can provide insights. Between 2003 and 2013, the number of jobs in the agbioscience industry in Northeast Minnesota declined by 33 percent. In comparison, the number of jobs in the agbioscience industry in Greater Minnesota declined by 3 percent. The Northeast region was one of three regions to lose jobs in the agbioscience industry during the period. The total number of jobs in the Northeast (across all industries) grew by 2 percent in the period.

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	55	3	2	50
Pulp mills	15	-4	1	18
None				
Top 3 Job Loss Industries				
Reconstituted wood product manufacturing	-573	-281	39	-331
Paper mills	-542	-908	122	241
Sawmills	-125	-64	10	-71

Source: EMSI

Testing laboratories added far more jobs than anticipated given industry and national trends. The overall economy expanded during the time period, so jobs would have been added (national growth effect). The testing laboratories sector also grew moderately at the national level so job gains would have been expected in the region. The sector in Northeast Minnesota added even more jobs, however, thus making Northeast Minnesota competitive in the sector.

As highlighted in the table, pulp mills in the region also marginally outperformed national and industry trends. The sector added 15 jobs between 2003 and 2013 which was better than the trends would have indicated.

Testing laboratories and pulp mills were the only two sectors within the agbioscience industry in Northeast Minnesota to add jobs during the time period studied.

The reconstituted wood products manufacturing sector led the region in job losses. While the industry fared poorly at the national level, the sector in Northeast Minnesota lost more jobs than would be expected.

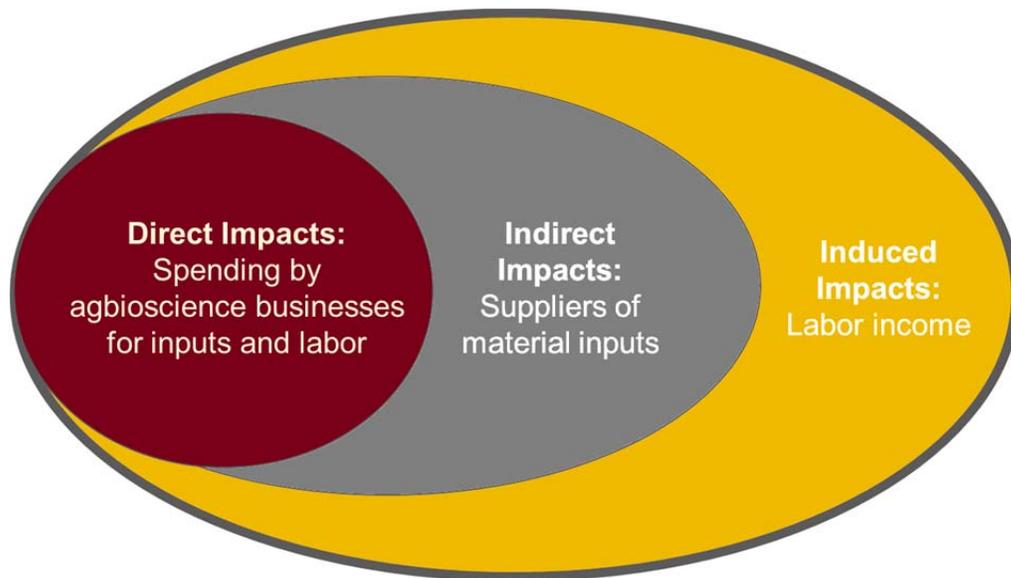
The paper mills sector in Northeast however, lost fewer jobs than would have been anticipated, given industry trends. In other words, the sector was relatively competitive in the region, despite steep job declines.

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

Total economic contribution is comprised of three parts - direct, indirect, and induced effects (chart 6). This section of the report explains each of these components and how they were calculated for this study.

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

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 Northeast 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.² 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.

In 2013, agbioscience companies in Northeast Minnesota employed 2,720 people (table 2). The highest shares of jobs were in the sectors of paper mills, reconstituted wood product manufacturing, and sawmills. All three (paper mills, reconstituted wood product manufacturing, and sawmills) were among the sectors within the agbioscience industry in the region that lost the most jobs between 2003 and 2013.

Companies in the Northeast region's agbioscience industry created \$2.1 billion of output (sales). Output is led by paper mills, ethyl alcohol manufacturing, and fluid milk and butter manufacturing.

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

Table 2: Direct Effect of Agbioscience Industry in Northeast Minnesota

Industry Name	Employment	Output (millions)
Paper mills	1,976	\$1,774.3
Reconstituted wood product manufacturing	224	\$55.9
Sawmills and wood preservation	114	\$32.2
Testing laboratories	93	\$9.8
Remediation services	72	\$15.1
Ethyl alcohol manufacturing (ethanol)	48	\$81.9
Wood windows and doors and millwork manufacturing	46	\$8.2
Fluid milk and butter manufacturing	45	\$58.3
Pulp mills	41	\$35.0
Breweries	27	\$23.3
Environmental consulting services	14	\$1.0
Soil preparation, planting, and cultivating	5	\$0.03
Fruit and vegetable canning, pickling, and drying	5	\$2.6
Farm supplies merchant wholesalers	5	\$0.9
Research and development services in biotechnology	5	\$0.8
Total	2,720	\$2,099.3

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 the Northeast region. In other words, purchases made outside of the Northeast 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 impact.

Total Effect

In 2013, the agbioscience industry contributed an estimated \$2.8 billion dollars in economic activity to the Northeast region of Minnesota (table 3) from all effects – direct, indirect, and induced. The industry’s presence in the Northeast region supports an estimated 7,580 jobs. These employees receive an estimated \$478.5 million in wages, salaries, and benefits.

The agbioscience industry directly creates \$2.1 billion in economic activity annually in the region, as detailed above. Agbioscience companies directly employ 2,720 residents of the region and spend \$259.6 million in compensation for those workers. The average annual compensation per agbioscience employee is approximately \$95,000.

When agbioscience companies make purchases from businesses in the region, this generates additional economic activity (indirect effects). From these indirect effects, agbioscience companies generate \$472.3 million in activity each year at regional businesses and support jobs for 2,820 individuals in those businesses.

When employees of agbioscience companies spend their wages and salaries in the Northeast region, this creates economic activity at businesses in the region (induced effects). Employee spending generated \$235.7 million in economic activity in 2013 in the region and supported employment for 2,040 workers.

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,099.3	2,720	\$259.6
Indirect	\$472.3	2,820	\$144.8
Induced	\$235.7	2,040	\$74.1
Total	\$2,807.3	7,580	\$478.5

Estimates by University of Minnesota Extension

Top Industries Affected

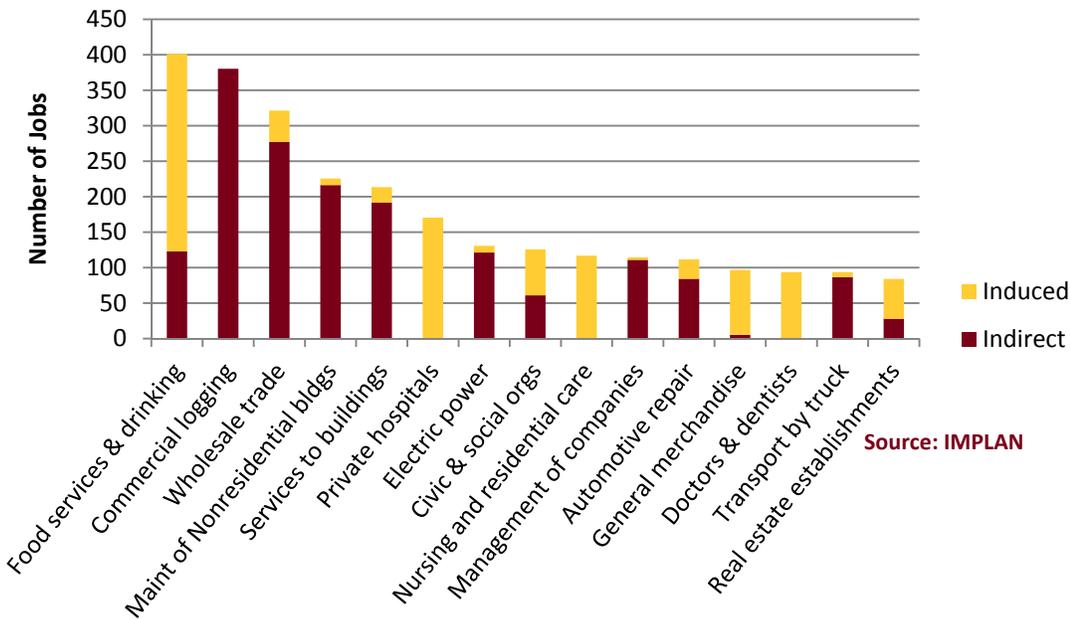
Agbioscience companies support employment for 7,580 people in Northeast Minnesota. Of these, 2,720 jobs are with the agbioscience industry itself. Thus, the agbioscience industry supports 4,860 jobs in other businesses in the region. Chart 7 illustrates the top fifteen sectors with jobs supported

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

by the agbioscience industry. These impacts are driven by the 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 commercial logging; wholesale trade; and maintenance and repair construction of non-residential buildings 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 the food services and drinking places sector as well the general merchandise retail trade sector.

Many economic impact studies show relatively high employment impacts on the food services and drinking places 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.

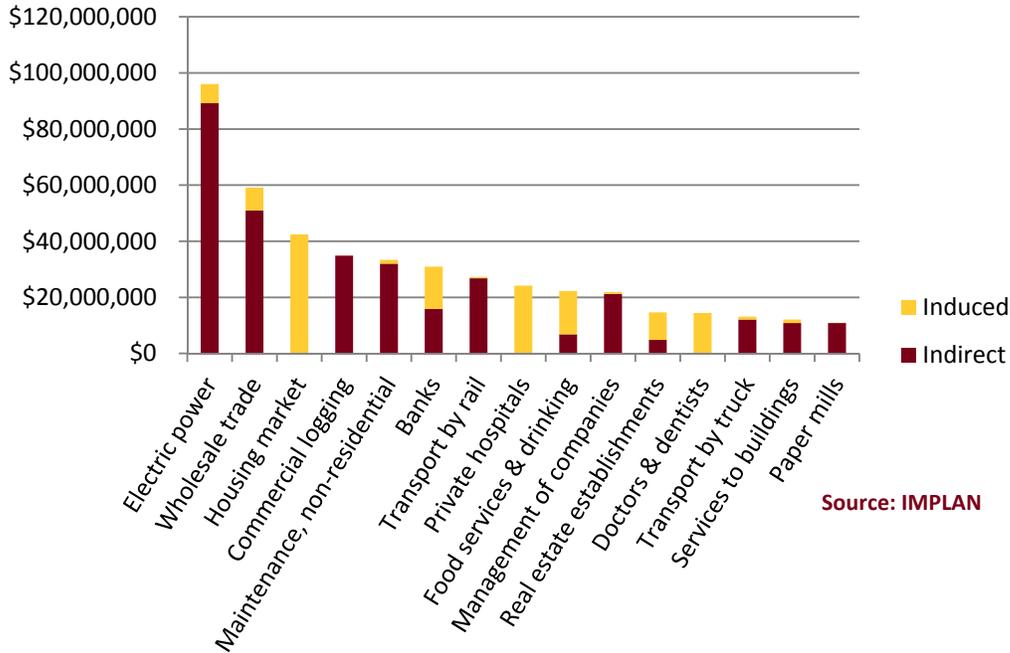
Chart 7: Top Industries Affected, Sorted by Employment, Northeast Minnesota



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 \$2.8 billion in economic activity to the Northeast region. Agbioscience companies directly spend \$2.1 billion in the region. The remainder, approximately \$700 million, is activity at other businesses in the region. Activities by agbioscience companies in the region contribute most strongly to the electric power, wholesale trade, housing, and commercial logging sectors.

Chart 8: Top Industries Affected, Sorted by Output, Northeast 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. The highest levels of output and employment are in the Southeast and Southwest regions. Together, the two regions produce over 65 percent of agbioscience output in Greater Minnesota.

The Northeast region is responsible for 13 percent of Greater Minnesota’s total agbioscience output. In comparison, the Northeast region is responsible for 13 percent of Greater Minnesota’s total output from all industries.

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

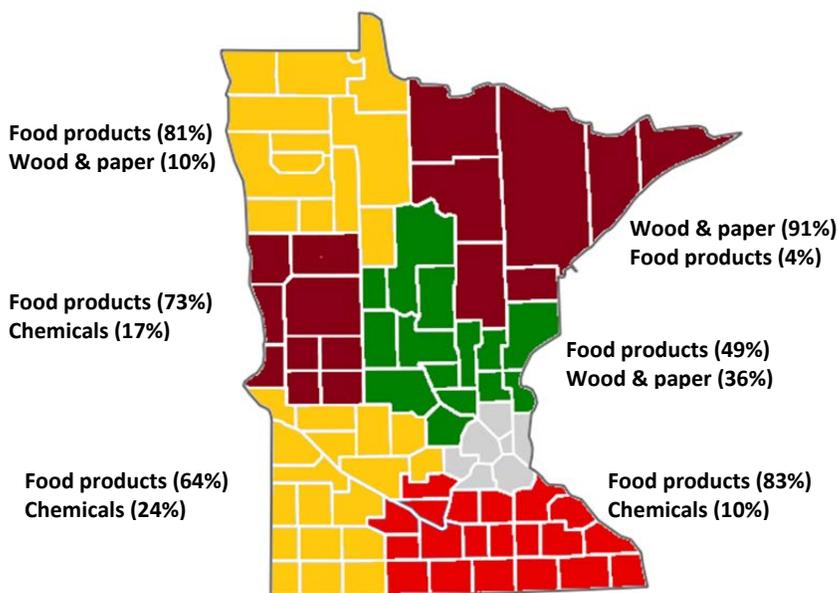
	Output (millions)	Employment (rounded)	Labor Income (millions)	Total Regional Output (billions)	Agbioscience Output Percent of Total Regional Output
Central	\$2,813.3	8,940	\$474.0	\$52.0	5.7%
Northeast	\$2,807.3	7,580	\$478.5	\$28.5	10.2%
Northwest	\$1,230.3	4,870	\$234.8	\$15.6	8.2%
Southeast	\$11,737.1	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 composition of the direct effect of the agbioscience industry also varies by region (chart 9). 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.

The Northeast region is dominated by wood and paper products manufacturing. Of all the regions, the Northeast has the highest percentage of its agbioscience output in this sub-sector.

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



Source: IMPLAN

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.

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

Future Growth and Development of Agbioscience

The agbioscience industry in Northeast 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 declined by 33 percent, partially as a result of 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 Northeast 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 the predictions by Battelle. The tables below are meant to illustrate the potential changes if the growth rates were to occur.

If employment in the agbioscience industry in Northeast 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 \$2.9 billion in output, an estimated 7,960 jobs, and an estimated \$502.4 million in labor income (table 5).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,204.3	2,860	\$272.6
Indirect	\$495.9	2,960	\$152.0
Induced	\$247.5	2,140	\$77.8
Total	\$2,947.7	7,960	\$502.4

Estimates by University of Minnesota Extension

If employment in the agbioscience industry in Northeast 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 8,330 jobs, and an estimated \$526.4 million in labor income (table 6).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$2,309.2	2,990	\$285.6
Indirect	\$519.5	3,100	\$159.3
Induced	\$259.3	2,240	\$81.5
Total	\$3,088.0	8,330	\$526.4

Estimates by University of Minnesota Extension

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN NORTHEAST 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 Northeast Minnesota.

In terms of total impacts, the largest platform in the Northeast region is the biobased industrial products platform. In 2013, the platform supported \$2.7 billion of output in the Northeast region (table 7). The platform also supported employment for 7,040 workers and paid \$451.0 million in wages, salaries, and benefits.

Table 7: Total Economic Contribution of Agbioscience in Northeast 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	\$88.7	430	\$22.0
Resilient, efficient, & productive agricultural systems	\$125.7	340	\$16.2
Biobased industrial products	\$2,660.6	7,040	\$451.0
Value-added food and health products	\$108.4	260	\$13.8

Estimates by University of Minnesota Extension

While the biobased industrial 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 30 jobs, increasing the number of jobs in the platform by 16 percent. The growth was driven by the growth in employment at testing laboratories and pulp mills.

The microbial agbioscience platform was the only platform to add jobs in the ten year period. Jobs in the value-added food and health products platform declined by 47 percent, jobs in the resilient, efficient, and productive agricultural systems platform declined by 38 percent, and jobs in the biobased industrial products platform declined by 34 percent. Meanwhile, between 2003 and 2013, the number of jobs across all industries in Northeast Minnesota grew by 2 percent.

Table 8: Change in Number of Jobs by Agbioscience Platform in Northeast 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	186	216	16%
Resilient, efficient, & productive agricultural systems	240	149	-38%
Biobased industrial products	3,742	2,454	-34%
Value-added food and health products	163	87	-47%

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 in biotechnology; pulp mills; and food processing related to microbial agbioscience.⁵

In 2013, the microbial agbioscience platform supported an estimated \$88.7 million of output in Northeast Minnesota. The platform also supported an estimated 426 jobs, with those jobs paying an estimated \$22.0 million of labor income (table 9).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$60.7	216	\$13.0
Indirect	\$17.2	120	\$5.6
Induced	\$10.8	90	\$3.4
Total	\$88.7	426	\$22.0

Estimates by University of Minnesota Extension

The Northeast region is the smallest of Greater Minnesota’s regions in the production of microbial agbioscience output. Within the microbial agbioscience platform in the Northeast region, the largest sectors, measured by output, are pulp mills; remediation services; and testing laboratories. The highest ripple effects are in waste management and remediation services; the housing market; and electric power.

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

According to the Battelle report, the total global market for microbes and microbial products is projected to grow by a 10.7 percent 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 Northeast Minnesota would increase to an estimated \$97.8 million, including an estimated 470 jobs, and an estimated \$24.2 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.

In 2013, the resilient, efficient, and productive agricultural systems platform supported an estimated \$125.7 million of output in Northeast Minnesota. The platform also supported an estimated 339 jobs, with those jobs paying an estimated \$16.2 million of labor income (table 10).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$99.6	149	\$8.4
Indirect	\$18.1	120	\$5.3
Induced	\$8.0	70	\$2.5
Total	\$125.7	339	\$16.2

Estimates by University of Minnesota Extension

Compared to other regions, the Northeast region has a modest percentage of total output in the resilient, efficient, and productive agricultural systems platform. Within the Northeast region, the largest sectors in the platform (measured by output) are ethanol manufacturing and remediation services. The largest ripple effects are in the waste management and remediation services, wholesale trade, and electric power sectors.

According to the Battelle report regarding 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.

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).

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 \$138.3 million of output, including 370 jobs and \$17.8 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 an estimated \$2.7 billion of output in Northeast Minnesota. The platform also supported 7,044 jobs, with those jobs paying \$451.0 million in labor income (table 11).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$1,988.2	2,454	\$242.5
Indirect	\$450.2	2,660	\$138.7
Induced	\$222.2	1,930	\$69.8
Total	\$2,660.6	7,044	\$451.0

Estimates by University of Minnesota Extension

The Central, Northeast, and Southwest regions all have significant levels of output in the platform (over \$1 billion in each region), but the Southeast region is the largest source of output in the platform. In the Northeast region, paper mills are the major source within the biobased industrial products platform, accounting for 89 percent of the output. The largest ripple effects are in electric power, wholesale trade, the housing market, and commercial logging.

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. 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.

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).

If the rate of growth of 5 percent occurs, the economic contribution of the biobased industrial products platform would increase to \$2.8 billion of output, including 7,400 jobs and \$473.6 million in labor income.⁸

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.

In 2013, the value-added food and health products platform supported an estimated \$108.4 million in output in Northeast Minnesota, including an estimated \$13.8 million in labor income and 257 jobs (table 12).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	\$85.9	87	\$7.6
Indirect	\$15.7	110	\$4.1
Induced	\$6.8	60	\$2.1
Total	\$108.4	257	\$13.8

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 over \$1 billion of output. In the Northeast region, the largest sectors in the value-added food and health products platform include fluid milk production and breweries. The largest ripple effects in the Northeast region include the dairy cattle and milk production, wholesale trade, and electric power sectors.

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

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).

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 \$113.8 million of output, including an estimated 270 jobs and an estimated \$14.5 million in labor income.⁹

Contribution of Agbioscience Platforms by Region of Greater Minnesota

In comparison to the other regions, the Northeast region has a higher share of total economic contribution in the biobased industrial products platform. It is the second largest region in the platform, after the Southeast. The Northeast region is the smallest region 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 Northeast region produced \$28.5 billion of output. In comparison, the Southeast region produced \$76.4 billion and the Southwest 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 one 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

In addition to variation in the size of the platforms, the rate of growth of each platform also varies. All six regions added jobs in the microbial agbioscience platform. The Northeast had modest growth in the platform.

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).

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 agbioscience’s importance in 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 Northeast region of Minnesota, as defined by the boundaries of the Northland Foundation region.

The agbioscience industry contributes significantly to the economy of Northeast Minnesota. In 2013, the total economic contribution of the agbioscience industry was an estimated \$2.8 billion in Northeast Minnesota. Through its impacts across all industries, the agbioscience industry supported an estimated 7,580 jobs that paid \$478.5 million in income to workers in the region.

In Northeast Minnesota, the agbioscience industry is dominated by wood and paper product manufacturing which accounts for nearly 90 percent of agbioscience output. Large sectors within the wood and paper product manufacturing industry include paper mills and pulp mills. Growing agbioscience sectors in the region include: testing laboratories and pulp mills. These sectors have added jobs in the past 10 years. Paper mills, reconstituted wood products manufacturing, and newsprint mills are regional agbioscience sectors that shed jobs between 2003 and 2013.

Directly, agbioscience companies in the Northeast region employ 2,720 individuals. The companies produce \$2.1 billion in economic activity including compensation to workers of \$259.6 million. The average annual compensation per agbioscience employee is approximately \$95,000.

The \$2.1 billion of output represents approximately 7 percent of all economic activity in the region. In addition to the sales from agbioscience industries, the production agriculture and commercial forestry industry also generates output in the region. Production agriculture and commercial forestry, which falls outside the agbioscience category, recorded sales of \$250.5 million or about 1 percent of all sales in the region. The Northeast region is responsible for 13 percent of Greater Minnesota's agbioscience output.

Indirectly, industries with strong ties to commercial forestry and household spending are most affected by the agbioscience industry in Northeast Minnesota. The related industries benefiting most from the agbioscience industry include commercial logging, wholesale trade, health care, and housing.

Over the past 10 years, the number of jobs in the agbioscience industry in Northeast Minnesota declined by 33 percent. Despite these losses, the Battelle report suggests the agbioscience industry has the potential to grow in the next few years. Potential growth rates depend on the agbioscience sector, but overall, it is reasonable to assume the industry could grow by 5 percent between now and 2016. If that growth rate occurs, the economic impact of the agbioscience industry in the region will increase to an estimated \$2.9 billion in output, an estimated 7,960 jobs, and an estimated \$502.4 million in labor income.

Of the four platforms, the biobased industrial products platform is the largest in the Northeast region. In 2013, the platform supported an estimated \$2.7 billion of economic activity in the region, including an estimated 7,044 jobs. 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.

The fastest growing platform in the Northeast region was the microbial agbioscience platform which grew by 16 percent between 2003 and 2013. The microbial agbioscience platform supported an estimated \$88.7 million of output in Northeast Minnesota in 2013. The platform also supported an estimated 426 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 Northeast region is one component of the agbioscience industry in Greater Minnesota. It is currently strongest in 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 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 MIG, Inc.)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

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

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 the corn is built into the price of each of these items and then the sales of each of these items are added up 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 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 northeast 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.

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 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

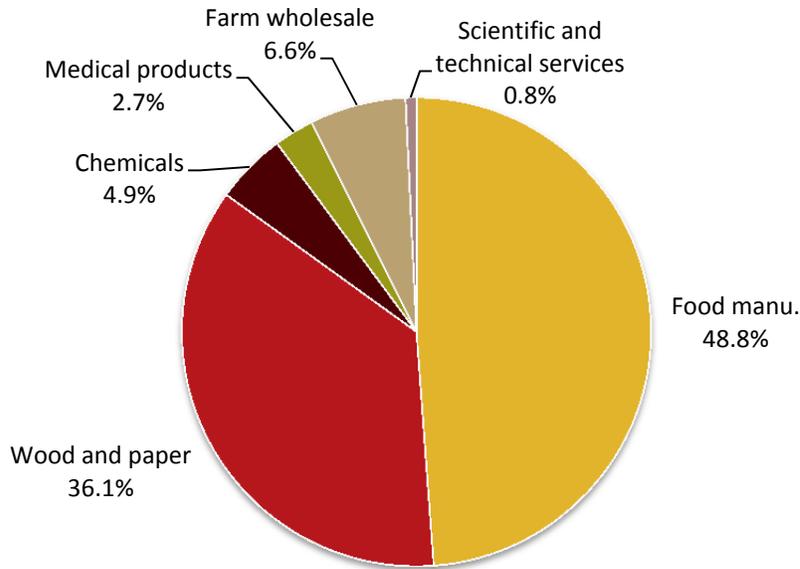
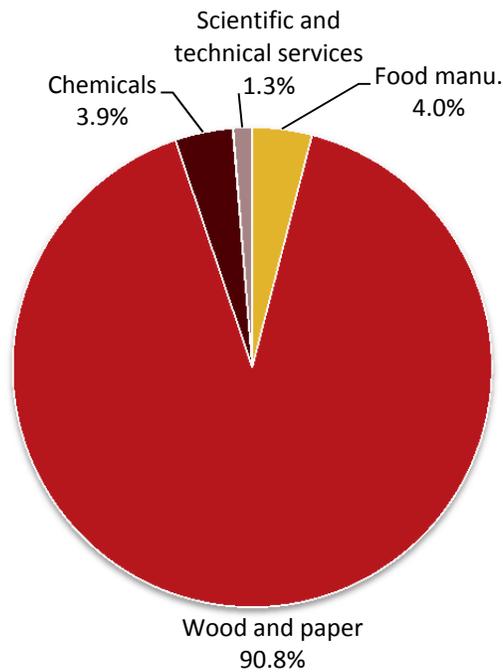


Chart A2: Agbioscience Output by Industry, Northeast Minnesota



Source: IMPLAN

Chart A3: Agbioscience Output by Industry, Northwest Minnesota

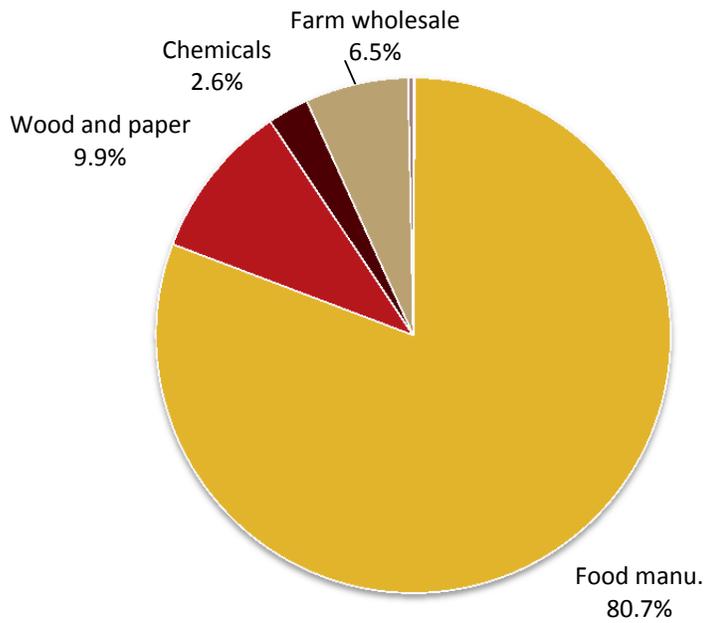
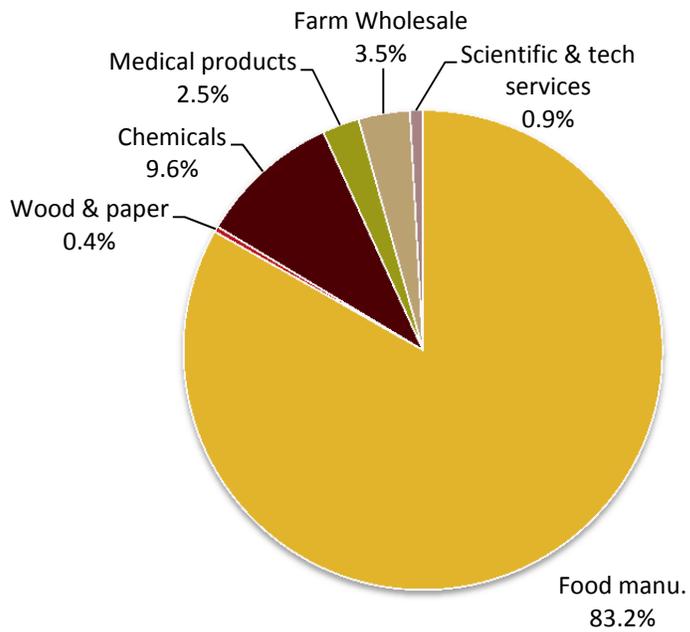


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

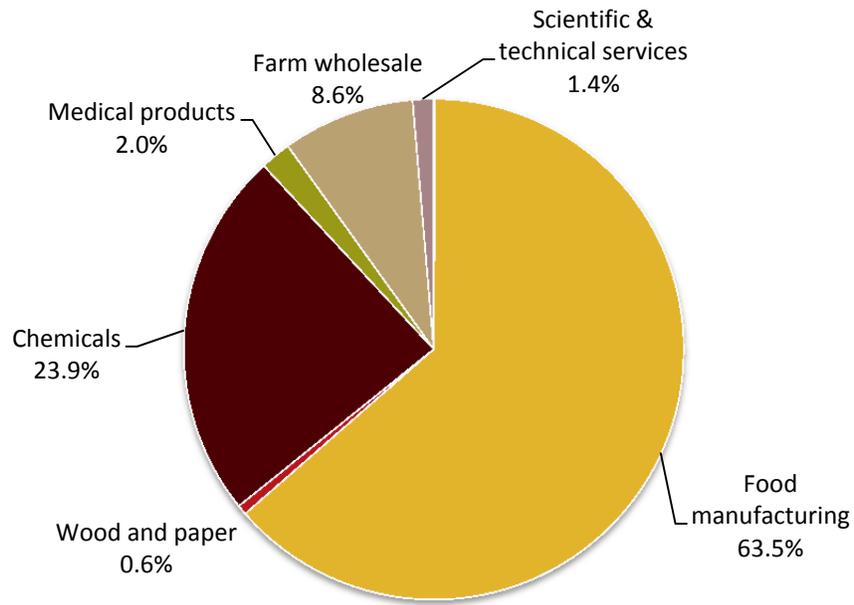
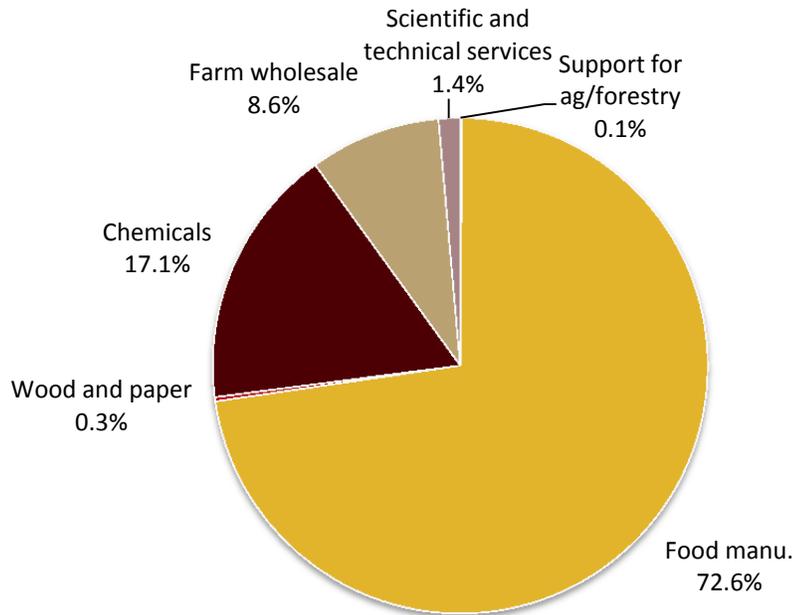


Chart A6: Agbioscience Output by Industry, West Central Minnesota



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 Northeast Minnesota, 2003 and 2013

Description	2003 Jobs	2013 Jobs	2003- 2013 Change	2003- 2013 % Change
Paper (except Newsprint) Mills	2,518	1,976	-542	-22%
Reconstituted Wood Product Manufacturing	797	224	-573	-72%
Testing Laboratories	38	93	55	145%
Sawmills	213	88	-125	-59%
Remediation Services	84	72	-12	-15%
Cut Stock, Resawing Lumber, and Planing	66	46	-20	-30%
Fluid Milk Manufacturing	52	45	-7	-14%
Ethyl Alcohol Manufacturing	51	48	-3	-6%
Pulp Mills	24	41	17	72%
Breweries	5	27	22	444%
Wood Preservation	44	26	-18	-41%
Environmental Consulting Services	42	14	-28	-66%
Softwood Veneer and Plywood Manufacturing	12	0	-12	-100%
Spice and Extract Manufacturing	14	0	-14	-100%
Cheese Manufacturing	14	0	-14	-100%
Biological Product (except Diagnostic) Manufacturing	23	0	-23	-100%
Rice Milling	5	0	-5	-100%
Soil Preparation, Planting, and Cultivating	0	5	5	NA
Fruit and Vegetable Canning	16	5	-11	-69%
Research and Development in Biotechnology	17	5	-12	-70%
Farm Supplies Merchant Wholesalers	47	5	-42	-89%
Total	4,083	2,720	-1,363	-33%

Source: EMSI