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Economic Contribution of the Agbioscience Industry in Greater Minnesota

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

Authored by Brigid Tuck and Neil Linscheid



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February 2015

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ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: GREATER MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Greater Minnesota. The study builds on the work of Battelle Technology Partnership Practice, which defined agbioscience and identified four platforms for additional investment and development.

- **Direct Effect:** Agbioscience businesses in Greater Minnesota directly produced an estimated \$16.6 billion in output during 2013. The businesses employed an estimated 22,760 workers, paying \$1.8 billion in compensation. Agbioscience in this report includes components of the manufacturing, wholesale trade, and professional and business services industries. It does not include production agriculture.
- **Total Economic Contribution:** In 2013, the agbioscience industry, through its total effects, supported an estimated \$23.4 billion of economic activity in Greater Minnesota. The industry supported an estimated 63,753 jobs, including \$3.7 billion in labor income. In comparison, the Greater Minnesota economy overall produced \$223.1 billion in output, including \$60.8 billion in labor income and 1.4 million jobs.
- **Businesses Influenced:** The agbioscience industry has relatively high effects on its supplying industries. Industry ripples impact employment in agricultural production (sugar beets, grain, dairy and milk production, and oilseeds), wholesale trade, trucking, and care for physical infrastructure. Spending by employees of agbioscience businesses creates economic activity in both the health care and housing markets.
- **Agbioscience and Greater Minnesota's Initiative Foundation Regions:** In terms of total industry size, agbioscience is largest in the southern region of the state. The Southeast and Southwest regions combined account for 65 percent of Greater Minnesota's agbioscience output. The Northeast region, while a smaller percentage of Greater Minnesota's agbioscience industry, has a similar share of its regional output derived from agbioscience.
- **Agbioscience in the Twin Cities Metro:** In 2013, Twin Cities-based agbioscience businesses supported \$12.5 billion in output, including \$3.4 billion in labor income and 42,960 jobs in the 7-county metro region. The Twin Cities area also benefited from the presence of Greater Minnesota's agbioscience industry. In 2013, the industry in Greater Minnesota supported an estimated \$3.2 billion of economic activity in the metro, including an estimated 15,060 jobs. Jobs supported by the industry are focused on business operations, including corporate headquarters, advertising, and engineering and architectural services.
- **Trends in Agbioscience Employment:** The number of jobs in Greater Minnesota's agbioscience industry declined modestly (by 3 percent) between 2003 and 2013. The fastest gains were recorded in ethyl alcohol manufacturing, breakfast cereal manufacturing, and fluid milk manufacturing. The fastest losses, however, were noted in paper mills, reconstituted wood products manufacturing, and cheese manufacturing.
- **Future Growth and Development:** If employment in the agbioscience industry were to grow by 10 percent between now and 2016, the economic impact of the industry would increase to an estimated \$25.7 billion, including 70,130 jobs, and \$4.0 billion in labor income in Greater Minnesota.
- **Microbial Agbioscience Platform:** This platform supported an estimated \$4.9 billion in output, 14,905 jobs, and \$786.0 million in labor income in 2013. Employment grew by 15 percent between 2003 and 2013. The Southeast has the largest share of the platform's output, primarily due to soybean processing. It was also the fastest growing region, with employment in the region growing by 37 percent.
- **Resilient, Efficient, and Productive Agricultural Systems:** This platform supported an estimated \$3.1 billion in output, 11,360 jobs, and \$713.3 million in labor income in 2013. Employment grew by 10 percent between 2003 and 2013. The Southeast had the largest share of the platform's output, primarily due to ethyl alcohol manufacturing. The Southwest was the fastest growing region, growing by 37 percent.
- **Biobased Industrial Products:** This platform supported an estimated \$8.6 billion in output, 19,440 jobs, and \$1.3 billion in labor income in 2013. Employment declined by 20 percent between 2003 and 2013. The Southeast has the largest share of the platform's output, primarily due to soybean processing. The Southwest region was the fastest growing, increasing employment by 352 percent.
- **Value-Added Food and Health Products:** This platform supported an estimated \$17.0 billion in output, 45,640 jobs, and \$2.5 billion in labor income in 2013. Employment grew by 4 percent in the period. The Southeast region had the largest share of the platform's output, primarily due to cheese manufacturing. The Central region was the fastest growing region, up 25 percent.

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 Greater Minnesota. It also explores past industry trends in employment and potential for future growth and development of the agbioscience industry in Greater Minnesota. Additionally, the economic contribution of agbioscience by region and by platform is included in this analysis. In supplement to this publication, other

reports will be published examining the agbioscience industry individually in each of the six Initiative Foundation regions in Minnesota.

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

Greater Minnesota is defined as the 80 counties not classified as being in the 7-county Twin Cities metro area.

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

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

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

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

Agbioscience is one component of Greater Minnesota’s economy. Communicating its role within the economy will assist decision-makers in identifying actions that could be taken to further support the industry. Economic contribution analysis is a type of analysis that details the overall role of an industry in an economy and illustrates the linkages the industry has with other businesses and industries within the economy. An examination of industry trends can provide context for changes the industry has undergone. Finally, analyzing the opportunities for growth and development provides insights into the future of the industry.

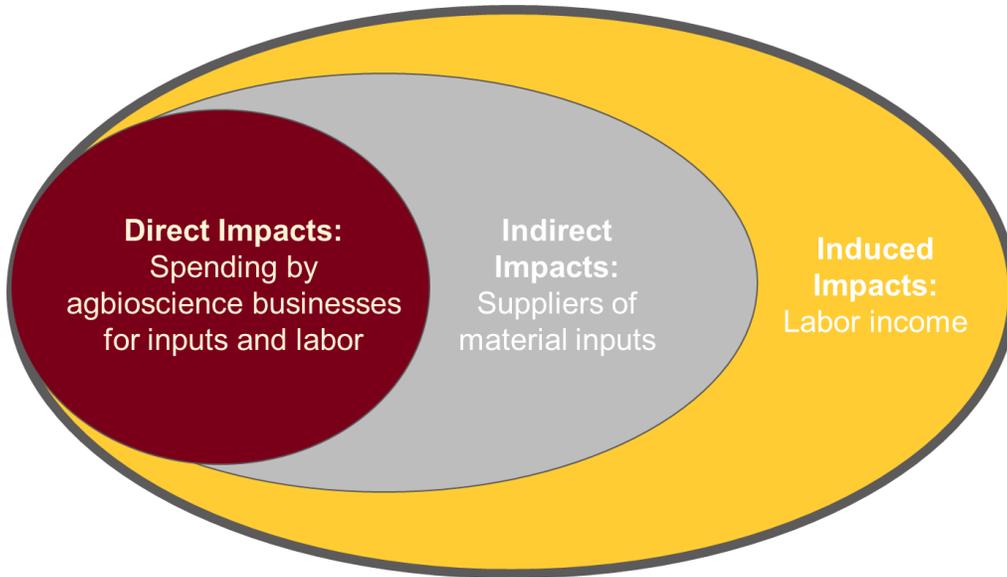
Economic Contribution of Agbioscience in Greater Minnesota

Total economic contribution is comprised of three parts — direct, indirect, and induced effects (chart 1). Economic contribution can be measured by three metrics – output, employment, and labor income. This section of the report explains each component and how they were calculated for this study.

Direct effects are the output, employment, and labor income created by agbioscience businesses themselves. To calculate the direct effect, University of Minnesota Extension used the Economic Modeling Specialists International (EMSI) database to determine employment by sector in the agbioscience definition. The number of direct jobs was entered into the input-output model IMPLAN, which then estimated the level of output and labor income associated with the employment.¹

¹ To learn more about EMSI, visit www.economicmodeling.com. To learn more about IMPLAN, visit implan.com.

Chart 1: Economic Impact Analysis Diagram



In 2013, agbioscience businesses in Greater Minnesota produced an estimated \$16.6 billion of output (table 1). Agbioscience businesses employed an estimated 22,760 individuals and paid an estimated \$1.8 billion of labor income.

Table 1: Economic Contribution of Agbioscience in Greater Minnesota, 2013

	Output (millions)	Employment	Labor Income (millions)
Direct	\$16,607.9	22,763	\$1,783.1
Indirect	\$5,024.4	25,970	\$1,350.6
Induced	\$1,745.5	15,020	\$539.9
Total	\$23,377.8	63,753	\$3,673.6

Estimates by University of Minnesota Extension Center for Community Vitality

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

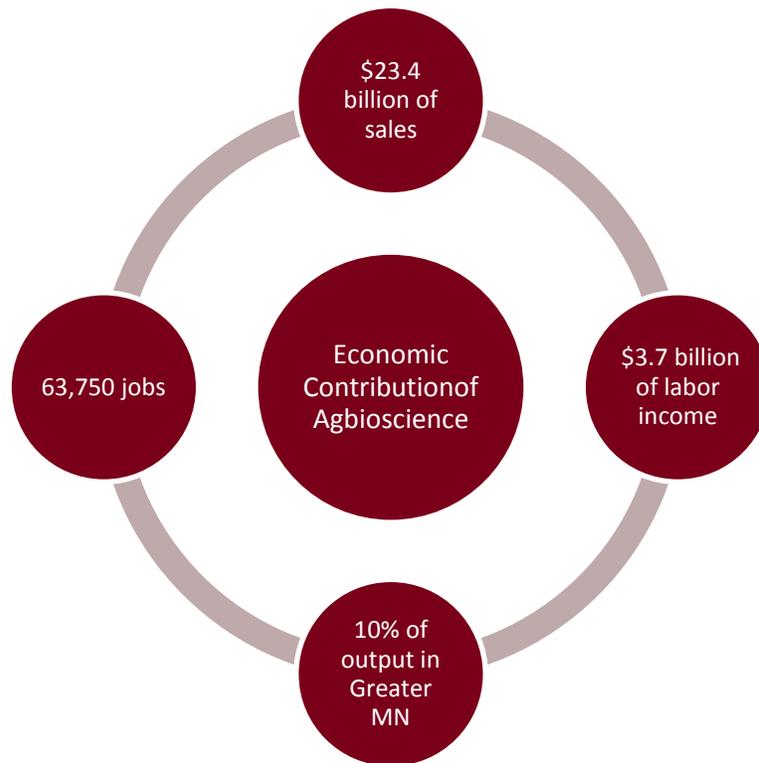
Indirect effects are those associated with a change in economic activity due to spending for goods and services directly tied to the industry. In this case, changes in the local economy occur because agbioscience businesses purchase goods and related services. As the agbioscience businesses make purchases, this creates an increase in purchases across the supply chain. Indirect effects are the summary of these changes across an economy. In 2013, agbioscience businesses in Greater Minnesota created \$5.0 billion of indirect output effects and \$1.4 billion of indirect labor income

effects. Agbioscience businesses supported 25,970 jobs in industries that provide supplies to their production process.

Induced effects are those associated with a change in economic activity due to spending by the employees of businesses (labor) and by households. In this study, these effects are economic changes primarily related to spending by employees of agbioscience businesses. They also include household spending related to indirect effects. As employees of the agbioscience businesses make purchases locally, this triggers increases in purchases within that supply chain. In 2013, agbioscience businesses in Greater Minnesota created \$1.7 billion of induced output effects and \$540 million of induced labor income effects. Spending by agbioscience employees supported 15,020 jobs in industries from which they make purchases.

The agbioscience industry in Greater Minnesota, through its total economic contribution, supports an estimated \$23.4 billion of output, including \$3.7 billion of labor income (chart 2). The agbioscience industry also supports employment for 63,753 people in Greater Minnesota. Total output in Greater Minnesota across all industries in 2013 totaled \$223.1 billion. Therefore, the agbioscience industry supports about 10 percent of output in the region. There were 1.4 million jobs in Greater Minnesota, with agbioscience supporting approximately 4.5 percent of those jobs. Total labor income in Greater Minnesota was \$60.8 billion, with agbioscience supporting approximately 6 percent of labor income.

Chart 2: Total Economic Contribution of Agbioscience in Greater Minnesota



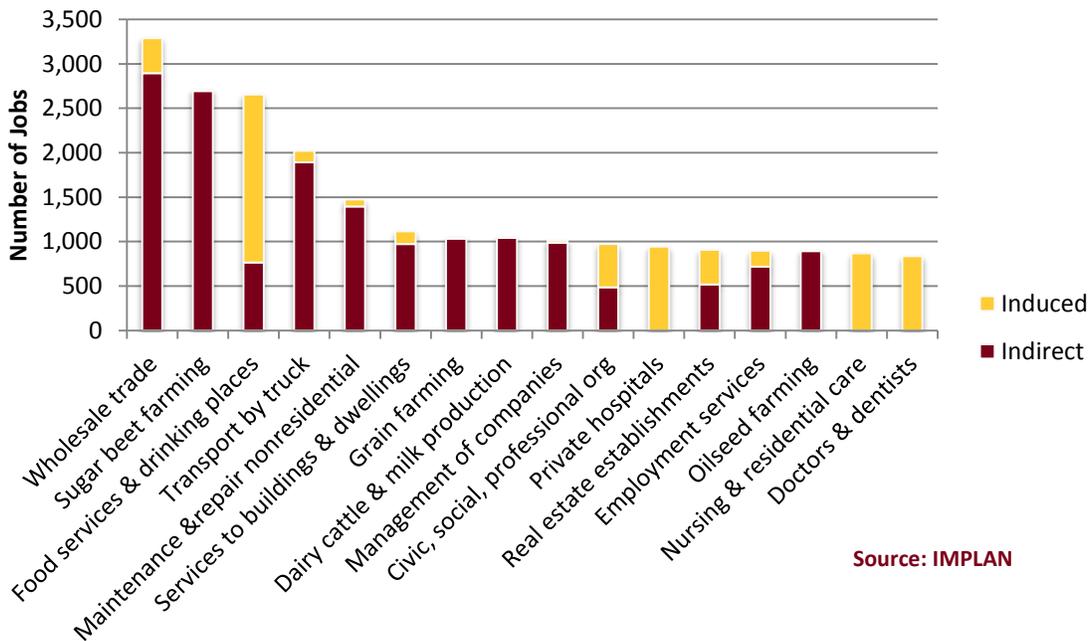
Top Industries Impacted in Greater Minnesota

The agbioscience industry in Greater Minnesota supports an estimated 63,753 jobs. Of those jobs, 22,763 are within agbioscience businesses themselves. Thus, there are an estimated 40,990 jobs with other businesses in Greater Minnesota that exist due to the agbioscience industry. Knowing which industries have the highest share of these supported jobs can be useful for understanding the role of agbioscience in the Greater Minnesota economy (chart 3).

Indirect effects constitute 63 percent of the employment ripple effects generated by the agbioscience industry. The prevalence of agricultural products as inputs into the production process of agbioscience businesses is reflected in the indirect impacts. Sugar beet farming, grain farming, dairy cattle and milk production, and oilseed farming are all industries that benefit highly from the agbioscience industry. In addition, the businesses and industries providing essential services to agbioscience companies are also reflected in the results. Impacts are high in the wholesale trade industry, in transportation by truck, and in the care for agbioscience physical infrastructure (buildings).

Induced effects comprise 37 percent of the employment ripple effects generated by the agbioscience industry and represent household expenditures. Households spend a significant portion of their income on items such as health care and housing (measured as real estate establishments), both of which are among the highest industries impacted in terms of employment. Food services and drinking establishments also have large induced effects.

Chart 3: Top Industries Impacted by Agbioscience in Greater Minnesota, Sorted by Employment



Source: IMPLAN

Examining the impacts by employment provides one perspective on the types of industries impacted by the agbioscience industry. Examining the impacts by output provides another perspective.

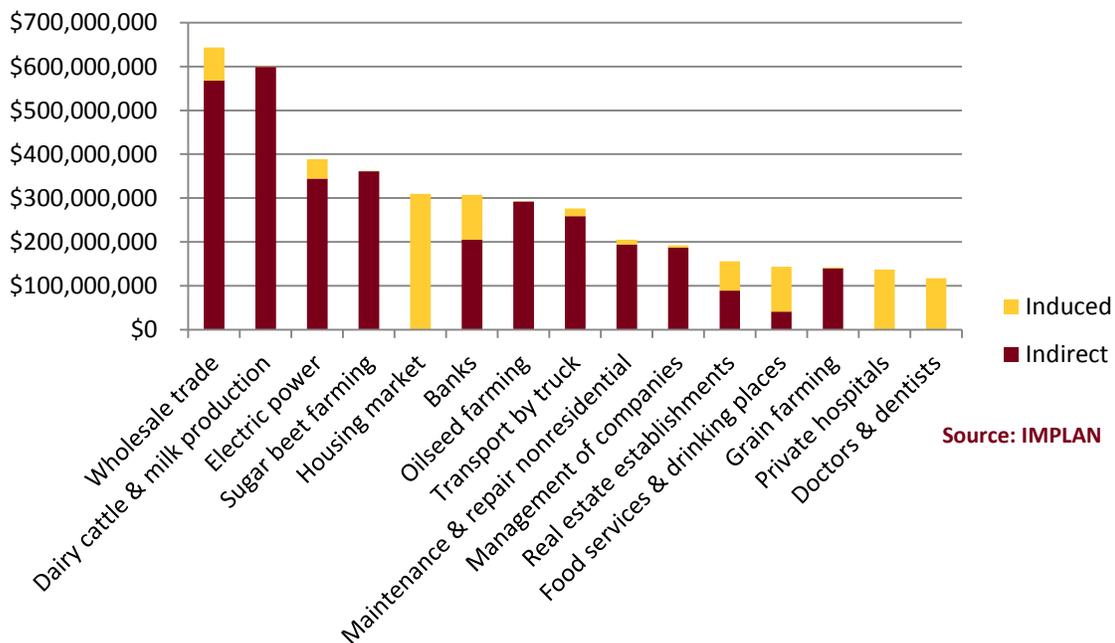
Certain industries are more labor-intensive (i.e. food services and drinking establishments), so employment impacts tend to be higher for these industries. Others are more capital-intensive (i.e. electric power generation), so output impacts tend to be higher for these industries.

Chart 4 illustrates the top industries impacted by the agbioscience industry sorted by output. When considering the industries impacted through this frame, new ones appear, including electricity, banking, and an even stronger emphasis on housing.

Indirect effects are relatively high for the agbioscience industry in Greater Minnesota. This is due in part to the connections the agbioscience industry has to the production agriculture industry. Economic impacts increase when businesses make purchases from other local businesses. Since agbioscience industries make purchases from local agricultural producers, wholesalers, and truckers, the impact of the industry is higher.

Induced effects are also notable for the agbioscience industry. Labor income (including wages, salaries, and benefits) are approximately \$78,000 per worker. These relatively high wages are driving additional economic activity in the housing market, in the health care industry, and at food and beverage businesses.

Chart 4: Top Industries Impacted by Agbioscience in Greater Minnesota, Sorted by Output



Source: IMPLAN

Contribution of Agbioscience by Region of Greater Minnesota

Agbioscience businesses exist in all regions of Minnesota (table 2).² The analysis here, however, focuses on the role of agbioscience in Greater Minnesota. Agbioscience economic activity is highest in the southern portion of the state and the highest levels of output and employment are in the

² 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/>.

southeastern and southwestern regions. Together, the two regions produce more than 65 percent of agbioscience output in Greater Minnesota.

In sheer numbers, agbioscience is largest in southern Minnesota. However, the sizes of the regional economies vary, partially because the regions are not equal in terms of the number of counties included in each one. Therefore, it is important to also consider the size of the agbioscience industry in relation to the size of the regional economy. In Northeast Minnesota, the total economic contribution of the industry accounts for approximately 10 percent of output in the region. In the Northwest, however, the industry accounts for about 8 percent of output.

The Southeast region clearly is notable in the size of its agbioscience industry. The agbioscience industry in the Southeast supported \$11.7 billion in output in 2013, far larger than the other regions. The above note regarding the size of the regional economy is important here. The Southeast region is comprised of 20 counties, the most of any Initiative Foundation region. Within the region is the City of Rochester, the third largest city in Minnesota. Correspondingly, the economy of the region is larger relative to the other regions. While the Southeast region’s output, in sheer numbers, is more than three times the output in the Southeast region, agbioscience output as a percentage of total regional output is closer (11.1 percent as compared to 15.5 percent). Curious readers can learn more about the agbioscience industry in the Southeast region by reading a companion document to this report titled “Economic Contribution of the Agbioscience Industry: Southeast Minnesota.”

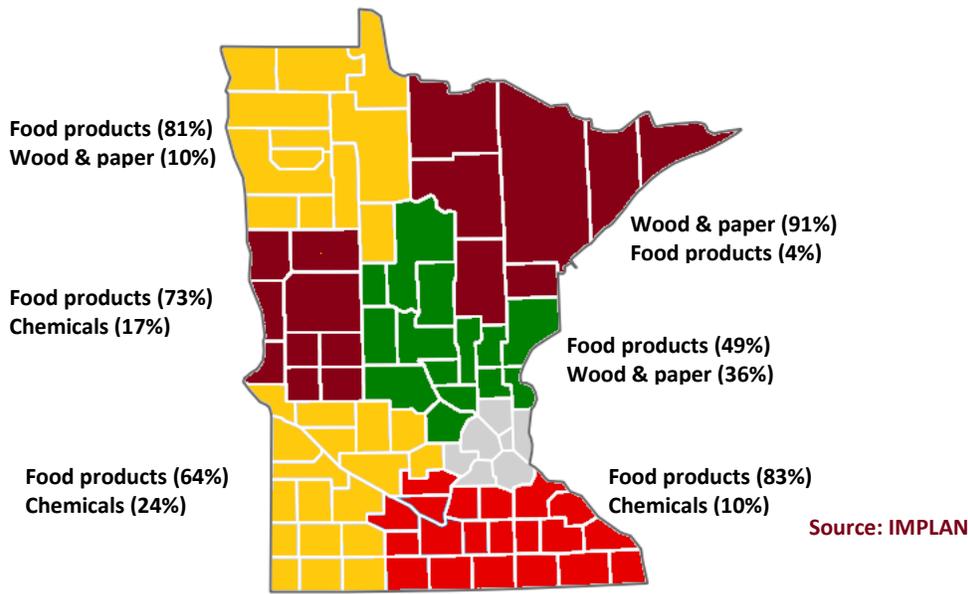
Table 2: Total Economic Contribution of Agbioscience by Region in Minnesota, 2013

	Output (millions)	Employment (rounded)	Labor Income (millions)	Agbioscience Output Percent of Total Regional Output
Central	\$2,813.3	8,940	\$474.0	5.7%
Northeast	\$2,807.3	7,580	\$478.5	10.2%
Northwest	\$1,230.3	4,870	\$234.8	8.2%
Southeast	\$11,737.1	29,220	\$1,719.6	15.5%
Southwest	\$3,590.6	9,440	\$554.5	11.1%
West Central	\$1,199.2	3,700	\$212.2	6.4%
Total	\$23,377.8	63,750	\$3,673.6	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 5). For example, food manufacturing is a major component of the agbioscience industry in Minnesota. It composes a significant share of output in all of the regions - with the exception of the Northeast. In Southeast Minnesota, food manufacturing accounts for 83 percent of total agbioscience output. 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 5: Top Agbioscience Sectors by Region and Percent of Total Regional Agbioscience Output



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

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

For more information on the composition of the agbioscience industry by region, please see appendix 2.

Economic Contribution of Agbioscience to the Metro Economy

While the primary focus of this analysis concerns the role of the agbioscience industry in Greater Minnesota, the industry also has a notable impact on the Twin Cities metropolitan area. In 2013, agbioscience businesses in the Twin Cities employed 11,590 workers. Those businesses made \$6.5 billion in sales (output) and paid \$1.3 billion in labor income. This is the direct effect of the agbioscience industry in the Twin Cities (table 3). Major sectors within the Twin Cities' agbioscience industry include testing laboratories (2,070 employees), in-vitro diagnostic substance manufacturing (1,760 employees), farm supplies merchant wholesalers (1,368 employees), and toilet preparation manufacturing (1,248 employees).

As a result of spending by agbioscience businesses and their employees, the Twin Cities-based agbioscience industry supported \$12.5 billion of output in the Twin Cities metro region. This included \$3.4 billion in income to residents of the Twin Cities. The industry also supported employment for 42,960 metro employees.

Table 3: Economic Contribution of Agbioscience in the Twin Cities 7-County Metro of Minnesota, 2013

	Output (millions)	Employment	Labor Income (millions)
Direct	\$6,523.7	11,590	\$1,303.4
Indirect	\$3,934.3	17,330	\$1,335.9
Induced	\$2,022.0	14,040	\$738.6
Total	\$12,480.0	42,960	\$3,377.9

Estimates by University of Minnesota Extension Center for Community Vitality

Beyond jobs at agbioscience businesses in the Twin Cities metropolitan area, there are also ones supported by the agbioscience industry in Greater Minnesota. Twin Cities-based firms provide goods and services to agbioscience businesses located across the state. The input-output model used in this analysis allows the ability to trace the effects of the agbioscience industry in Greater Minnesota on Twin Cities businesses.

In 2013, agbioscience businesses in Greater Minnesota supported 15,060 jobs at businesses and industries in the Twin Cities (table 4). Agbioscience businesses also supported \$3.2 billion of output, including \$1.1 billion in labor income for workers in the metro. Overall, output in the Twin Cities metropolitan area from all industries totaled \$349.1 billion in 2013, including \$128.9 billion in labor income. The direct effect here is zero, as the impact of the agbioscience activity in Greater Minnesota is being measured on the Twin Cities economy.

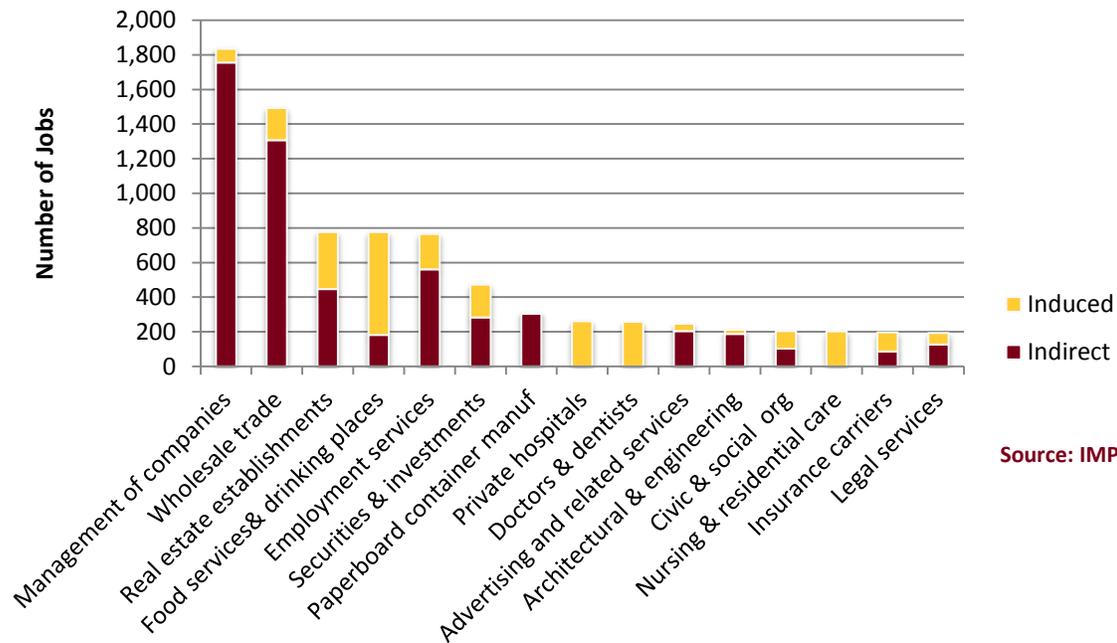
Table 4: Economic Contribution of Agbioscience in Greater Minnesota on the Twin Cities Metro Economy, 2013

	Output (millions)	Employment	Labor Income (millions)
Direct	\$0.0	0	\$0.0
Indirect	\$2,388.8	9,330	\$828.1
Induced	\$844.9	5,730	\$309.4
Total	\$3,233.7	15,060	\$1,137.5

Estimates by University of Minnesota Extension Center for Community Vitality

Of note is the type of industries in the Twin Cities affected by the agbioscience industry in Greater Minnesota (chart 6). While the agbioscience industry's highest impacts in Greater Minnesota are related to goods and services directly tied to the production process, the impacts in the Twin Cities metro are more related to business operations. The highest number of Twin Cities jobs supported by agbioscience in Greater Minnesota is in the management of companies, which is essentially corporate headquarters. This indicates that while production is taking place in Greater Minnesota, the operations responsible for decision making are located in the metro. Indirect impacts are also apparent in advertising; architectural and engineering services; securities and investments; insurance; and legal services. These are often office-based activities.

Chart 6: Top Twin Cities Metro Industries Impacted by Agbioscience in Greater Minnesota, Sorted by Employment



Source: IMPLAN

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 fell by 3 percent in Greater Minnesota. The number of jobs grew fastest in the ethyl alcohol manufacturing sector, in breakfast cereal manufacturing, and in fluid milk manufacturing. The sharpest job declines were noted in paper mills, reconstituted wood products, and cheese manufacturing (table 5).

Shift-share analysis examines the drivers of growth and decline for a specific industry within a specific region by comparing changes in the number of regional jobs in an industry to national and industry trends. The analysis provides an interesting interpretation of the changes in each industry. In this analysis, however, the primary focus is on competitive effect. A strongly positive competitive effect indicates particular characteristics of the local economy are driving growth in the region. A strongly negative competitive effect, on the other hand, can be interpreted as a warning that the local region may not be faring as well as it could. Table 4 highlights the three agbioscience sectors that added the most jobs, as well as the three sectors that lost the most jobs between 2003 and 2013. For a full shift-share analysis of all agbioscience sectors in Greater Minnesota, please see appendix 3.

The ethyl alcohol manufacturing sector added 457 jobs between 2003 and 2013. The majority of this growth resulted from growth in the ethyl alcohol manufacturing sector across the nation (industry mix effect). Overall growth across all industries in the United States (national growth effect) also contributed to the increase in the ethyl alcohol manufacturing jobs. In other words, the ethyl alcohol manufacturing sector in Greater Minnesota grew due to national trends. Growth in the ethyl alcohol manufacturing sector was strong during 2003 to 2006, but has slowed since 2007.

Table 5: Shift-Share Analysis for Growth and Decline of Agbioscience Industries (measured in number of jobs)³

Industry	Change 2001-2013	Industry Mix Effect	National Growth Effect	Competitive Effect
Top 3 Job Adding Industries				
Ethyl alcohol manufacturing	457	382	12	63
Breakfast cereal manufacturing	382	-76	47	411
Fluid milk manufacturing	250	-17	7	261
Top 3 Job Loss Industries				
Paper mills	-889	-1,025	137	-2
Reconstituted wood products	-765	-442	58	-401
Cheese manufacturing	-327	201	119	-646

Source: EMSI

The breakfast cereal manufacturing sector in Greater Minnesota, however, grew mostly as a result of competitive effect, as the breakfast cereal sector declined at the national level (industry mix effect). A fraction of new jobs in this sector was due to the modest growth of the United States economy across all industries (national growth effect). This suggests Greater Minnesota has a competitive advantage in the production of breakfast cereal. Modest employment declines in the early part of the period (2003-2008) were offset by growth in the latter half of the time period.

Paper mills lost 889 jobs between 2003 and 2013. Sector trends (reflected in the industry mix effect) indicate the paper mill industry also performed poorly on a national level. Most jobs lost in this sector in Greater Minnesota were a result of this national trend. The number of jobs lost in the paper mill sector declined steadily during this time period, with higher losses noted between 2003 and 2004, 2008 and 2009, and 2011 and 2012.

Cheese manufacturing also lost jobs. At the national level, however, the cheese manufacturing sector grew (industry mix effect). The cheese industry in Greater Minnesota also should have added jobs due to overall positive growth trends in the United States (national growth effect). This suggests the region is not as competitive as it could be in the cheese manufacturing sector. The number of jobs in Greater Minnesota's cheese manufacturing sector experienced a slow decline, as there was not a single year in which a significant number of jobs were lost.

Job growth rates vary by region (table 6). The number of agbioscience jobs increased in the Southwest, Central, and Southeast regions. The reason for these job gains vary upon the region. For instance, ethyl alcohol production was critical for an increase in jobs in the Southwest and the Central region had increases in fruit and vegetable canning. The Southeast grew primarily due to new jobs at testing laboratories.

³ For an explanation of shift-share analysis, please see the methodology section. Note, the table may not sum due to rounding.

Job losses, however, were recorded in the Northeast, Northwest, and West Central regions; paper mills drove losses in all three regions. Reconstituted wood products also drove losses in the Northeast and Northwest. To illustrate this point, ethyl alcohol production grew by 1,906 percent in the Southwest region, while reconstituted wood product manufacturing declined by 72 percent in the Northeast region.

Table 6: Agbioscience Industry Job Changes by Region

	Percent Job Change 2003-2013	Top 3 Job Gain Industries	Top 3 Job Loss Industries
Central	12%	Fruit and vegetable canning, distilleries, paper mills	Engineered wood products, hardwood veneer and plywood, cheese manufacturing
Northeast	-34%	Testing laboratories, pulp mills, newsprint mills	Paper mills, reconstituted wood products, sawmills
Northwest	-28%	Beet sugar, sawmills, fluid milk	Frozen food manufacturing, reconstituted wood products, paper mills
Southeast	7%	Testing laboratories, breakfast cereal manufacturing, fluid milk	Farm supplies wholesalers, cheese manufacturing, fats and oils refining and blending
Southwest	20%	Ethyl alcohol, farm supplies wholesalers, testing laboratories	Biological products manufacturing, fruit and vegetable canning, sawmills
West Central	-2%	Fluid milk, wineries, soil preparation, planting, and cultivating	Creamery butter, paper mills, beet sugar manufacturing
Greater Minnesota	-3%	Ethyl alcohol, breakfast cereal manufacturing, fluid milk	Paper mills, reconstituted wood products, cheese manufacturing

Source: EMSI

Future Growth and Development of Agbioscience in Greater Minnesota

The agbioscience industry is not static; it is continuously growing and changing in Greater Minnesota. Understanding these changes and potential changes for the future can assist in decision making regarding the industry. Past trends are one tool for considering future growth and development in an industry, and another tool is to look at the potential for market growth in individual sectors. The Battelle report examines the potential for growth by each platform. Projected growth rates vary from 5 to 10 percent.



Assuming a growth rate of 10 percent, the economic contribution of the agbioscience industry in Greater Minnesota will increase to \$25.7 billion, including 70,130 jobs and \$4.0 billion of labor income (table 7). The growth rate of 10 percent is an assumption made by University of Minnesota Extension for illustrative purposes.

Table 7: Economic Contribution of Agbioscience in Greater Minnesota, 10 Percent Growth Rate until 2016

	Output (millions)	Employment	Labor Income (millions)
Direct	\$18,268.7	25,039	\$1,961.4
Indirect	\$5,526.8	28,570	\$1,485.7
Induced	\$1,920.1	16,520	\$593.9
Total	\$25,715.6	70,130	\$4,041.0

Estimates by University of Minnesota Extension Center for Community Vitality

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

The Battelle report identified four agbioscience platforms in Minnesota which were identified based on Minnesota’s relative strengths. Agbioscience sectors can be included in multiple platforms. For example, soybean processing is included in microbial agbioscience, biobased industrial products, and value-added food and health product platforms. Therefore, the individual platforms will not add to the total agbioscience contribution in Greater Minnesota.

In relative terms and as measured by output, the value-added food and health products industry is the largest agbioscience industry in Minnesota, with a total economic contribution of \$17.0 billion in 2013 (table 8). As mentioned, food manufacturing is a significant component of agbioscience in the majority of the regions, with the exception of the Northeast and is reflected in the figures.

Table 8: Total Economic Contribution of Minnesota’s Agbioscience Platforms by Region, 2013, (measured by output in millions) Note: Individual platforms will not sum to total economic contribution of agbioscience since sectors can be classified in more than on platform.

	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

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, as well as testing laboratories; research and development; pulp mills; and food processing related to microbial agbioscience.⁴

In 2013, the microbial agbioscience platform supported an estimated \$4.9 billion of output in Greater Minnesota. The platform also supported an estimated 14,905 jobs, with those jobs paying an estimated \$786.0 million of labor income (table 9).

Table 9: Total Economic Contribution of Minnesota’s Microbial Agbioscience Platform by Region, 2013
(measured in millions of dollars)

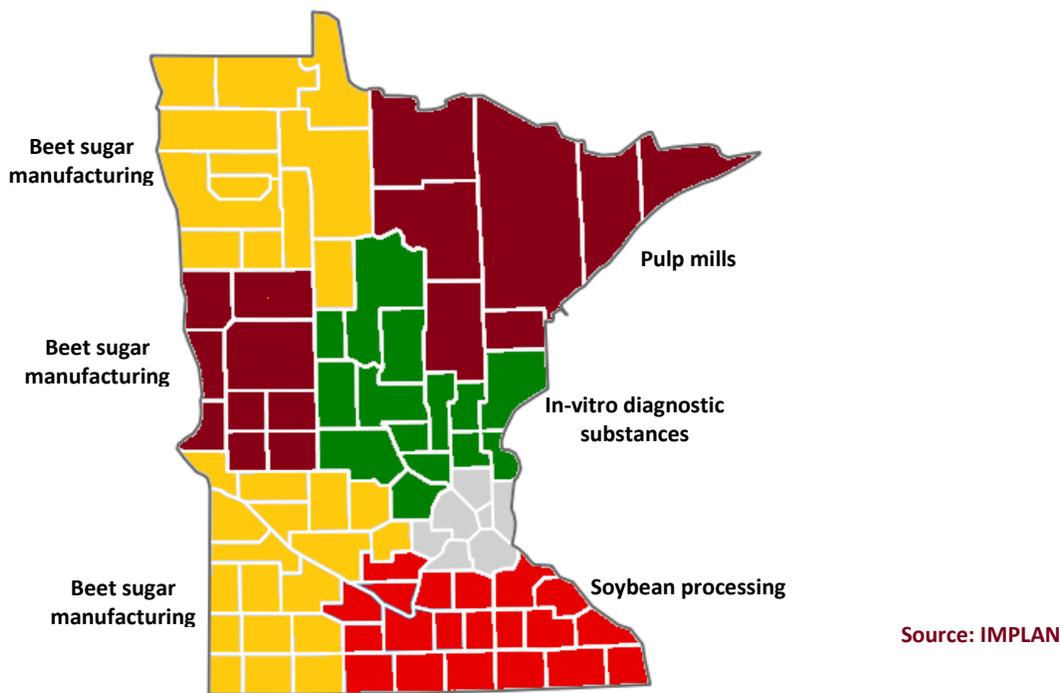
	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$787.9	\$169.9	\$88.7	\$857.5	\$452.1	\$2,583.4	\$4,939.5
Employment	3,100	765	430	2,960	1,760	5,890	14,905
Labor Income	\$134.5	\$41.6	\$22.0	\$152.0	\$75.7	\$360.2	\$786.0

Estimates by University of Minnesota Extension Center for Community Vitality

The Southeast region is the largest region for the microbial agbioscience platform in terms of both output and employment. Within the platform in the Southeast region, the largest sectors are soybean processing, and fats and oils refining and blending. The Northwest region is the second largest, as measured by employment. By far, the largest source of employment by platform in the Northwest region is beet sugar manufacturing. The Southwest is the second largest, as measured by output. The largest sources of output in the platform in the Southwest are beet sugar manufacturing, and fats and oils refining and blending (chart 7).

⁴ For an exact definition of what is included in the microbial agbioscience platform, please see the appendix 4.

Chart 7: Top Sector in Microbial Agbioscience Platform as Measured by Output, by Region



The microbial agbioscience platform has been growing in employment since 2003. The number of jobs in the platform grew in Greater Minnesota by 15 percent between 2003 and 2013. The fastest growth rates were in the Southeast, Central, and Southwest regions (table 10).

Table 10: Job Growth Rates for Microbial Agbioscience Platform, 2003-2013

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Growth Rate	7%	35%	16%	26%	6%	37%	15%

Source: EMSI

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

Given these projections, the total economic contribution of the microbial agbioscience platform would be expected to increase. Assuming a 10 percent growth rate between 2013 and 2016, the total

economic contribution in Greater Minnesota would increase to an estimated \$5.4 billion, including an estimated 16,400 jobs and an estimated \$864.6 million in labor income (table 11).⁵

Table 11: Total Economic Contribution of Minnesota’s Microbial Agbioscience Platform by Region, 10 Percent Growth Rate to 2016 (measured in millions of dollars)

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$866.7	\$186.9	\$97.6	\$943.3	\$497.3	\$2,841.7	\$5,433.5
Employment	3,410	840	470	3,260	1,940	6,480	16,400
Labor Income	\$148.0	\$45.8	\$24.2	\$167.2	\$83.3	\$396.2	\$864.6

Estimates by University of Minnesota Extension Center for Community Vitality

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 \$3.1 billion of output in Greater Minnesota. The platform also supported an estimated 11,360 jobs, with those jobs paying an estimated \$713.3 million of labor income (table 12).

Table 12: Total Economic Contribution of Minnesota’s Resilient, Efficient, and Productive Agricultural Systems Platform by Region 2013 (measured in millions of dollars)

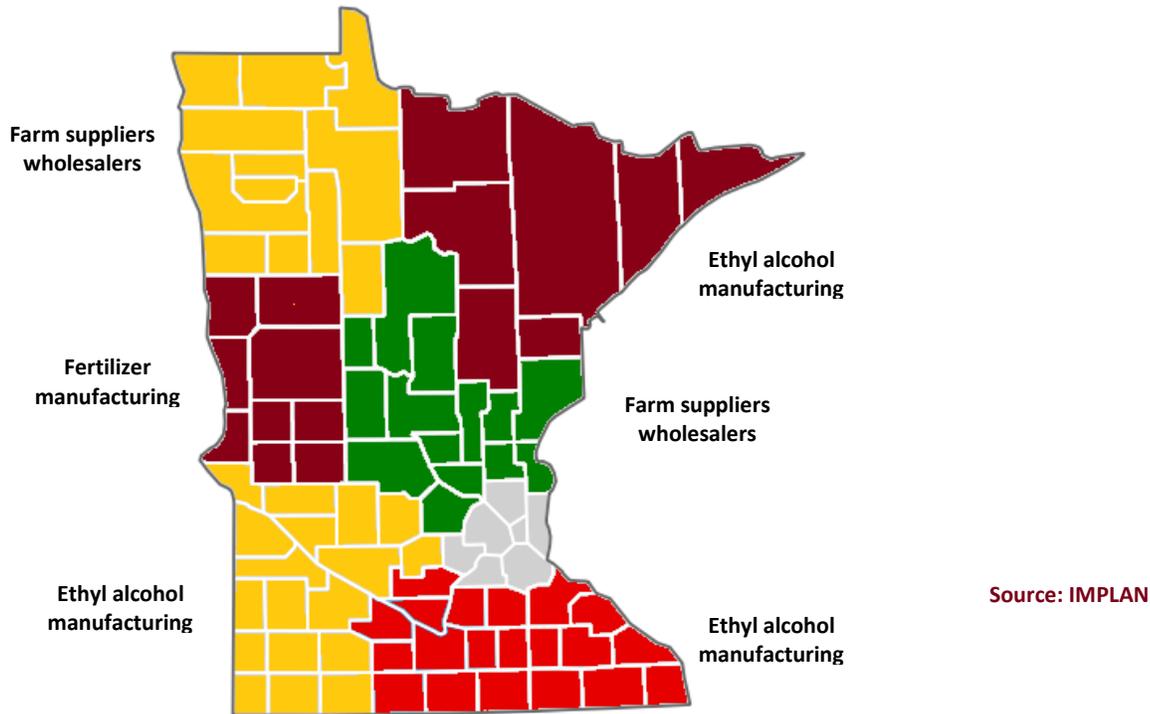
	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$82.6	\$277.9	\$125.7	\$1,111.8	\$288.0	\$1,246.9	\$3,132.9
Employment	500	1,590	340	3,530	1,160	4,240	11,360
Labor Income	\$25.2	\$76.4	\$16.2	\$241.1	\$94.4	\$260.0	\$713.3

Estimates by University of Minnesota Extension Center for Community Vitality

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 (chart 8). The Southwest region is the second largest region. Within this region, the largest sectors in the platform (measured by output) also are ethyl alcohol manufacturing and farm suppliers wholesalers.

⁵ The 10 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on historical growth in employment (15 percent) and Battelle’s projected growth rate (10 percent).

Chart 8: Top Sector in the Resilient, Efficient, and Productive Agricultural Systems Platform as Measured by Output, by Region



Between 2003 and 2013, the number of jobs in the resilient, efficient, and productive agricultural systems platform grew by 10 percent (table 13). This growth was driven primarily by an increase in the number of jobs in ethyl alcohol manufacturing, as well as research and development in biotechnology sectors. The Southwest, West Central, and Central regions added jobs to the platform during this period, while the Northeast, Northwest, and Southeast regions lost jobs during the same period. In the Northwest and Southeast these losses are primarily the result of job losses in the farm suppliers wholesale sector. The Northeast region, on the other hand, lost a significant number of environmental consulting jobs.

Table 13: Job Growth Rates for Resilient, Efficient, and Productive Agricultural Systems Platform, 2003-2013

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Growth Rate	-20%	11%	-38%	37%	18%	-16%	10%

Source: EMSI

In regards to the resilient, efficient, and productive agricultural systems platform, the Battelle report concludes “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 at growth of 10 percent occurs, the economic contribution of the resilient, efficient, and productive agricultural systems platform would increase to \$3.4 billion of output, including 12,490 jobs and \$784.6 million in labor income (table 14).⁶

Table 14: Total Economic Contribution of Minnesota’s Resilient, Efficient, and Productive Agricultural Systems Platform by Region, 10 Percent Growth Rate by 2016 (measured in millions of dollars)

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$90.9	\$305.7	\$138.3	\$1,223.0	\$316.8	\$1,371.6	\$3,446.2
Employment	550	1,750	370	3,880	1,280	4,660	12,490
Labor Income	\$27.7	\$84.0	\$17.8	\$265.2	\$103.8	\$286.0	\$784.6

Estimates by University of Minnesota Extension Center for Community Vitality

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 (wood products, paper mills), chemical manufacturing (especially around ethanol), and fertilizer manufacturing.

In 2013, the biobased industrial products platform supported \$8.6 billion of output in Greater Minnesota. The platform also supported 19,440 jobs, with these jobs paying \$1.3 billion in labor income (table 15).

Table 15: Total Economic Contribution of Minnesota’s Biobased Industrial Products Platform by Region, 2013 (measured in millions of dollars)

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$116.2	\$1,088.1	\$2,660.6	\$1,068.3	\$191.1	\$3,443.5	\$8,567.8
Employment	520	3,180	7,040	2,010	450	6,240	19,440
Labor Income	\$30.9	\$187.6	\$451.0	\$162.6	\$60.0	\$401.2	\$1,293.3

Estimates by University of Minnesota Extension Center for Community Vitality

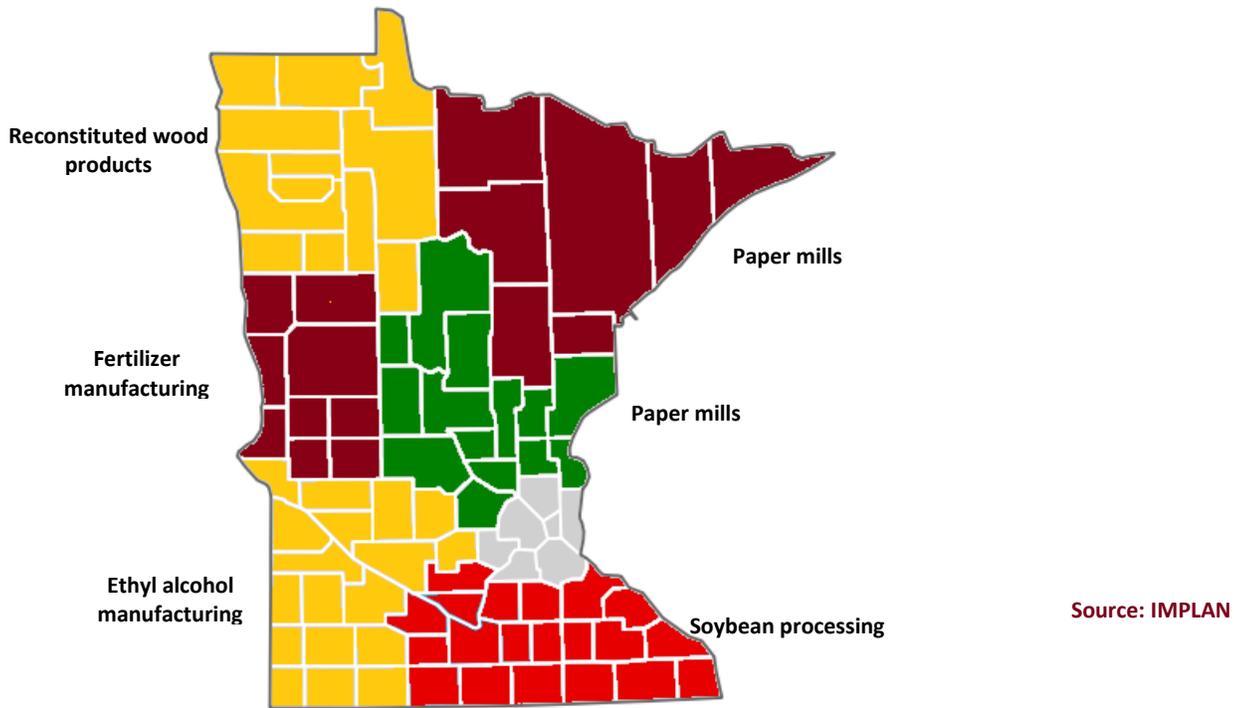
Within the platform, the Southeast region produces the highest level of output. The Northeast, Central, and Southwest regions also have significant levels of output in the platform (more than \$1 billion in each region). The Northeast has the highest level of employment. In the Southeast region,

⁶ The 10 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on historical growth in employment (10 percent) and Battelle’s projected growth rates (7-10 percent).



soybean and oilseed processing and ethyl alcohol manufacturing are major employers within the platform. The platform has different drivers in the Northeast region where paper mills and reconstituted wood products are major employers within the platform.

Chart 9: Top Sector in the Biobased Industrial Products Platform as Measured by Employment, by Region



In Greater Minnesota, the number of jobs in the biobased industrial products platform declined by 20 percent between 2003 and 2013 (table 16). These jobs losses were driven by those in the wood and paper manufacturing industry, particularly in the number of paper mills and reconstituted wood products. The number of jobs in the platform in the Southwest region, however, grew by 352 percent. This was largely due to increases in the ethyl alcohol manufacturing sector. As noted by the Battelle report, the biofuels market, one component of the biobased industrial products platform, was negatively affected by the Great Recession of 2008-2009.

Table 16: Job Growth Rates for Biobased Industrial Products Platform, 2003-2013

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Growth Rate	-57%	-4%	-34%	352%	27%	-5%	-20%

Source: EMSI

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 according to Battelle, the demand for biomaterial is expected to post a yearly growth of 6.9 percent. 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 reasonable.

If the rate of growth of 5 percent occurs, the economic contribution of the biobased industrial products platform would increase to \$9.0 billion of output, including 20,410 jobs and \$1.4 billion in labor income (table 17).⁷

Table 17: Total Economic Contribution of Minnesota’s Biobased Industrial Products Platform by Region, 5 Percent Growth Rate by 2016 (measured in millions of dollars)

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$122.0	\$1,142.5	\$2,793.6	\$1,121.7	\$200.7	\$3,615.7	\$8,996.2
Employment	550	3,340	7,390	2,110	470	6,550	20,410
Labor Income	\$32.5	\$197.0	\$473.6	\$170.7	\$63.0	\$421.3	\$1,358.0

Estimates by University of Minnesota Extension Center for Community Vitality

Value-added Food and Health Products

This platform is based on Minnesota’s strengths in agricultural value-added, particularly regarding 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 2013, the value-added food and health products platform supported an estimated \$17.0 billion in output in Greater Minnesota, including an estimated \$2.5 billion in labor income and 45,640 jobs (table 18).

⁷ The 5 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on historical growth in employment (-20 percent) and Battelle’s projected growth rates (3-7 percent).



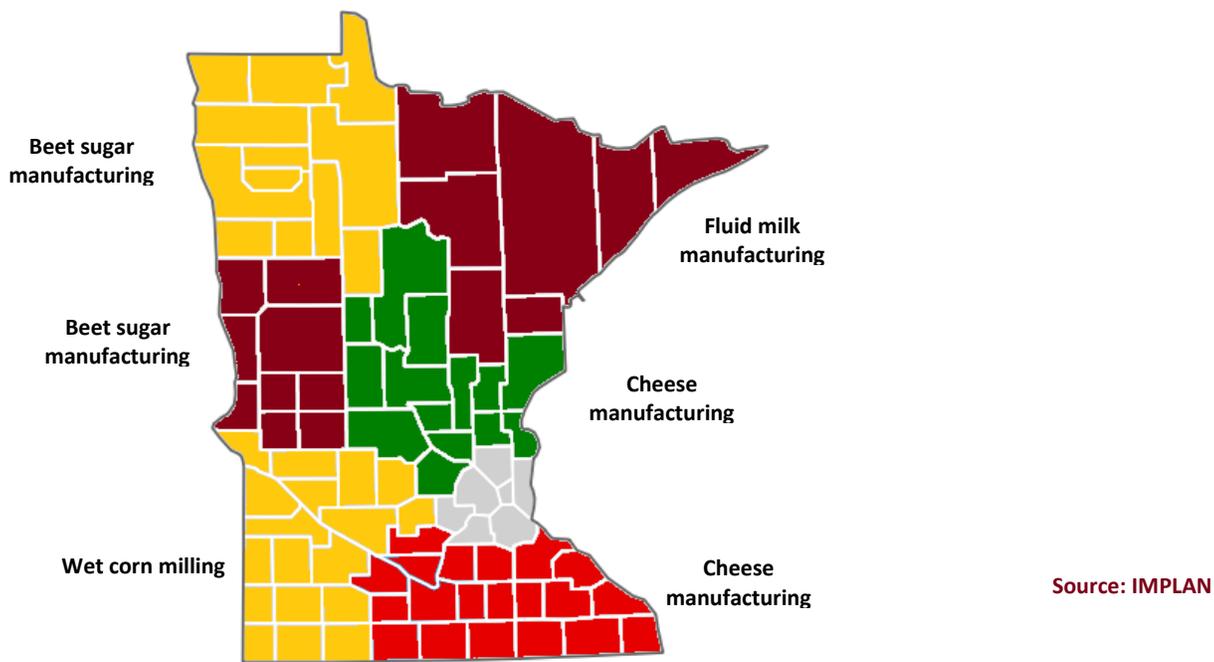
Table 18: Total Economic Contribution of Minnesota’s Value-Added Food and Health Products Platform by Region, 2013 (measured in millions of dollars)

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$1,092.2	\$1,613.3	\$108.4	\$2,709.7	\$1,004.2	\$10,502.2	\$17,030.0
Employment	4,230	5,230	260	7,550	3,110	25,260	45,640
Labor Income	\$198.3	\$253.8	\$13.8	\$398.9	\$148.0	\$1,533.4	\$2,546.2

Estimates by University of Minnesota Extension Center for Community Vitality

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 include beet sugar manufacturing, wholesale trade, and fluid milk and butter manufacturing.

Chart 10: Top Sector in Value-Added Food and Health Products Platform as Measured by Output, by Region



The number of jobs in the value-added food and health products platform increased in Greater Minnesota by 4 percent between 2003 and 2013 (table 19). Gains in breakfast cereal manufacturing, fluid milk manufacturing, breweries, and wineries were offset by losses in cheese manufacturing, frozen foods manufacturing, and flour milling. The Central and Southwest regions posted positive

job gains in the platform, but the Northeast, Northwest, and West Central regions lost jobs. The Northeast lost a large percentage of jobs (47 percent) as well, but the total number of jobs was relatively small (fewer than 80 jobs).

Table 19: Job Growth Rates for Value-Added Food and Health Products Platform, 2003-2013

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Growth Rate	-17%	25%	-47%	14%	-5%	1%	4%

Source: EMSI

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 (the market for health and nutrition-focused foods, including nutritional supplements), which currently accounts for less than 10 percent of the market (Battelle Technology Partnership Practice, November 2013). Market forces are strong, however, for traditional food and health companies to move into the value-added market.

The Battelle report states “Overall, the U.S. is leading the global nutraceuticals market with more than 33.1 percent of the market share in 2010, and this market is anticipated to grow at a 6.5 percent compound annual growth rate (CAGR) from 2011 to 2016” (p. 61). The report only provides a compound annual growth rate for the nutraceuticals market only and does not provide a growth rate for the platform as a whole.

As noted above, employment in the platform increased by 4 percent across Greater Minnesota between 2003 and 2013. Therefore, an overall future growth rate of 5 percent appears to be reasonable.

If employment in the platform were to increase by 5 percent, the economic contribution of the value-added food and health products platform would increase to an estimated \$17.9 billion of output, including an estimated 47,930 jobs and an estimated \$2.7 billion in labor income (table 20).⁸

Table 20: Total Economic Contribution of Minnesota’s Value-Added Food and Health Products Platform by Region, 5 Percent Growth Rate by 2016

	Northwest	Central	Northeast	Southwest	West Central	Southeast	Greater Minnesota
Output	\$1,146.8	\$1,694.0	\$113.8	\$2,845.2	\$1,054.4	\$11,027.3	\$17,881.5
Employment	4,440	5,500	270	7,930	3,270	26,520	47,930
Labor Income	\$208.2	\$266.5	\$14.5	\$418.9	\$155.4	\$1,610.1	\$2,673.5

Estimates by University of Minnesota Extension Center for Community Vitality

⁸ The 5 percent growth rate is an assumption made by University of Minnesota Extension. The growth rate is a potential rate based on historical growth in employment (4 percent) and Battelle’s projected growth rate for the nutraceuticals market (6.5 percent).

The Platforms in the Twin Cities Metro

While the focus of this report is on the agbioscience industry in Greater Minnesota, agbioscience businesses operate in each of the four platforms in the 7-county Twin Cities metro (table 21). In this region, the value-added food and health platform produces the most output (\$6.9 billion) and employs the most workers (22,580). Major sectors within the platform include farm supplies merchant wholesalers, toilet preparation manufacturing, fluid milk manufacturing, and research and development in biotechnology.

Table 21: Total Economic Contribution of Agbioscience in the 7-County Twin Cities Region by Platform, 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)	Employment	Labor Income (Millions)
Microbial Agbioscience	\$1,322.2	7,500	\$534.0
Resilient, Efficient, and Productive Agricultural Systems	\$2,172.0	9,120	\$717.9
Bio-based Industrial Products	\$2,338.9	5,890	\$508.3
Value-Added Food and Health	\$6,875.2	22,580	\$1,667.5

Estimates by the University of Minnesota Extension Center for Community Vitality

SUMMARY

In 2013, the Agricultural Utilization Research Institute sponsored, along with the Minnesota Corn Research and Promotion Council and the Minnesota Soybean Research and Promotion Council, a study of the agbioscience industry in Minnesota. Battelle Technology Partnership Practice (Battelle) conducted the analysis. The report identified the core strengths of agbioscience in Minnesota and recommended four platforms for further investment and development and the statewide report significantly bolsters understanding of the agbioscience industry. As leaders in the agbioscience industry explore opportunities to support the industry in Greater Minnesota, understanding the role of the industry at a regional level is necessary. This report is designed to be a bridge between the statewide analysis of the Battelle report and an analysis of regional differences in Greater Minnesota.

In 2013, agbioscience businesses directly produced an estimated \$16.6 billion in output in Greater Minnesota. Agbioscience industries employed an estimated 22,760 workers, paying those workers an estimated \$1.8 billion in labor income. On average, each agbioscience employee received approximately \$78,000 in compensation (wages, salaries, and benefits). An analysis of employment trends indicates agbioscience employment fell by a modest 3 percent between 2003 and 2013 in Greater Minnesota.

In 2013, the agbioscience industry in Greater Minnesota supported an estimated \$23.4 billion in output and jobs for 63,750 people.

The direct economic activity generated by the agbioscience industry in Greater Minnesota supported additional activity at companies and industries that supply goods and services to agbioscience

businesses and their employees. In 2013, taking all impacts into account, the agbioscience industry supported a total estimated \$23.4 billion in economic activity in Greater Minnesota. The activity supported by agbioscience businesses accounts for approximately 10 percent of the total \$223.1 billion of output from all industries in Greater Minnesota. In addition, the agbioscience industry supported an estimated 63,750 workers out of Greater Minnesota's 1.4 million jobs. The agbioscience industry supported a total of \$3.7 billion in labor compensation, in comparison to Greater Minnesota's \$60.8 billion of labor compensation across all industries.

Due to its ties to the agricultural industry in Minnesota, the agbioscience industry has relatively high ripple effects. Industries benefiting most from the presence of the agbioscience industry include sugar beet farming, grain farming, dairy and milk production, and oilseed production. The agbioscience industry also strongly influences industries that provide services to agbioscience businesses, including wholesale trade, trucking, and care for physical infrastructure. Relatively strong wages also drive impacts in the housing market and health care industries.

On a regional level, the southern tier of the state is most positively affected by the agbioscience industry. Agbioscience businesses in the Southeast and Southwest regions were responsible for 65 percent of the total economic contribution of the industry in Greater Minnesota. By sheer numbers, the southern region is largest, but the two regions also have sizable economies. In the Northeast region, the output is not as high, but the agbioscience industry supports about 10 percent of regional output, as compared to approximately 11 percent of the Southwest's and 15.5 percent of the Southeast's.

While this report focuses on Greater Minnesota, agbioscience also influences the economy of the Twin Cities 7-county metro area. In 2013, Twin Cities-based agbioscience businesses supported \$12.5 billion of output in the metro region. This is approximately 3.5 percent of the metro's \$349.1 billion of output. Twin Cities-based agbioscience industries also supported 42,960 jobs (out of 2.1 million in the region) and \$3.4 billion of labor income.

In addition to Twin Cities agbioscience businesses generating economic activity, agbioscience businesses in Greater Minnesota generate output, employment, and labor income effects in the Twin Cities metro. In 2013, the Greater Minnesota agbioscience industry supported 15,060 jobs in the Twin Cities region. The industry also supported \$3.2 billion in output, including \$1.1 billion of wages, salaries, and benefits. While the impact of Greater Minnesota's agbioscience industry within its own region tends to be at industries providing support to the agbioscience production process; the Twin Cities impacts tend to be at industries providing operational support (for example, corporate headquarters, advertising, engineering and architectural services).

Agbioscience employment trends show the number of jobs in the industry declined slightly (by 3 percent) between 2003 and 2013. Growth was strong in the number of jobs in the ethyl alcohol manufacturing sector, the breakfast cereal manufacturing sector, and the fluid milk production sector. These gains, however, were offset by job losses at paper mills, in reconstituted wood production, and in cheese manufacturing. The Southwest region experienced rapid growth in the ethyl alcohol manufacturing sector, leading it to the highest growth rate among the regions. The Northeast region, which has the highest percentage of its agbioscience in the wood and paper product manufacturing sector, experienced the highest rates of job losses.

Growth is expected in the agbioscience industry in Greater Minnesota. While the rate of growth depends on the agbioscience platform, the Battelle report predicted growth rates between 3 and 10 percent. If employment in the agbioscience industry were to grow by 10 percent, the total economic

contribution would increase to an estimated \$25.7 billion in economic activity, including 70,130 jobs and an estimated \$4.0 billion in labor income.

The microbial agbioscience platform contributed an estimated \$4.9 billion in output to Greater Minnesota's economy in 2013. The platform supported an estimated 14,905 jobs and paid compensation to workers of \$786.0 million. Between 2003 and 2013, employment in the platform increased by 15 percent. The Southeast region has the largest share of the total economic contribution for the platform, primarily as a result of soybean processing. If output in the microbial agbioscience platform would increase by 10 percent between now and 2016, the economic contribution would also increase to an estimated \$5.4 billion, including 16,400 jobs and an estimated \$864.6 million in labor income. A 10 percent increase was modeled to illustrate potential growth and is based on historical growth rates and Battelle's estimates for market demand.

The resilient, efficient, and productive agricultural systems platform contributed an estimated \$3.1 billion in output to Greater Minnesota's economy in 2013. The platform supported an estimated 11,360 jobs, including \$713.3 million in labor income. Between 2003 and 2013, employment in the platform increased by 10 percent. The Southeast region has the largest share of total economic contribution of the platform, primarily due to ethyl alcohol manufacturing. However, the Southwest region added jobs the most quickly from 2003 to 2013, growing employment by 37 percent. Based on historical growth rates and Battelle estimates for market demand in the platform, a growth rate of 10 percent between now and 2016 was assumed for illustrative purposes. A 10 percent increase in output for the resilient, efficient, and productive agricultural systems platform would increase the economic contribution to an estimated \$3.4 billion in output, 12,490 jobs, and an estimated \$784.6 million in employee compensation.

The biobased industrial products platform contributed an estimated \$8.6 billion in output to Greater Minnesota's economy in 2013. The platform supported an estimated 19,440 jobs and paid an estimated \$1.3 billion to workers in the region. Between 2003 and 2013, employment in the platform declined by 20 percent, as this platform was particularly affected by the Great Recession of 2008-2009. The Southeast region had the largest share of the total economic contribution of the platform, primarily due to the soybean processing sector. However, the Northeast had the highest level of employment, and the Southwest region added jobs at the fastest rate from 2003 to 2013, growing employment by 352 percent. This was largely driven by increases in the ethyl alcohol sector. Based on Battelle's predictions for growth in the platform, a 5 percent growth rate was assumed to illustrate potential growth. A 5 percent increase would increase the economic contribution to an estimated \$9.0 billion in output, 20,410 jobs, and an estimated \$1.4 billion in labor income.

The value-added food and health products platform contributed an estimated \$17.0 billion in output to Greater Minnesota's economy in 2013. The platform supported an estimated 45,640 jobs and paid an estimated \$2.5 billion in employee compensation. Between 2003 and 2013, employment in the platform increased by a modest 4 percent. The Southeast region had the largest share of the total economic contribution of the platform, primarily due to the cheese manufacturing sector. However, the Central region added jobs the most quickly, growing by 25 percent. Using historical growth rates and Battelle's research for increased market demand in the nutraceuticals portion of the platform, a potential growth rate of 5 percent was assumed to demonstrate the potential for growth. A 5 percent increase in output for the value-added food and health products platform would increase the economic contribution to an estimated \$17.9 billion in output, 47,930 jobs, and an estimated \$2.7 billion in payments to employees.

Agbioscience is an important component of Greater Minnesota's economy. Given its ties to agriculture and manufacturing, its influence on other businesses and industries in Greater

Minnesota is strong. The industry's relatively high wages also support jobs in health care and housing. Additionally, agbioscience in Greater Minnesota also supports employment in the Twin Cities.

Agbioscience is a complex system of businesses and enterprises in Greater Minnesota. The role of the industry varies considerable by region – from its total contribution to the economy to the type of firms that constitute the industry. Understanding and embracing those regional differences may help Minnesota's leaders advance the future growth and development of the industry.

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)⁹ 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 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 sale of each of these items 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. For instance, 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 southeast region of Minnesota.

⁹ IMPLAN Version 3.0 was used in this analysis. The trade flows model with SAM multipliers was implemented.

- **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 covered by the Unemployment Insurance Program are required to report their total payroll and the number of employees to DEED. The data is then aggregated by business classification code and geographic location. The QCEW database is one of the most robust and current sets of data available, covering about 97 percent of all workers in the state. The database, however, has drawbacks, including the fact that the self-employed are not included in the numbers; agriculture is one group often under-represented in the data.

Shift-Share Analysis

The results of shift-share analysis are presented in this report. Shift-share analysis is a powerful tool for understanding the drivers of economic change in an industry. Shift-share analysis parses economic change (in this instance, 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, 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, a 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: COMPOSITION OF AGBIOSCIENCE OUTPUT BY REGION

Chart A1: Agbioscience Output by Industry, Central Minnesota

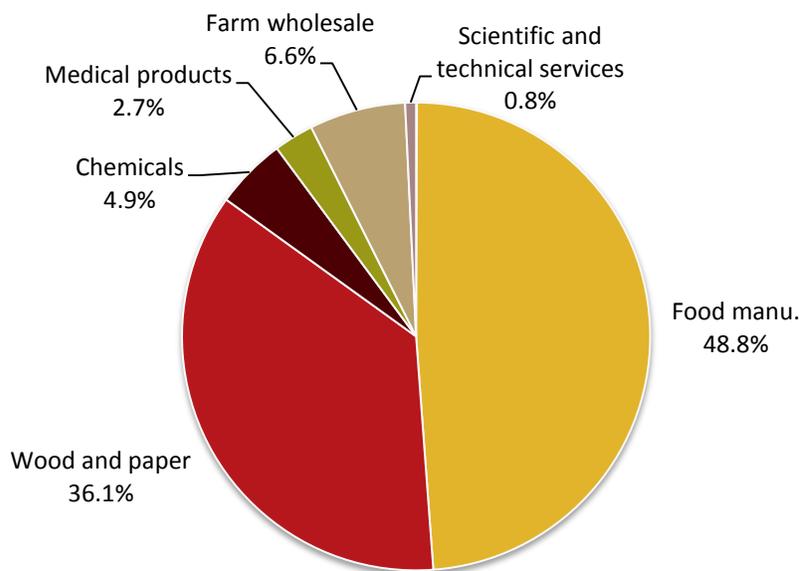


Chart A2: Agbioscience Output by Industry, Northeast Minnesota

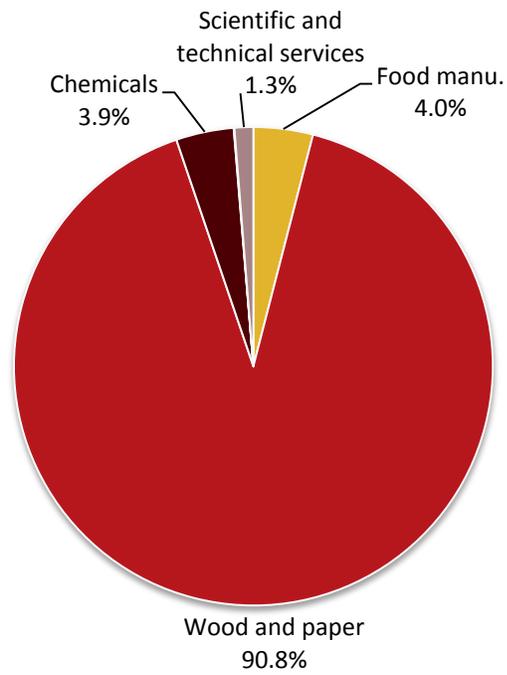


Chart A3: Agbioscience Output by Industry, Northwest Minnesota

Source: IMPLAN

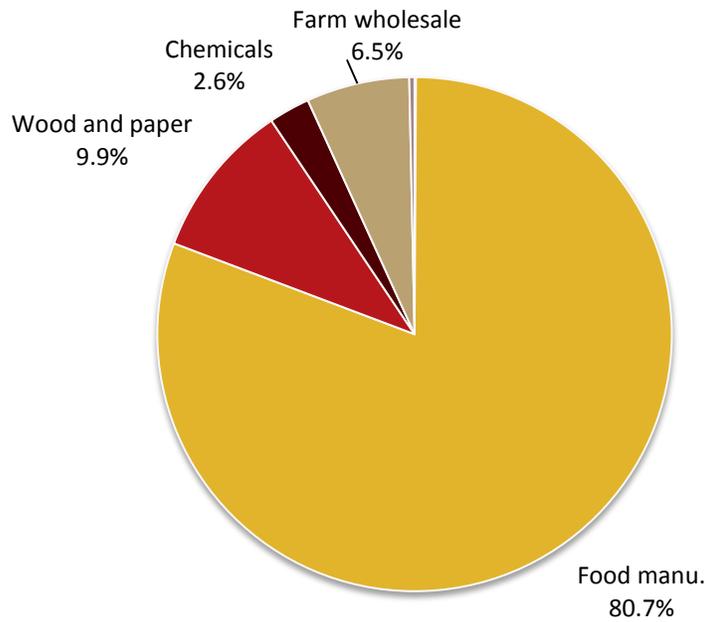
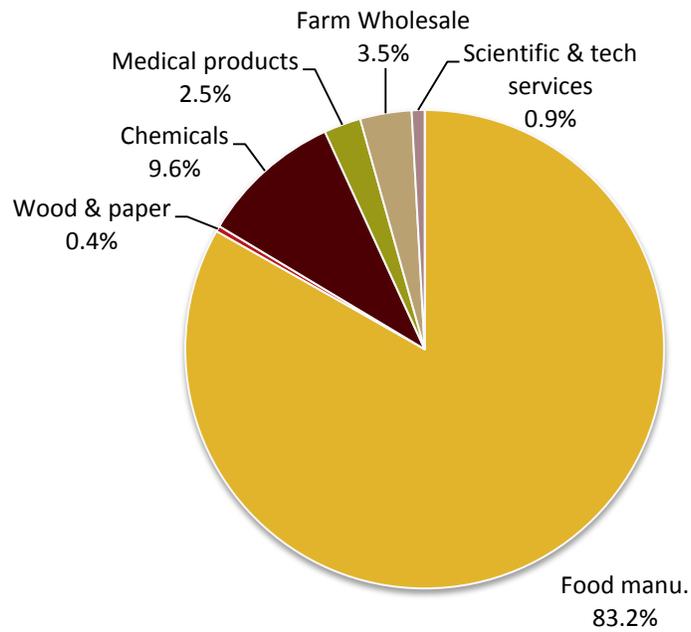


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

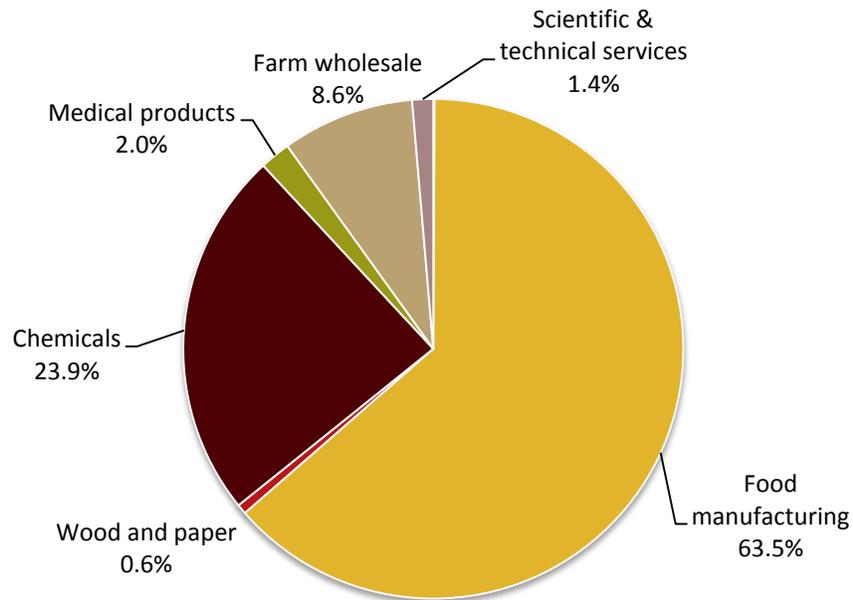
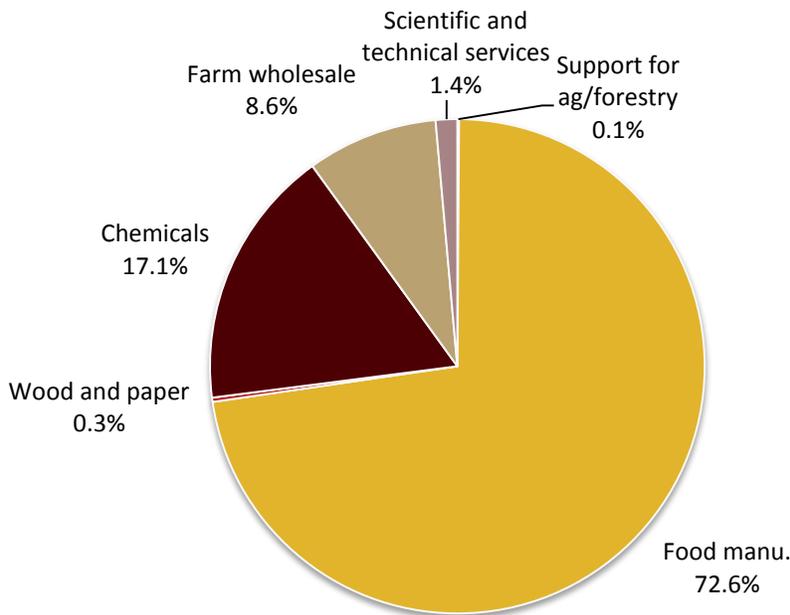


Chart A6: Agbioscience Output by Industry, West Central Minnesota



Source: IMPLAN

APPENDIX 3: SHIFT-SHARE ANALYSIS FOR ALL AGBIOSCIENCE SECTORS IN GREATER MINNESOTA

Table A3: Shift-Share Analysis for All Agbioscience Sectors in Greater Minnesota, Sorted by Change in the Number of Jobs

Description	2003 Jobs	2013 Jobs	2003 - 2013 Change	2003 - 2013 % Change	2013 Location Quotient	Ind. Mix Effect	Nat'l Growth Effect	Expected Change	Competitive Effect
Ethyl Alcohol Manufacturing	251	708	457	182%	9.27	382	12	394	63
Breakfast Cereal Manufacturing	967	1,349	382	40%	12.64	(76)	47	(29)	411
Fluid Milk Manufacturing	145	395	250	172%	0.98	(17)	7	(10)	261
Breweries	129	335	206	160%	1.27	33	6	39	168
Testing Laboratories	324	530	206	64%	0.43	23	16	39	167
Newsprint Mills	433	615	182	42%	11.79	(158)	21	(137)	320

Wineries	35	181	146	417%	0.49	20	2	22	125
Research and Development in Biotechnology	99	230	131	132%	0.21	16	5	21	111
Distilleries	75	205	130	173%	3.02	14	4	18	112
Soil Preparation, Planting, and Cultivating	389	490	101	26%	2.53	27	19	46	55
In-Vitro Diagnostic Substance Manufacturing	63	155	92	146%	0.90	36	3	39	54
Creamery Butter Manufacturing	209	264	55	26%	14.68	17	10	27	28
Fruit and Vegetable Canning	2,523	2,576	53	2%	5.48	(339)	122	(217)	270
Spice and Extract Manufacturing	199	242	43	22%	1.45	75	10	85	(41)
Wood Preservation	115	147	32	28%	2.18	(40)	6	(34)	66
Toilet Preparation Manufacturing	79	104	25	32%	0.27	(9)	4	(5)	30
Synthetic Rubber Manufacturing	13	36	23	177%	0.44	(3)	1	(2)	25
Wet Corn Milling	296	318	22	7%	3.37	137	14	151	(130)
Rice Milling	12	31	19	158%	0.85	(0)	1	1	18
Pulp Mills	24	39	15	63%	0.84	(4)	1	(3)	18
Paperboard Mills	116	121	5	4%	0.55	(36)	6	(30)	35
Flavoring Syrup and Concentrate Manufacturing	0	0	0	0%	0.00	0	0	0	0
Softwood Veneer and Plywood Manufacturing	12	0	(12)	(100%)	0.00	(5)	1	(4)	(8)
Beet Sugar Manufacturing	1,362	1,346	(16)	(1%)	27.35	(62)	66	4	(20)
Cut Stock, Resawing Lumber, and Planing	105	82	(23)	(22%)	0.85	(40)	5	(35)	13



Farm Supplies Merchant Wholesalers	3,923	3,899	(24)	(1%)	4.56	(66)	189	123	(147)
All Other Basic Organic Chemical Manufacturing	139	111	(28)	(20%)	0.42	(4)	7	3	(30)
Fertilizer (Mixing Only) Manufacturing	87	50	(37)	(43%)	0.78	(3)	4	1	(38)
Remediation Services	196	149	(47)	(24%)	0.26	35	9	44	(91)
Plastics Material and Resin Manufacturing	130	79	(51)	(39%)	0.19	(18)	6	(12)	(39)
Hardwood Veneer and Plywood Manufacturing	113	54	(59)	(52%)	0.48	(48)	5	(43)	(17)
Environmental Consulting Services	165	106	(59)	(36%)	0.17	45	8	53	(111)
Biological Product (except Diagnostic) Manufacturing	151	71	(80)	(53%)	0.34	2	7	9	(90)
Fats and Oils Refining and Blending	280	168	(112)	(40%)	3.55	10	14	24	(136)
Sawmills	480	323	(157)	(33%)	0.55	(144)	23	(121)	(37)
Flour Milling	353	188	(165)	(47%)	1.89	(55)	17	(38)	(128)
Frozen Fruit, Juice, and Vegetable Manufacturing	831	666	(165)	(20%)	2.79	(154)	40	(114)	(51)
Engineered Wood Member (except Truss) Manufacturing	289	115	(174)	(60%)	2.89	(119)	14	(105)	(69)
Cheese Manufacturing	2,456	2,129	(327)	(13%)	6.50	201	119	320	(646)
Reconstituted Wood Product Manufacturing	1,199	434	(765)	(64%)	4.43	(422)	58	(364)	(401)
Paper (except Newsprint) Mills	2,842	1,953	(889)	(31%)	3.95	(1,025)	137	(888)	(2)
Pesticide and Other Agricultural Chemical Manufacturing	<10	24	Insf. Data	Insf. Data	0.22	(2)	0	(2)	17

Medicinal and Botanical Manufacturing	25	<10	Insf. Data	Insf. Data	0.02	(5)	1	(4)	(18)
Phosphatic Fertilizer Manufacturing	0	<10	Insf. Data	Insf. Data	0.03	(0)	0	0	2
Nitrogenous Fertilizer Manufacturing	13	<10	Insf. Data	Insf. Data	0.02	(2)	1	(1)	(11)
Malt Manufacturing	94	<10	Insf. Data	Insf. Data	1.44	(22)	5	(17)	(67)
Total	21,748	21,031	(717)	(3%)		(1,808)	1,050	(758)	40

Source: EMSI

APPENDIX 4: 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.” You can view the study here: (<http://www.auri.org/assets/2013/12/Minnesotas+Agbioscience+Strategy+-+Final+Report-1.pdf>).

Table A4: 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 A5: 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 A6: 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 A7: 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 A8: 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 5: REFERENCES

Battelle Technology Partnership Practice (November 2013). *Agbioscience as a development driver: Minnesota's agbioscience strategy*. Retrieved from: <http://www.auri.org/assets/2013/12/Minnesotas+Agbioscience+Strategy+-+Final+Report-1.pdf>.

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