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Economic Contribution of the Agbioscience Industry: Northwest Minnesota

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

Authored by Brigid Tuck and Neil Linscheid

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

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March 2015

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ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: NORTHWEST MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Northwest Minnesota, which includes the 12 counties served by the Northwest Minnesota 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 Northwest Minnesota:* In 2013, agbioscience companies in the Northwest region directly created an estimated $789.4 million of economic activity, which represents 5 percent of regional output. Agbioscience in the region is based primarily on food products manufacturing, although wood and paper product manufacturing also contributes a significant share. Growth sectors (measured by employment) include beet sugar manufacturing, sawmills, and fluid milk manufacturing. Sectors with job losses include frozen food manufacturing, reconstituted wood products manufacturing, and paper mills. Northwest Minnesota is responsible for 5 percent of Greater Minnesota's total agbioscience output.
- *Agbioscience Platforms*: Of the four agbioscience platforms identified by Battelle, the value-added food and health products platform is the largest in the Northwest region. Businesses in the platform directly produced $690.1 million in output in 2013. In comparison, the microbial agbioscience platform produced $463.7 million, the biobased industrial products platform produced $85.4 million and the resilient, efficient, and productive agricultural systems platform produced $61.0 million. However, it was the microbial agbioscience platform that grew the fastest between 2003 and 2013, adding 45 jobs, which is a 7 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 agbioscience in Minnesota. In Northwest Minnesota, production agriculture and commercial forestry created an estimated $2.0 billion, or 13 percent, of output in the region. Together, production agriculture, commercial forestry, and agbioscience companies create 18 percent of output in Northwest Minnesota.
- *Direct Effect of Agbioscience*: In 2013, agbioscience companies in Northwest Minnesota directly generated an estimated $789.4 million of output (sales). The companies employed 1,670 workers and paid an estimated $118.8 million in salaries, wages, and benefits. The average annual compensation per agbioscience employee is approximately $71,100.
- *Total Contribution of Agbioscience*: In 2013, the agbioscience industry in Northwest Minnesota supported an estimated $1.2 billion of output across all industries in the region, including output from supplier industries and industries that benefit from spending by agbioscience workers. Based on this broad measure, the industry supported an estimated 4,870 jobs and $234.8 million of labor income.
- *Top Industries Impacted:* The contribution of the agbioscience industry in Northwest Minnesota is strongest in the industries of sugar beet farming, wholesale trade, banking, and the housing market.
- *Future Growth and Development*: During the past 10 years, the number of jobs in the agbioscience industry in Northwest Minnesota declined by 28 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 Northwest were to grow by 5 percent by 2016, the economic contribution of the agbioscience industry would increase to an estimated $1.3 billion in output, 5,110 jobs, and $246.4 million in labor income. During the same period, the total number of jobs across all industries in the Northwest region increased by 1 percent. The total number of jobs across all industries in 2013 was marginally higher than the number of jobs in 2008, indicating the region has recovered from the Great Recession.

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 Northwest Minnesota. It also explores past industry trends in employment and potential for future growth and development of the agbioscience industry in the region. Additionally, the economic contribution of agbioscience by platform is included in this analysis. In supplement to this publication, other reports will be published examining the agbioscience industry individually in each of the six Initiative Foundation regions in Minnesota. A report examining the agbioscience 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

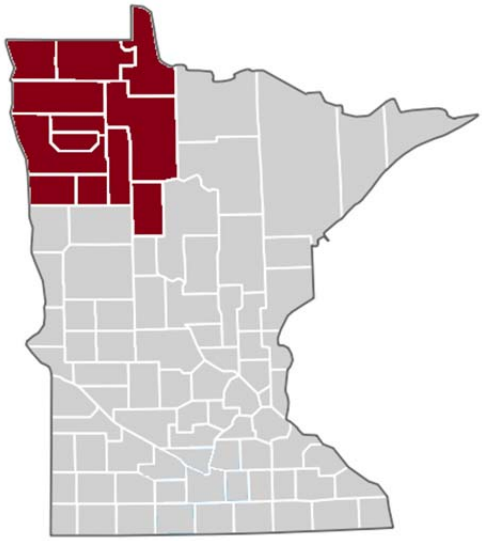
soybean processing is a sector within the manufacturing industry. More broadly, however, the definition of agbioscience includes components of food manufacturing; wood and paper product manufacturing; chemical manufacturing; farm supplies wholesalers; environmental consulting; and research and development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

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

DEFINING THE NORTHWEST REGION

The region in this analysis is Northwest Minnesota, as defined by the boundaries of the Northwest Minnesota Foundation. Counties included in this analysis are Beltrami, Clearwater, Hubbard, Kittson, Lake of the Woods, Mahnomen, Marshall, Norman, Pennington, Polk, Red Lake, and Roseau.

Map 1: Northwest Region



ECONOMIC OVERVIEW AND THE AGBIOSCIENCE INDUSTRY IN NORTHWEST MINNESOTA

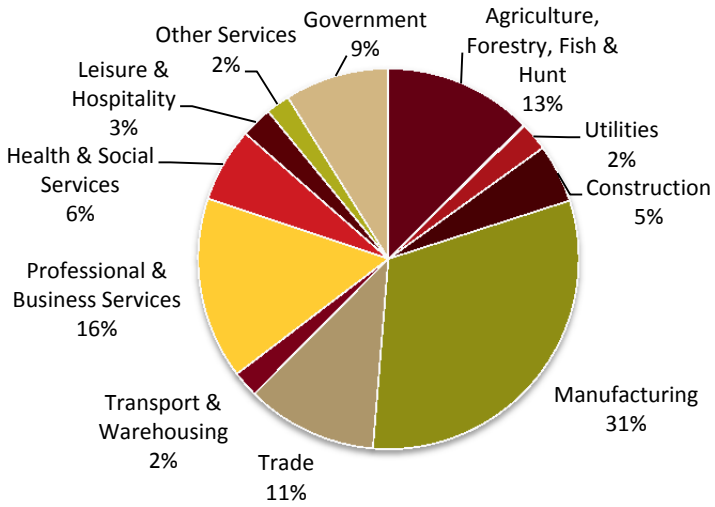
Understanding the role of agbioscience in the Northwest region requires an understanding of the broader economy in the region. Several metrics exist for measuring economic activity, and this analysis focuses on output and employment. Output is a measure of the total transactions in an economy. Most transactions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

Output

In 2013, businesses and enterprises in the Northwest Minnesota economy produced $15.6 billion of output. The manufacturing industry was the single largest contributor of output in the region, producing $4.9 billion of sales in 2013 (chart 1). Large manufacturing sectors include transportation equipment (51 percent of manufacturing output), food products (22 percent), wood products (13 percent), and machinery manufacturing (4 percent).

In 2013, the professional and business services industry produced $2.4 billion of output in the Northwest region. The largest sector within the industry is the real estate and rental sector which accounted for 42 percent of industry output. Other major sectors include finance and insurance, professional, scientific, and technical services, and information.

Chart 1: Output by Industry, Northwest Minnesota



Source: IMPLAN

Agriculture, forestry, fishing and hunting is the third largest industry in the Northwest region. In 2013, industry output was $2.0 billion. Crop farming is a major source of the industry's output (85 percent). Production agriculture is explored in more detail below.

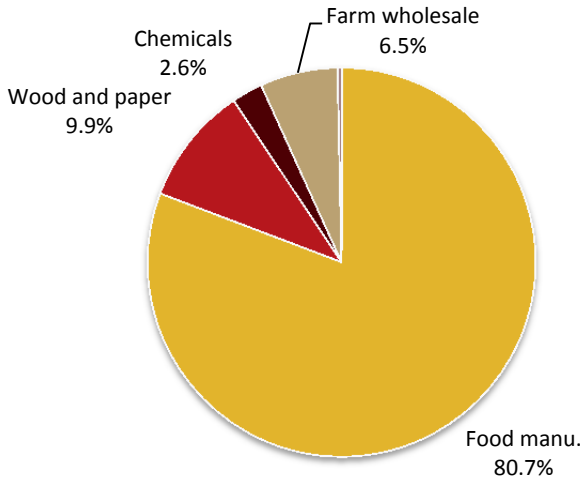
Agbioscience Output

In 2013, agbioscience businesses generated $789.4 million of output in the Northwest region. This represents 5 percent of total output in the region. Food manufacturing is responsible for 81 percent

of all agbioscience output in the Northwest region (chart 2). Major food manufacturing sectors included in the definition of agbioscience include beet sugar manufacturing, frozen food manufacturing, flour milling and malt manufacturing, and fluid milk and butter manufacturing.

Wood and paper manufacturing is responsible for nearly 10 percent of agbioscience output. Within the agbioscience definition, major sectors in the Northwest include reconstituted wood products, and sawmills and wood preservation.

Chart 2: Agbioscience Output by Industry, Northwest Minnesota



Source: IMPLAN

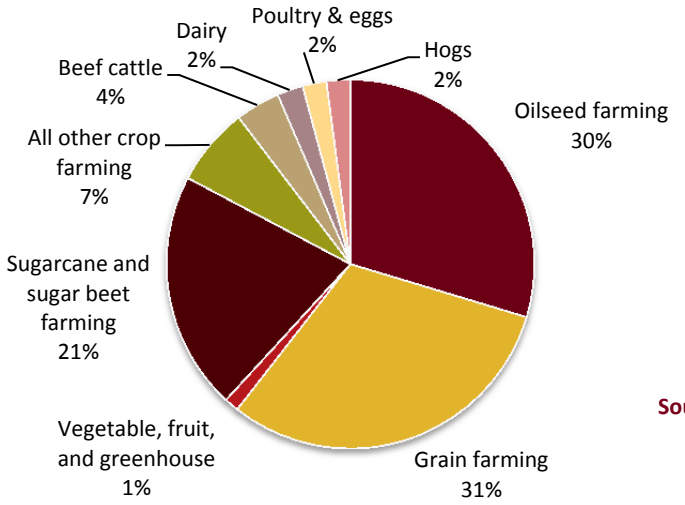
In comparison with other regions, the Northwest region is the second smallest source of agbioscience output in Greater Minnesota. In 2013, the Northwest region accounted for 5 percent of Greater Minnesota's agbioscience output.

Production Agriculture and Commercial Forestry

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

Production agriculture and commercial forestry produced $2.0 billion in economic activity in the Northwest region in 2013. Production agriculture produced $1.9 billion of the industry's output. Grain farming was responsible for 31 percent of production agriculture output. Oilseed production was responsible for 30 percent (chart 3). Commercial forestry produced $18.5 million of output in 2013.

Chart 3: Production Agriculture Output by Sector, Northwest Minnesota



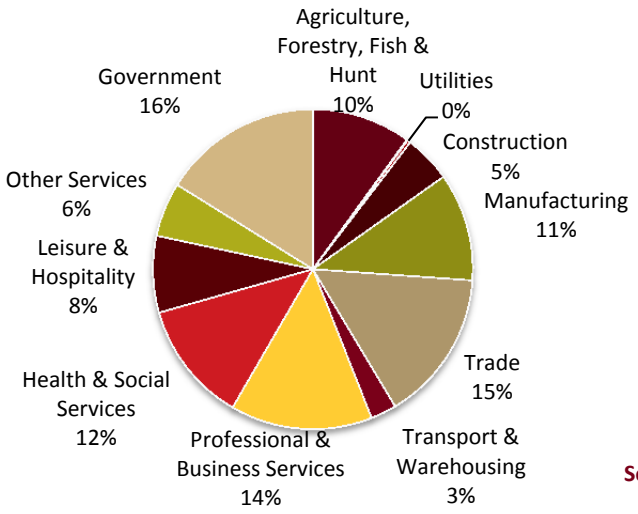
Source: IMPLAN

Employment

Output is one measure of economic activity; another is employment. According to IMPLAN, there were 99,670 jobs in the Northwest region in 2013. Employment is relatively diverse in the Northwest. Government accounts for 16 percent of all employment in the region (chart 4). Government employment includes federal, state, local, and tribal employment. Also included in the government definition are government-owned and operated enterprises, such as municipal liquor stores and public hospitals.

The trade industry (including both wholesale and retail trade) employs 15 percent of all workers in the Northwest region. The professional and business services industry employs 14 percent, and the health and social services industry employs 11 percent.

Chart 4: Employment by Industry: Northwest Minnesota



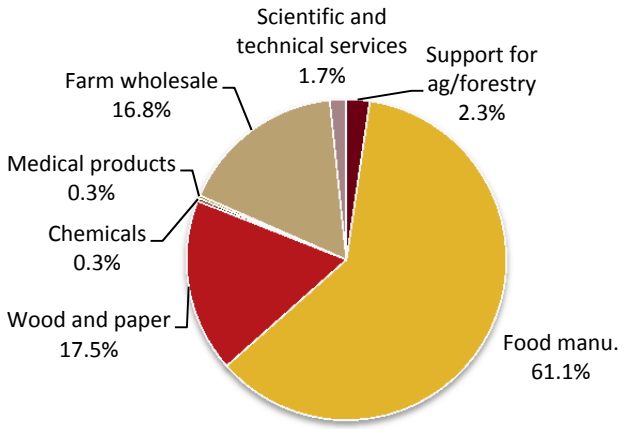
Source: IMPLAN

Agbioscience Employment

Agbioscience industries in the Northwest region employ 1,670 of the 99,670 workers in the region. Sixty-one percent of those employees are in food manufacturing. Wood and paper product manufacturing employs nearly 18 percent of all agbioscience workers, while farm supplies wholesalers employ nearly 17 percent.

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

Chart 5: Agbioscience Employment by Industry, Northwest Minnesota



Source: EMSI

Trends in Agbioscience Employment

Beyond understanding the current status of the industry, studying how an industry is changing also provides insights. Between 2003 and 2013, the number of jobs in the agbioscience industry in Northwest Minnesota declined by 28 percent. In comparison, the number of jobs in the agbioscience industry in Greater Minnesota declined by 3 percent. The Northwest region was one of three regions to lose jobs in the agbioscience industry during the period. The total number of jobs in the Northwest (across all industries) grew by 1 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 Industries[1]

Industry	Change 2003-2013	Industry Mix Effect	National Growth Effect	Competitive Effect
Top 3 Job Adding Industries				
Beet sugar manufacturing	56	-25	27	54
Sawmills	20	-8	1	26
Fluid milk manufacturing	11	0	0	11
Top 3 Job Loss Industries				
Frozen fruit, juice, and vegetable manufacturing	-243	-111	29	-161
Reconstituted wood products	-192	-142	19	-70
Paper (except newsprint) mills	-168	-61	8	-116

Source: EMSI

Beet sugar manufacturers in Northwest Minnesota added 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 beet sugar manufacturing sector, however, declined moderately at the national level so job losses would have been expected in the region. The industry in Northwest Minnesota added jobs, thus making Northwest Minnesota competitive in the industry.

As highlighted in the table, sawmills in the region also marginally outperformed national and industry trends. Fluid milk manufacturing also posted positive job gains and a positive competitive effect during the period. Fluid milk manufacturing in Northwest Minnesota, according to the EMSI database, did not have any employment in 2003, thus all jobs are new jobs.

The frozen fruit, juice, and vegetable manufacturing sector lost the highest number of jobs within the agbioscience industry in the Northwest region. While the sector did not fare well at the national level, it appears the Northwest region lost even more jobs than would have been anticipated given those trends.

As highlighted in the table, reconstituted wood product manufacturing and paper mills experienced the second and third highest number of job losses in the region during this period. Both industries were less competitive than they could have been, given national industry trends.

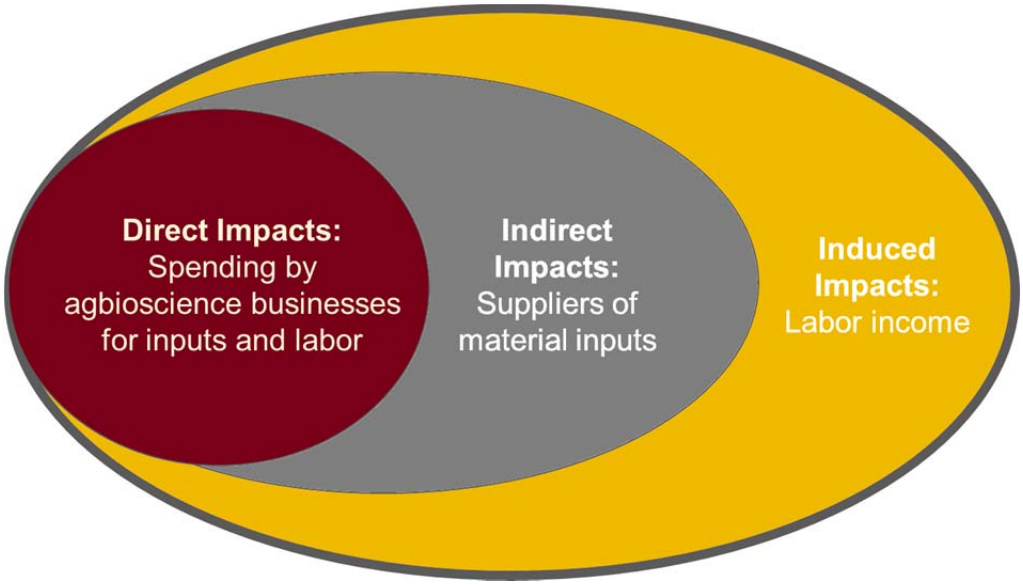
For further detail on employment by agbioscience sector, please see appendix 5.

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

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

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

In 2013, agbioscience companies in Northwest Minnesota employed 1,670 people (table 2). The highest shares of jobs were in the sectors of beet sugar manufacturing, frozen food manufacturing, and farm supplies wholesalers. Beet sugar manufacturing was one of the sectors that added jobs between 2003 and 2013, whereas frozen food manufacturing lost jobs.

Companies in the Northwest region's agbioscience industry created $789.4 million of output (sales). Output is led by beet sugar manufacturing, frozen food manufacturing, and reconstituted wood products manufacturing.

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

Table 2: Direct Effect of Agbioscience Industry in Northwest Minnesota

Industry Name	Employment	Output (millions)
Beet sugar manufacturing	615	$460.4
Frozen food manufacturing	339	$117.0
Farm supplies merchant wholesalers	280	$51.1
Reconstituted wood product manufacturing	210	$54.8
Sawmills and wood preservation	77	$21.9
Soil preparation, planting, and cultivating	39	$0.7
Wineries	32	$9.7
Flour milling and malt manufacturing	19	$25.4
Testing laboratories	18	$1.5
Fluid milk and butter manufacturing	11	$13.7
Soybean and other oilseed processing	5	$10.3
Wood windows and doors and millwork manufacturing	5	$1.0
Fertilizer manufacturing	5	$7.7
Toilet preparation manufacturing	5	$12.8
Environmental consulting services	5	$0.3
Remediation services	5	$1.1
Total	1,670	$789.4

Sources: EMSI (employment) and IMPLAN (output)

Indirect and Induced Effects

Using estimated direct effects, the data was entered into an input-output model. Input-output models trace the flow of dollars throughout a local economy and capture the indirect and induced -- or ripple -- effects of an economic activity. The IMPLAN input-output model was used in this analysis. The indirect and induced effects measured are the result of spending in the Northwest region. In other words, purchases made outside of the Northwest 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 $1.2 billion dollars in economic activity to the Northwest region of Minnesota (table 3) from all effects – direct, indirect, and induced. The industry's presence in the Northwest region supports an estimated 4,870 jobs. These employees receive an estimated $234.8 million in wages, salaries, and benefits.

The agbioscience industry directly creates $789.4 million in economic activity annually in the region, as detailed above. Agbioscience companies directly employ 1,670 residents of the region and spend $118.8 million in compensation for those workers. Thus, on average, each agbioscience employee earns approximately $71,100 in wages, salaries, and benefits.

When agbioscience companies make purchases from businesses in the region, this generates additional economic activity (indirect effects). From these indirect effects, agbioscience companies generated an estimated $341.3 million in activity in 2013 at regional businesses and supported jobs for an estimated 2,340 individuals in these businesses.

When employees of agbioscience companies spend their wages and salaries in the Northwest region, this creates economic activity at businesses in the region (induced effects). Employee spending generated an estimated $99.6 million in economic activity in 2013 in the region and supported employment for an estimated 860 workers.

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$789.4	1,670	$118.8
Indirect	$341.3	2,340	$88.2
Induced	$99.6	860	$27.8
Total	$1,230.3	4,870	$234.8

Estimates by University of Minnesota Extension

Top Industries Affected

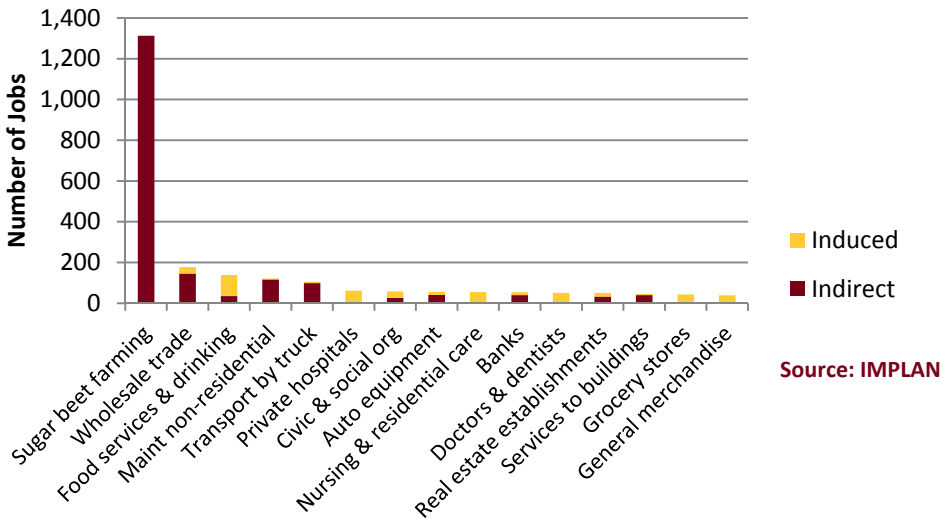
Agbioscience companies support employment for 4,870 people in Northwest Minnesota. Of these, 1,670 jobs are within the agbioscience industry itself. Thus, the agbioscience industry supports

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

3,200 jobs in other businesses in the region. Chart 7 illustrates the top 15 sectors with jobs supported by the agbioscience industry. These impacts are driven by 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 sugar beet farming, wholesale trade, and maintenance of non-residential structures 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 establishments sector, as well as several retail trade sectors.

Many economic impact studies show relatively high employment impacts on the food services and drinking establishment 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, Northwest Minnesota

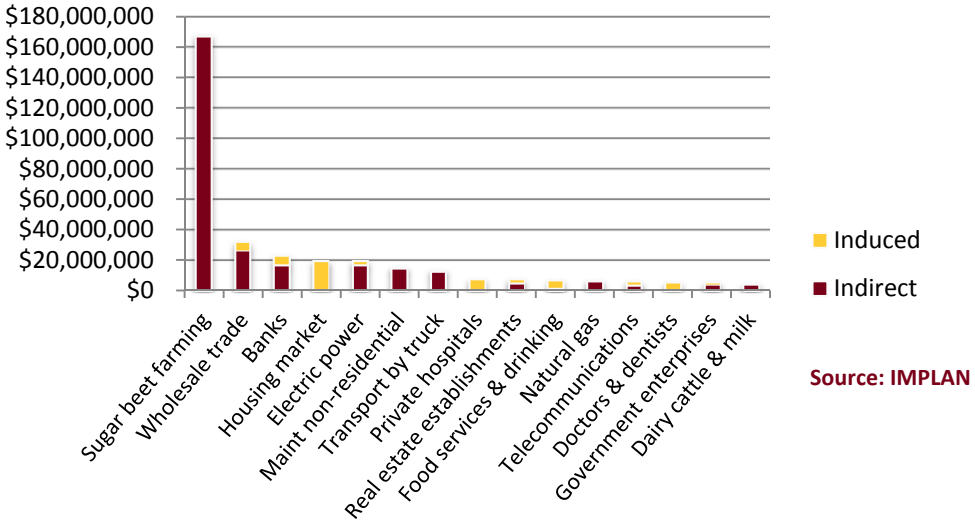


Source: IMPLAN

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

Chart 8 shows the top sectors affected, but sorted by output. Agbioscience companies contribute $1.2 billion in economic activity to the Northwest region. Agbioscience companies directly spend $789.4 million in the region. The remainder, approximately $400 million, is activity at other businesses in the region. Activities by agbioscience companies in the region contribute most strongly to the sugar beet farming, wholesale trade, banking, and housing market sectors.

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



Source: IMPLAN

Contribution of Agbioscience by Region of Greater Minnesota

Agbioscience businesses exist in all regions of Minnesota[4] (table 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 of the state. Together, the two regions produce more than 65 percent of agbioscience output in Greater Minnesota.

Table 4: 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

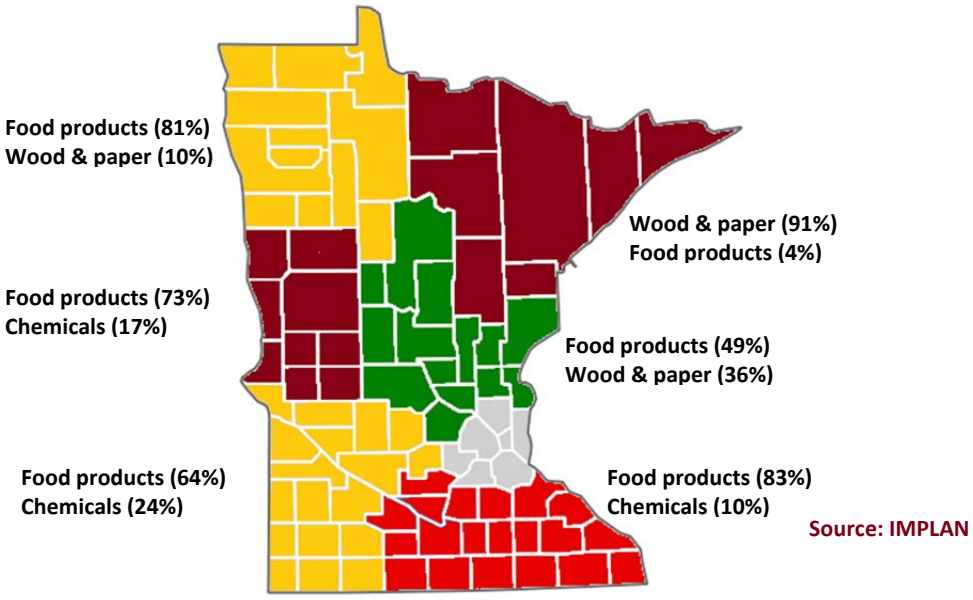
[4] Regions are defined by the boundaries of the Minnesota Initiative Foundations. For more on the counties included in each region, please see http://www.greaterminnesota.net/.

The Northwest region is responsible for 5 percent of Greater Minnesota's total agbioscience output. In comparison, the Northwest region is responsible for 7 percent of Greater Minnesota's total output from all industries.

The composition of the direct effect of the agbioscience industry also varies by region (chart 9). Food manufacturing 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 Northwest region is dominated by food manufacturing. Of all the regions, the Northwest has one of the highest percentages 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 and includes ethanol production and fertilizer production.

Wood and paper production, including wood preservation, paper mills, pulp mills, and sawmills, is a significant sector in the Northeast, Central, and Northwest regions.

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

Future Growth and Development of Agbioscience

The agbioscience industry in Northwest Minnesota is not a stagnant industry; it is expanding, contracting, and changing. Between 2003 and 2013, the total number of jobs in the agbioscience industry in the region declined by 28 percent, partially as a result of the Great Recession of 2008-2009. The 2013 Battelle Technology Partnership Practice report identified potential growth in the industry through 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 Northwest 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 projections from 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 Northwest 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 $1.3 billion in output, an estimated 5,110 jobs, and an estimated $246.4 million in labor income (table 5).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$828.9	1,750	$124.7
Indirect	$358.4	2,460	$92.6
Induced	$104.6	900	$29.1
Total	$1,291.9	5,110	$246.4

Estimates by University of Minnesota Extension

If employment in the agbioscience industry in Northwest 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 $1.4 billion in output, an estimated 5,360 jobs, and an estimated $258.3 million in labor income (table 6).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$868.3	1,840	$130.7
Indirect	$375.4	2,570	$97.0
Induced	$109.6	950	$30.6
Total	$1,353.3	5,360	$258.3

Estimates by University of Minnesota Extension

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN NORTHWEST 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 Northwest Minnesota.

In terms of total impacts, the largest platform in the Northwest region is the value-added food and health products platform. In 2013, the platform supported $1.1 billion of output in the Northwest region (table 7). The platform also supported employment for 4,230 workers and paid $198.3 million in wages, salaries, and benefits.

Table 7: Total Economic Contribution by Agbioscience Platform in Northwest Minnesota, 2013

(Note: as industries within the platforms overlap, platform totals will not equal agbioscience total)

	Output (Millions)	Employment (Rounded)	Labor Income (Millions)
Microbial agbioscience	$787.9	3,100	$134.5
Resilient, efficient, & productive agricultural systems	$82.6	500	$25.2
Biobased industrial products	$116.2	520	$30.9
Value-added food and health products	$1,092.2	4,230	$198.3

Estimates by University of Minnesota Extension

While the value-added food and health products platform is the largest platform in the region, the microbial agbioscience platform was the fastest growing between 2003 and 2013 (table 8). Businesses in the platform added 45 jobs, increasing the number of jobs in the platform by 7 percent. The growth was driven by growth in employment at beet sugar manufacturers and at testing laboratories.

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 17 percent, jobs in the resilient, efficient, and productive agricultural systems platform declined by 20 percent, and jobs in the biobased industrial products platform declined by 57 percent. Heavy job losses in reconstituted wood product manufacturing and paper mills drove the decreases in the biobased industrial products platform. Meanwhile, between 2003 and 2013, the number of jobs across all industries in Northwest Minnesota grew by 1 percent.

Table 8: Change in Number of Jobs by Agbioscience Platform in Northwest 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	632	677	7%
Resilient, efficient, & productive agricultural systems	419	334	-20%
Biobased industrial products	697	297	-57%
Value-added food and health products	1,565	1,301	-17%

Source: EMSI

Microbial Agbioscience

The microbial agbioscience platform is based on Minnesota's expertise in the areas related to microbiology, genomics, ecological sciences, infectious disease, and biosecurity. It involves using this expertise to ensure adequate food supply and food production. Battelle identified this platform as a strength for Minnesota, due in part to Minnesota's breadth and depth in the advancing field of microbiology, coupled with its traditional strengths in the agricultural sciences. Included in the definition of the microbial agbioscience platform are medicinal, botanical, and related manufacturing, testing laboratories, research and development, pulp mills, and food processing related to microbial agbioscience.[5]

In 2013, the microbial agbioscience platform supported an estimated $787.9 million of output in Northwest Minnesota. The platform also supported an estimated 3,087 jobs, with those jobs paying an estimated $134.5 million of labor income (table 9).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$463.7	677	$50.9
Indirect	$267.2	1,920	$67.7
Induced	$57.0	490	$15.9
Total	$787.9	3,087	$134.5

Estimates by University of Minnesota Extension

The Northwest region is the third largest of Greater Minnesota's regions in the production of microbial agbioscience output. Within the microbial agbioscience platform in the Northwest region, the largest sectors, measured by output, are beet sugar manufacturing, testing laboratories, and remediation services. The highest ripple effects are in beet sugar farming, banking, and wholesale trade.

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 Northwest Minnesota would increase to an estimated $866.7 million, including an estimated 3,400 jobs, and an estimated $148.0 million in labor income.[6]

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

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

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 related to biotechnology, and remediation services.

In 2013, the resilient, efficient, and productive agricultural systems platform supported an estimated $82.6 million of output in Northwest Minnesota. The platform also supported an estimated 504 jobs, with those jobs paying an estimated $25.2 million of labor income (table 10).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$61.0	334	$18.9
Indirect	$10.9	80	$3.3
Induced	$10.7	90	$3.0
Total	$82.6	504	$25.2

Estimates by University of Minnesota Extension

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

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

If the forecasted rate of growth of 10 percent occurs, the economic contribution of the resilient, efficient, and productive agricultural systems platform would increase to $90.9 million of output, including 550 jobs and $27.7 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 agricultural systems are food

[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).

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 $116.2 million of output in Northwest Minnesota. The platform also supported 517 jobs, with those jobs paying $30.9 million in labor income (table 11).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$85.4	297	$21.6
Indirect	$17.7	110	$5.7
Induced	$13.1	110	$3.6
Total	$116.2	517	$30.9

Estimates by University of Minnesota Extension

The Northwest region is the smallest contributor to the biobased industrial products platform of all the regions in Greater Minnesota. In the Northwest region, reconstituted wood products and sawmills are the major sources of output within the biobased industrial products platform. The largest ripple effects are in commercial logging, wholesale trade, and electric power.

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

If the rate of growth of 5 percent occurs, the economic contribution of the biobased industrial products platform would increase to $122.0 million of output, including 540 jobs and $32.6 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 related to biotechnology.

[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).

In 2013, the value-added food and health products platform supported an estimated $1.1 billion in output in Northwest Minnesota, including an estimated $198.3 million in labor income and 4,231 jobs (table 12).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$690.1	1,301	$94.2
Indirect	$318.0	2,200	$80.6
Induced	$84.1	730	$23.5
Total	$1,092.2	4,231	$198.3

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, support more than $1 billion of output. In the Northwest region, the largest sectors in the value-added food and health products platform include beet sugar manufacturing and frozen food manufacturing. The largest ripple effects in the Northwest region include sugar beet farming, wholesale trade, and banking.

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). Therefore, University of Minnesota Extension estimated a 5 percent rate of growth in the platform.

If the forecasted rate of growth of 5 percent occurs, the economic contribution of the value-added food and health products platform would increase to an estimated $1.15 billion of output, including an estimated 4,440 jobs and an estimated $208.2 million in labor income.[9]

Contribution of Agbioscience Platforms by Region of Greater Minnesota

In comparison to the other regions, the Northwest region has a relatively small share of each of the platforms (table 13). It is the third largest region in the microbial agbioscience platform but is the smallest in the resilient, efficient, and productive agricultural systems platform and biobased industrial products platform, based on total output.

In relative terms, however the Northwest region has a smaller economy, accounting for 7 percent of Greater Minnesota's output across all industries. In 2013, businesses and industries in the

[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).

Northwest region produced $15.6 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: as industries within the platforms overlap, platform totals will not equal agbioscience total)

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

Estimates by University of Minnesota Extension Center for Community Vitality

In addition to variation in the size of the platforms, the growth rate of each platform also varies (table 14). All six regions added jobs in the microbial agbioscience platform. The Northwest had modest growth in the platform. As mentioned, the Northwest lost jobs in all the other platforms.

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%

Estimates by University of Minnesota Extension Center for Community Vitality

SUMMARY

Given Minnesota's long tradition in agriculture and science, the state is positioned with a strong agbioscience industry. The agbioscience industry is a broad continuum that includes many agricultural, scientific, and research activities, and 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 Northwest region of Minnesota, as defined by the boundaries of the Northwest Minnesota Foundation region.

The agbioscience industry contributes to the economy of Northwest Minnesota. In 2013, the total economic contribution of the agbioscience industry was an estimated $1.2 billion in the region. Through its impacts across all industries, the agbioscience industry supported an estimated 4,870 jobs that paid $234.8 million in income to workers in the region.

In Northwest Minnesota, the agbioscience industry is dominated by food manufacturing. Large sectors within the food manufacturing industry, included in the agbioscience industry are beet sugar manufacturing, frozen food manufacturing, flour milling and malt manufacturing, and fluid milk and butter manufacturing. Wood and paper products manufacturing also play a role in the agbioscience industry in Northwest Minnesota. Reconstituted wood products and sawmills are major sectors within wood and paper products manufacturing. Growing agbioscience sectors in the region include beet sugar manufacturing, sawmills, and fluid milk production. These sectors have added jobs in the past 10 years and have done so at rates faster than expected, given national and industry trends. Frozen food manufacturing, reconstituted wood products, and paper mills are agbioscience sectors that shed jobs between 2003 and 2013.

Directly, agbioscience companies in the Northwest region employ 1,670 individuals. The companies produce $789.4 million in economic activity, including compensation to workers of $118.8 million. The average annual compensation per agbioscience employee is approximately $71,100.

The $789.4 million represents approximately 5 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 $2.0 billion, or about 13 percent of all sales in the region. The Northwest region is responsible for 5 percent of Greater Minnesota's agbioscience output.

Indirectly, industries with strong ties to agricultural production and household spending are most affected by the agbioscience industry in Northwest Minnesota. The related industries benefiting most from the agbioscience industry include the sugar beet farming, wholesale trade, banking, and housing market sectors.

During the past 10 years, the number of jobs in the agbioscience industry in Northwest Minnesota declined by 28 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, based on those growth rates, the industry could grow by 5 percent between now and 2016. If that growth rate occurs, the economic contribution of the agbioscience industry in the region will increase to an estimated $1.3 billion in output, an estimated 5,110 jobs, and an estimated $246.4 million in labor income.

Of the four platforms, the value-added food and health products platform is largest in the Northwest region. In 2013, the platform supported an estimated $1.1 billion of economic activity in the region, including an estimated 4,230 jobs. 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. The platform involves expanding the historic core competencies of food manufacturing in Minnesota to new markets focused on health and nutrition, including nutritional supplements.

The fastest growing platform in the Northwest region was the microbial agbioscience platform, which grew by 7 percent between 2003 and 2013. The microbial agbioscience platform supported an estimated $787.9 million of output in Northwest Minnesota in 2013. The platform also supported an estimated 3,087 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 Northwest region is one component of the agbioscience industry in Greater Minnesota. It is currently strongest in the value-added food and health products platform. The region will clearly 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 food manufacturing and agricultural production on which to grow.

APPENDIX 1: METHODOLOGY

Input-Output Models

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

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

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

- **Output**: Output is measured in dollars and is equivalent to total sales. The output measure can include significant "double counting." Think of corn, for example. The value of 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 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

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

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

Quarterly Census of Employment and Wages (QCEW)

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

Shift-Share Analysis

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

- **National Growth**: National growth indicates how many jobs a local economy would have gained (or lost) as a result of the growth (or decline) of employment at the national level. For example, consider a local economy with 100,000 jobs at the beginning of the time period. If during the period under consideration, the number of jobs in the United States grew by a rate of 2 percent, then at the end of the time period under consideration, the local economy would be expected to have 102,000 jobs.
- **Industrial Mix**: Industrial mix indicates how many jobs a particular industry within the local economy would have gained (or lost) if the local industry grew (or declined) at a rate similar to the industry as a whole in the United States. For example, if 1,000 people were employed in the finance industry in the local economy at the beginning of the period, and the finance industry as a whole in the U.S. grew at a rate of 10 percent, then at the end of the time period under consideration, the local finance industry would be expected to have 1,100 jobs.
- **Competitive Share**: Competitive share is the remainder of change in employment for the region examined. From our example, the region's employment should have grown by 2,100 jobs, looking at overall national growth and then growth in the finance industry itself. If the local economy actually grew by 3,100 jobs in the finance industry, then 1,000 jobs were added because the local economy grew faster than expected, given national and industry trends. Conversely, if the local economy grew by only 1,000 jobs, then the economy was not as competitive as it should have been, given national and industry trends.

APPENDIX 2: DEFINITION OF AGBIOSCIENCE WITH NAICS CODES

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

Table A1: All Agbioscience Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311313	Beet Sugar Manufacturing
311411	Frozen Fruit, Juice, and Vegetable Manufacturing
311421	Fruit and Vegetable Canning
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing
311513	Cheese Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311942	Spice and Extract Manufacturing
312120	Breweries

312130	Wineries
312140	Distilleries
321113	Sawmills
321114	Wood Preservation
321211	Hardwood Veneer and Plywood Manufacturing
321212	Softwood Veneer and Plywood Manufacturing
321213	Engineered Wood Member (except Truss) Manufacturing
321219	Reconstituted Wood Product Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
322110	Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
325191	Gum and Wood Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325212	Synthetic Rubber Manufacturing
325221	Cellulosic Organic Fiber Manufacturing
325222	Noncellulosic Organic Fiber Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325411	Medicinal and Botanical Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325620	Toilet Preparation Manufacturing
424910	Farm Supplies Merchant Wholesalers
541380	Testing Laboratories
541620	Environmental Consulting Services
541711	Research and Development in Biotechnology
562910	Remediation Services

Table A2: Microbial Agbioscience Platform Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311313	Beet Sugar Manufacturing
322110	Pulp Mills
325320	Pesticide and Other Agricultural Chemical Manufacturing

325411	Medicinal and Botanical Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
541380	Testing Laboratories
541711	Research and Development in Biotechnology
562910	Remediation Services

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

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

Table A4: Biobased Industrial Products Platform Sectors and NAICS Codes

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

541711	Research and Development in Biotechnology

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

311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311313	Beet Sugar Manufacturing
311411	Frozen Fruit, Juice, and Vegetable Manufacturing
311421	Fruit and Vegetable Canning
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing
311513	Cheese Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311942	Spice and Extract Manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
325411	Medicinal and Botanical Manufacturing
325620	Toilet Preparation Manufacturing
424910	Farm Supplies Merchant Wholesalers
541711	Research and Development in Biotechnology

APPENDIX 3: COMPOSITION OF AGBIOSCIENCE OUTPUT BY REGION

Chart A1: Agbioscience Output by Industry, Central Minnesota

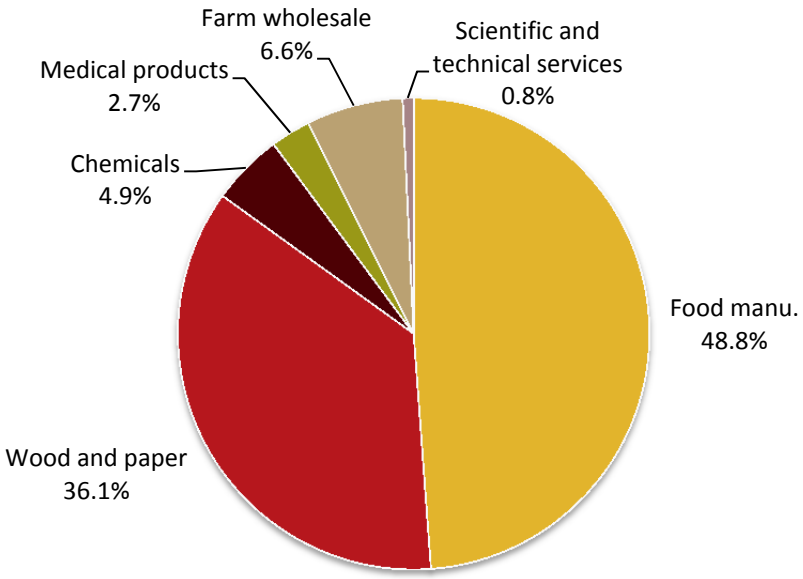
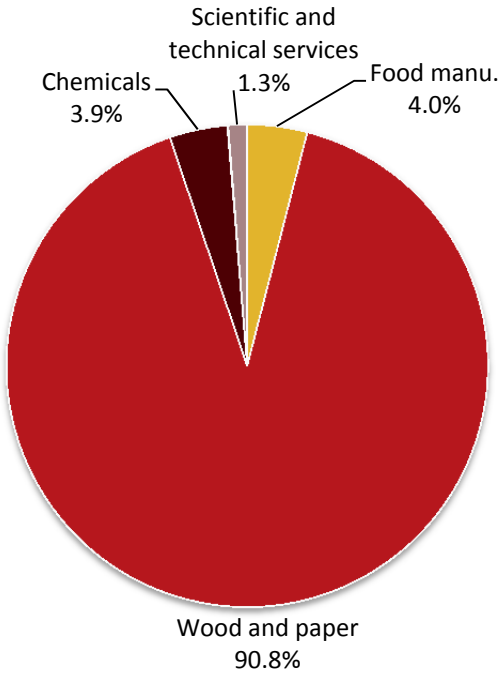


Chart A2: Agbioscience Output by Industry, Northeast Minnesota



Source: IMPLAN

Chart A3: Agbioscience Output by Industry, Northwest Minnesota

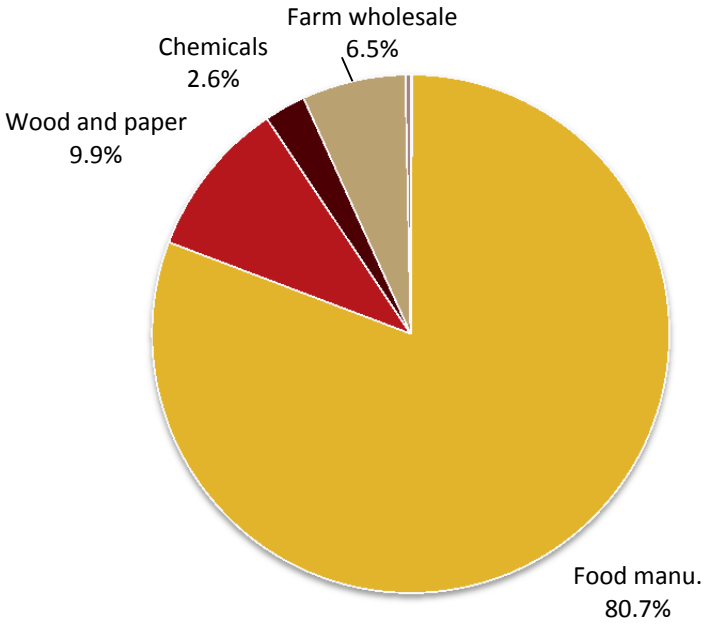
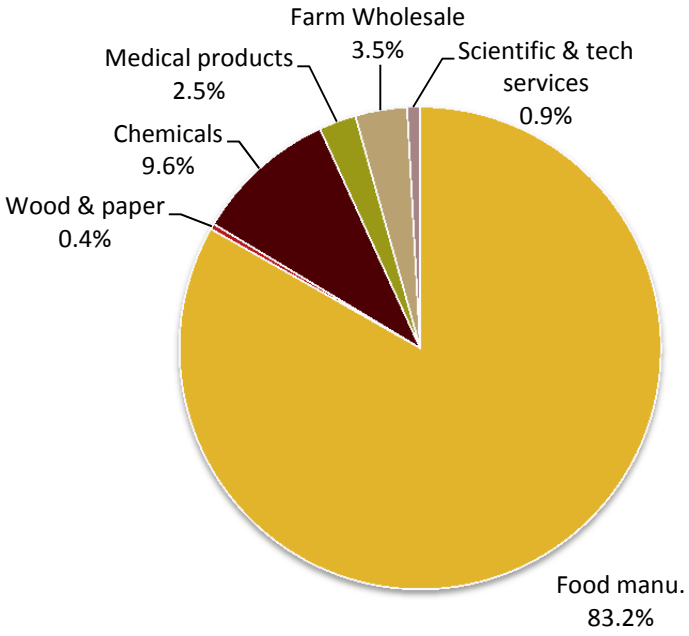


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

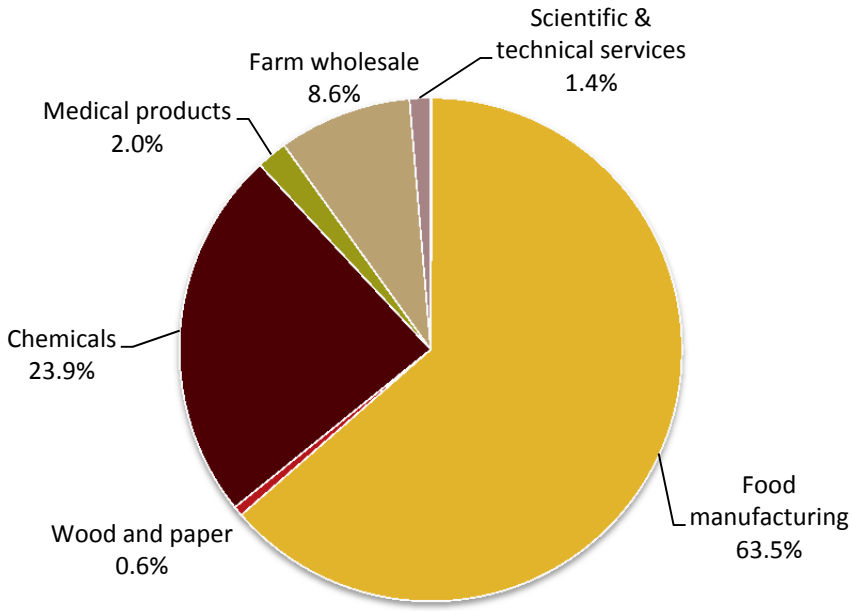
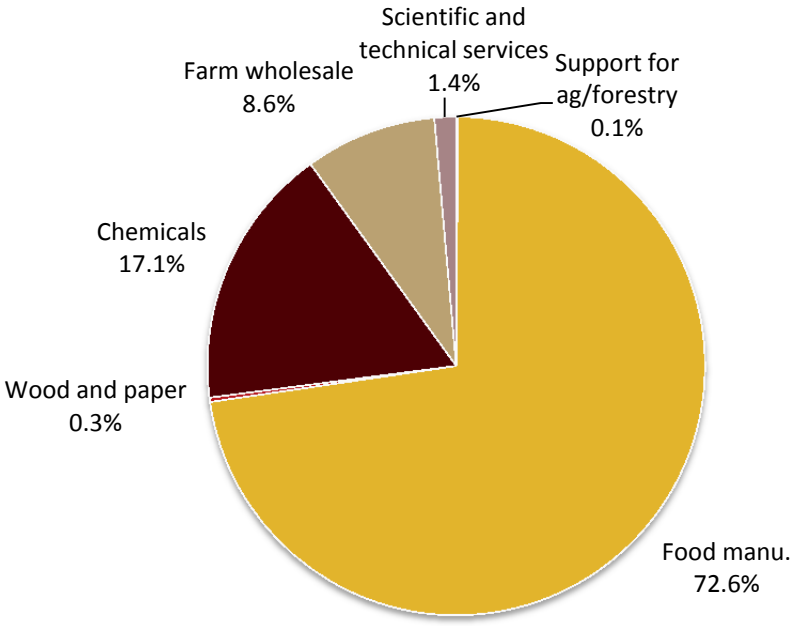


Chart A6: Agbioscience Output by Industry, West Central Minnesota



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 A8 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 Northwest Minnesota, 2003 and 2013

Description	2003 Jobs	2013 Jobs	2003 - 2013 Change	2003 - 2013 % Change
Beet Sugar Manufacturing	558	615	56	10%
Wineries	5	32	27	-84%
Sawmills	26	46	20	77%
Fluid Milk Manufacturing	0	11	11	Insf. Data
Testing Laboratories	16	18	2	13%
Soil Preparation, Planting, and Cultivating	46	39	-6	-13%
Flour Milling	30	19	-11	-37%
Wood Preservation	51	31	-20	-39%
Cut Stock, Resawing Lumber, and Planing	32	5	-27	-84%
Farm Supplies Merchant Wholesalers	348	280	-67	-19%
Paper (except Newsprint) Mills	168	0	-168	-100%
Reconstituted Wood Product Manufacturing	402	210	-192	-48%
Frozen Fruit, Juice, and Vegetable Manufacturing	601	339	-243	-40%
Pesticide and Other Agricultural Chemical Manufacturing	5	0	Insf. Data	Insf. Data
Fertilizer (Mixing Only) Manufacturing	5	5	Insf. Data	Insf. Data

Research and Development in Biotechnology	5	0	Insf. Data	Insf. Data
Environmental Consulting Services	5	5	Insf. Data	Insf. Data
Toilet Preparation Manufacturing	0	5	Insf. Data	Insf. Data
Remediation Services	0	5	Insf. Data	Insf. Data
Soybean and other oilseed processing	5	5	Insf. Data	Insf. Data
Total	2,308	1,670	-638	-28%

Source: EMSI