UNIVERSITY OF MINNESOTA | EXTENSION

EXTENSION CENTER FOR COMMUNITY VITALITY

Economic Contribution of the Agbioscience Industry: Southwest 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

Economic Contribution of the Agbioscience Industry: Southwest Minnesota

A REPORT OF THE ECONOMIC IMPACT ANALYSIS PROGRAM

April 2015

Authored by Brigid Tuck and Neil Linscheid

Editors:

Elyse Paxton, Senior Editor, University of Minnesota Extension Center for Community Vitality

Partners/Sponsors:
Agricultural Utilization Research Institute (AURI)
Initiative Foundation
Northwest Minnesota Foundation
Southern Minnesota Initiative Foundation
Southwest Initiative Foundation
West Central Initiative

Cover Photos Credit:
Rolf Hagberg, Rolf Hagberg Photography

Table of Contents

ECONOMIC CONTRIBUTION OF THE AGBIOSCIENCE INDUSTRY: SOUTHWEST MINNESOTA

University of Minnesota Extension recently completed a study of the economic contribution of the agbioscience industry in Southwest Minnesota. Southwest Minnesota includes the 18 counties served by the Southwest Initiative Foundation. The study builds on the work of Battelle Technology Partnership Practice, which defines agbioscience and identifies four platforms for additional investment and development.

- *Composition of Agbioscience in Southwest Minnesota*: In 2013, agbioscience companies in the region directly created an estimated $2.6 billion of economic activity, which represents 8 percent of regional output. Agbioscience in the region is based primarily on food production and the manufacturing of ethanol. Growth sectors (measured by employment) include ethyl alcohol manufacturing, farm supplies merchant wholesalers, and testing laboratories. Sectors with job losses include biological product manufacturing, fruit and vegetable canning, and sawmills. Southwest Minnesota is responsible for 15 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 Southwest region, directly producing $1.9 billion in output. In comparison, the resilient, efficient, and productive agricultural systems products platform produced $873.8 million of output, the biobased industrial products platform $842.0 million of output, and the microbial agbioscience platform $533.9 million of output. However, it was the biobased industrial products platform that grew the fastest between 2003 and 2013, adding more than 450 jobs, a 352 percent increase. Components of the agbioscience industry can be included in more than one platform.
- *Production Agriculture*: Production agriculture is not included in this study's definition of agbioscience; however, it is important to the success of the industry. In Southwest Minnesota, production agriculture created an estimated $5.8 billion, or 18 percent, of output in the region. Together, production agriculture and agbioscience companies created 26 percent of output in 2013.
- *Direct Effect of Agbioscience*: In 2013, agbioscience companies in Southwest Minnesota directly generated an estimated $2.6 billion of output (sales). The companies employed 3,364 workers and paid an estimated $289.1 million in salaries, wages, and benefits. The average annual compensation per agbioscience employee was approximately $86,000.
- *Total Contribution of Agbioscience*: In 2013, the agbioscience industry in Southwest Minnesota supported an estimated $3.6 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 9,444 jobs and $554.5 million of labor income.
- *Top Industries Impacted:* The contribution of the agbioscience industry in Southwest Minnesota is strongest in the industries of sugar beet manufacturing, wholesale trade, transport by truck, electric power generation, and banking.
- *Future Growth and Development*: During the past 10 years, employment in the agbioscience industry in Southwest Minnesota has grown by 19 percent. If the trend continues through 2016, the economic contribution of the industry will increase to an estimated $4.3 billion in output, 11,340 jobs, and $665.3 million in labor income. The Southwest region was the only region to post significant, positive job growth in all four of the platforms. During the same time period, the total number of jobs across all industries in the Southwest region increased by less than 1 percent. Evidence indicates the region has yet to completely recover from the Great Recession of 2008-2009.

INTRODUCTION

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

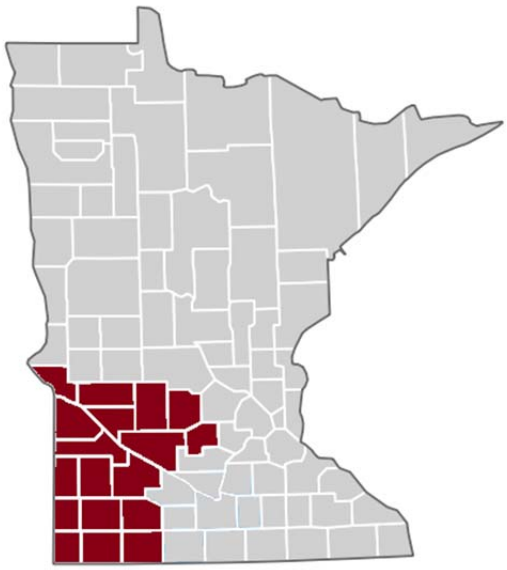
soybean processing is a sector within the manufacturing industry. More broadly, however, the definition of agbioscience includes components of food manufacturing; wood and paper product manufacturing; chemical manufacturing; farm supplies wholesalers; environmental consulting; and research and development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

The region in this analysis is Southwest Minnesota, as defined by the boundaries of the Southwest Initiative Foundation. Counties included in this analysis are Big Stone, Chippewa, Cottonwood, Jackson, Kandiyohi, Lac Qui Parle, Lincoln, Lyon, McLeod, Meeker, Murray, Nobles, Pipestone, Redwood, Renville, Rock, Swift, and Yellow Medicine.

Map 1: Southwest Region



ECONOMIC OVERVIEW AND THE AGBIOSCIENCE INDUSTRY IN SOUTHWEST MINNESOTA

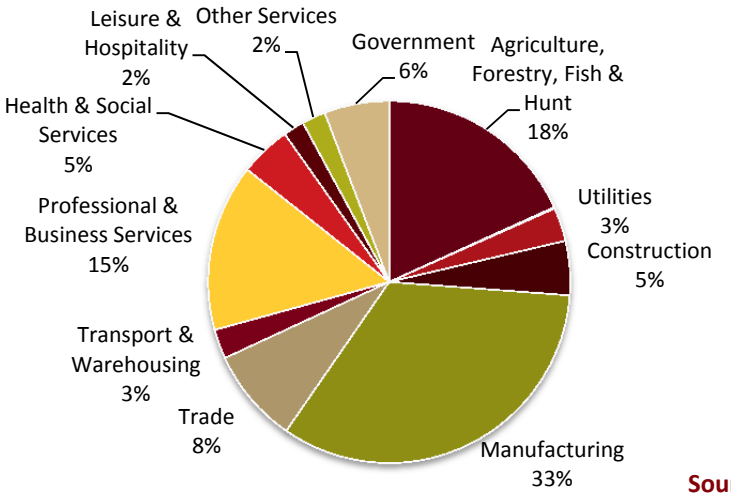
Understanding the role of agbioscience in the Southwest requires an understanding of the broader economy in the region. Several metrics exist for measuring economic activity. This analysis focuses on output and employment. Output is a measure of the total transactions in an economy. Most transactions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

Output

In 2013, businesses and enterprises in the Southwest Minnesota economy produced $31.6 billion of output. Manufacturers were the single largest contributors of output in the region, producing $10.6 billion in sales in 2013 (chart 1). The manufacturing sector in the region encompasses a broad range of activities. Large manufacturing sectors in Southwest Minnesota include food production (47 percent of manufacturing output), machinery manufacturing (17 percent), and computer and other electronic component manufacturing (8 percent).

Significant food product manufacturing sectors include animal slaughtering, rendering, and processing; poultry processing; and beet sugar manufacturing. Of these three sectors, only beet sugar manufacturing is included in the definition of agbioscience used in this report.

Chart 1: Output by Industry, Southwest Minnesota



Source: IMPLAN

The agriculture, forestry, fishing, and hunting industry produced $5.8 billion of output in 2013. Large sectors within the industry include crop farming and livestock. According to the IMPLAN database, crop farmers in Southwest Minnesota produced $3.7 billion of output in 2013 and livestock farmers produced nearly $2.0 billion of output.

The professional and business services industry produced $4.8 billion in output in the region. Real estate and rental businesses create nearly 40 percent of all output in the industry. Real estate and rental businesses include those renting or leasing real estate. It also includes businesses that manage and appraise real estate assets. Rental of agricultural land would be included in this sector.

Finance and insurance businesses create 25 percent of output in the professional and business services industry.

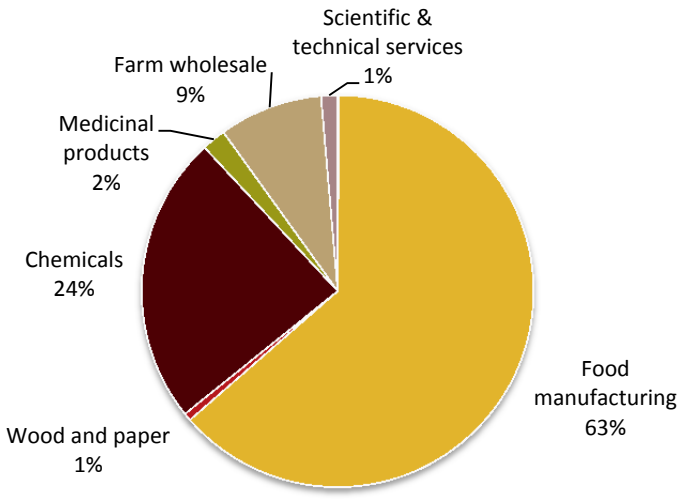
Agbioscience Output

In 2013, agbioscience businesses generated $2.6 billion of output in the Southwest region. This represents 8 percent of total output in the region. If agbioscience were to be categorized as its own industry, it would be the fourth largest industry, equal to the trade industry, in terms of output.

Food manufacturers are major contributors to the agbioscience industry in Southwest Minnesota (chart 2). In 2013, food manufacturers in the agbioscience industry made $1.6 billion of sales. Large food manufacturers in the agbioscience industry in the region include beet sugar manufacturing, wet corn milling, and cheese manufacturing.

Chemical product manufacturing created more than $600 million of output in 2013. Chemical manufacturing output, related to agbioscience in the region, is almost all sourced from the production of ethanol.

Chart 2: Agbioscience Output by Industry, Southwest Minnesota



Source: IMPLAN

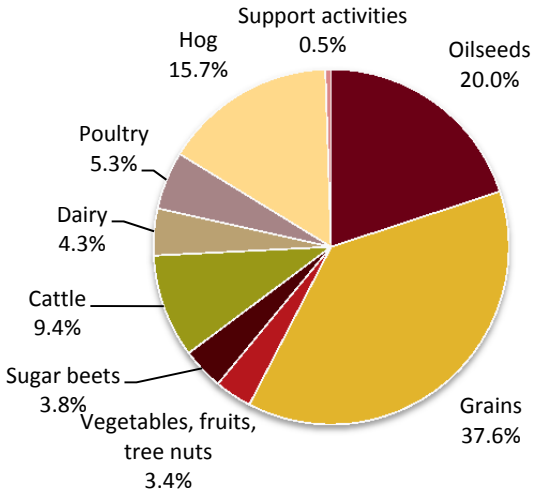
In comparison with other regions, the Southwest region is the second largest source of agbioscience output in Greater Minnesota. In 2013, the Southwest region accounted for 15 percent of Greater Minnesota's agbioscience output.

Production Agriculture Output

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

Production agriculture produced $5.8 billion in economic activity in the Southwest region in 2013. Grain production accounts for 38 percent of total output (chart 3), followed by oilseed production (20 percent), and hog production (16 percent).

Chart 3: Production Agriculture Output by Sector, Southwest Minnesota

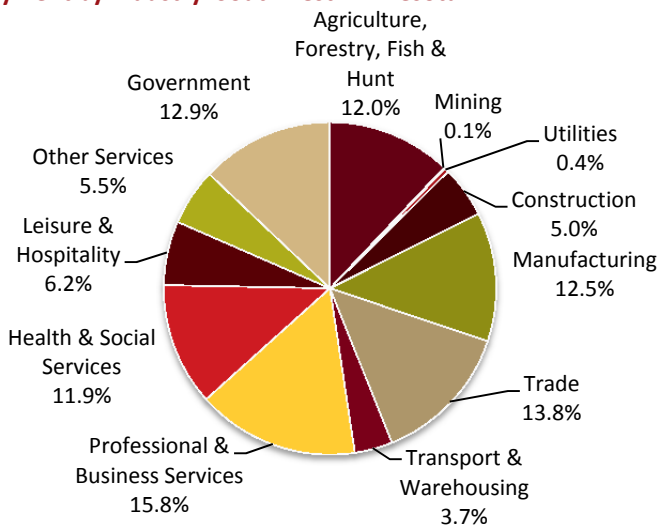


Source: IMPLAN

Employment

Output is one measure of economic activity; another measure is employment. According to IMPLAN, there are 182,800 jobs in the Southwest region. Employment is relatively diverse in the Southwest region (chart 4). The professional and business services industry employs 16 percent of all workers in the region; trade accounts for 14 percent.

Chart 4: Employment by Industry: Southwest Minnesota



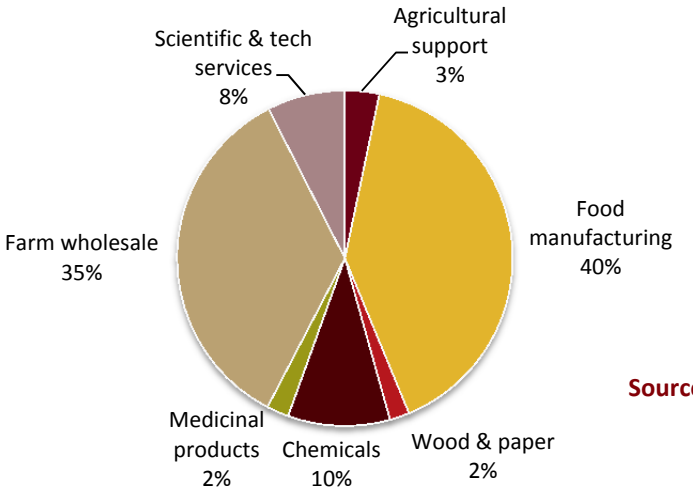
Source: IMPLAN

Agbioscience Employment

Agbioscience industries employ 3,364 of the 182,800 workers in Southwest Minnesota. Forty percent of those employees are in food manufacturing. Farm supplies wholesale businesses employ 35 percent of all agbioscience employees in the region (chart 5).

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, Southwest Minnesota



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 in Southwest Minnesota grew by 19 percent. In comparison, the number of jobs in the agbioscience industry in Greater Minnesota declined by 3 percent. The Southwest was one of three regions to post positive agbioscience job gains during this period. The total number of jobs in the Southwest (across all industries) grew by less than 1 percent during 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				
Ethyl alcohol manufacturing	327	25	1	301
Farm supplies wholesalers	94	-18	52	60
Testing laboratories	56	2	1	53
Top 3 Job Loss Industries				
Biological product manufacturing	-57	2	6	-65
Fruit and vegetable canning	-25	-49	18	6
Sawmills	-18	-15	2	-5

Source: EMSI

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

As highlighted in the table, farm supplies wholesalers and testing laboratories in the region also outperformed national and industry trends. Farm supplies wholesalers added 60 more jobs than expected, given trends. Testing laboratories added 53 more jobs than expected, based on national and industry trends.

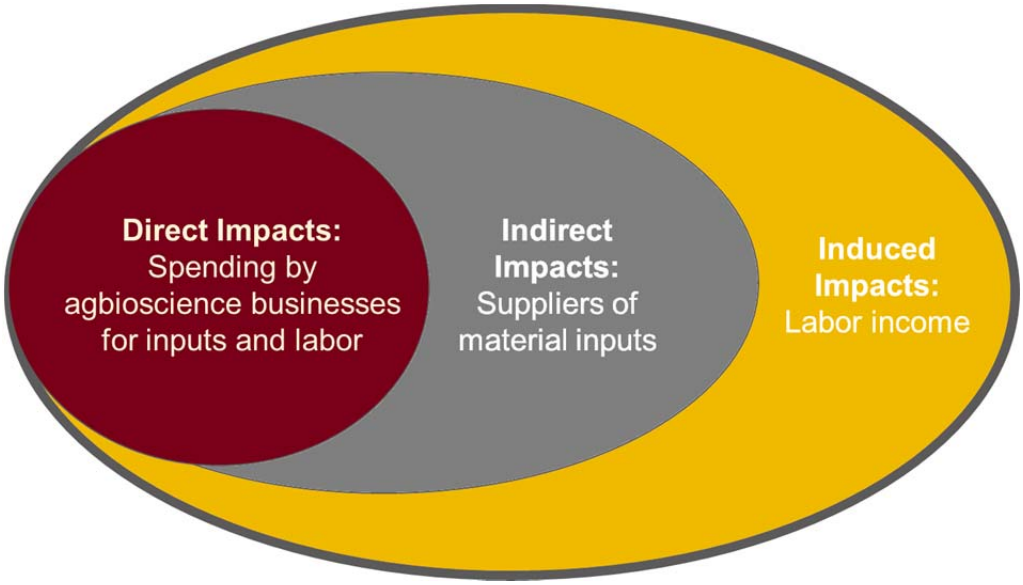
The biological product manufacturing sector, on the other hand, created fewer jobs than anticipated, given national and industry trends. Had the industry grown at the rate predicted based on those trends, Southwest Minnesota would have 65 more jobs in this sector than it currently has. Sawmills also lost more jobs than anticipated, given national and industry trends. The fruit and vegetable canning manufacturing sector shed 25 jobs between 2003 and 2013. However, this is fewer jobs than anticipated, given trends in the fruit and vegetable canning sector at the national level.

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN SOUTHWEST 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: the table may not sum due to rounding.

Chart 6: Economic Impact Analysis Diagram



Direct Effect

Direct effect is equal to the output and employment generated by businesses in the agbioscience industry in the Southwest 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 Southwest Minnesota employed 3,364 people (table 2). The highest shares of jobs were in the sectors of farm supplies wholesalers, beet sugar manufacturing, and fruit and vegetable canning. The farm supplies wholesaler sector was one sector within the agbioscience industry in the region that added the most jobs between 2003 and 2013. The fruit and vegetable canning was one industry that experienced losses.

Companies in the Southwest region's agbioscience industry created $2.6 billion of output (sales). Output is led by wet corn milling, ethyl alcohol manufacturing, and cheese manufacturing. As mentioned above, the ethyl alcohol manufacturing sector is growing in the region.

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

Table 2: Direct Effect of Agbioscience Industry in Southwest Minnesota

Industry Name	Employment	Output (millions)
Farm supplies wholesale	1,172	$222.7
Beet sugar manufacturing	356	$265.1
Fruit and vegetable canning, pickling, and drying	340	$175.2
Ethyl alcohol (ethanol) manufacturing	326	$613.1
Wet corn milling	310	$739.1
Cheese manufacturing	270	$274.7
Research and development in biotechnology	149	$24.4
Soil preparation, planting, and cultivating	111	$2.1
Testing laboratories	81	$6.9
Biological product (except diagnostic) manufacturing	72	$51.4
Sawmills and wood preservation	64	$16.5
Soybean and other oilseed processing	31	$63.8
Fats and oils refining and blending	26	$116.6
Remediation services	18	$3.5
Wineries	17	$5.5
Breweries	11	$11.0
Fertilizer manufacturing	5	$7.6
Environmental consulting services	5	$0.4
Total	3,364	$2,599.6

Sources: EMSI and IMPLAN

Indirect and Induced Effects

Using estimated direct effects, the data was entered into an input-output model. Input-output models trace the flow of dollars throughout a local economy and can capture the indirect and induced -- or ripple -- effects of an economic activity. The IMPLAN input-output model was used in

this analysis. The indirect and induced effects measured are the result of spending in the Southwest. In other words, purchases made outside of the Southwest 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 $3.6 billion dollars in economic activity to the Southwest region of Minnesota (table 3) from all effects – direct, indirect, and induced. The industry's presence in the Southwest region supported an estimated 9,444 jobs. These employees received an estimated $554.5 million in wages, salaries, and benefits.

The agbioscience industry directly created $2.6 billion in economic activity in the region, as detailed above. Agbioscience companies directly employed 3,364 residents of the region and spent $289.1 million in compensation for those workers. The average annual compensation per agbioscience employee was approximately $86,000.

When agbioscience companies make purchases from businesses in the region, this generates additional economic activity (indirect effects). From these indirect effects, agbioscience companies generated $771.1 million in activity in 2013 at regional businesses and supported jobs for 4,140 individuals in those businesses.

When employees of agbioscience companies spend their wages and salaries in the Southwest region, this creates economic activity at businesses in the region (induced effects). Employee spending generated $219.9 million in economic activity in 2013 in the region and supported employment for 1,940 workers.

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

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$2,599.6	3,364	$289.1
Indirect	$771.1	4,140	$204.7
Induced	$219.9	1,940	$60.7
Total	$3,590.6	9,444	$554.5

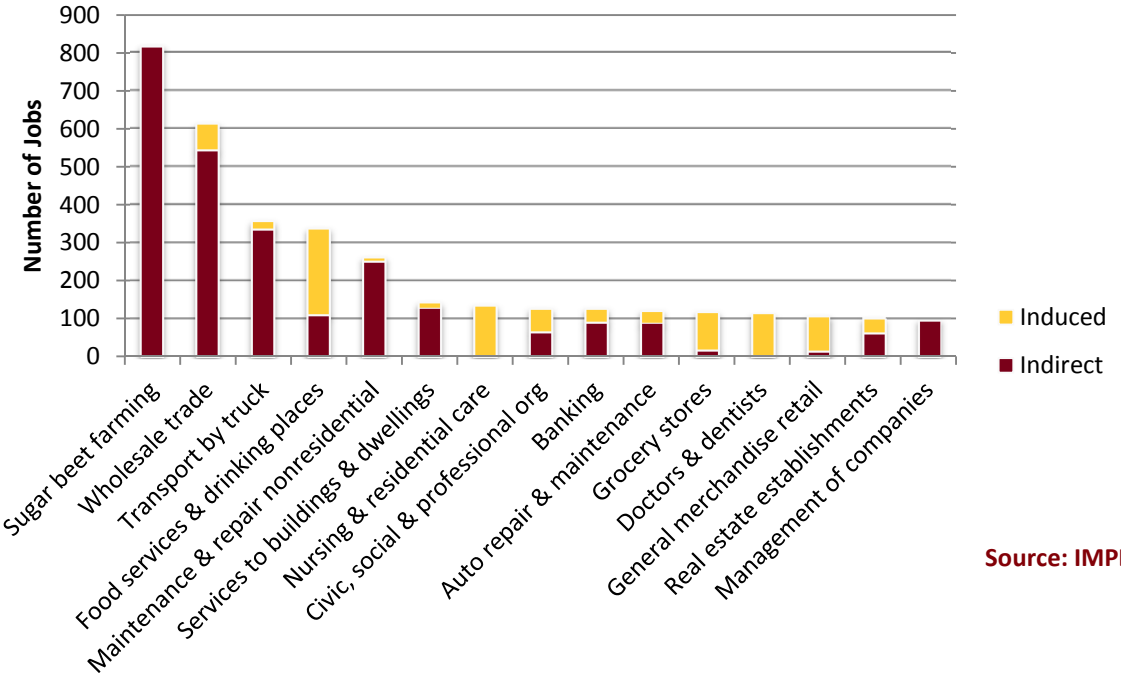
Estimates by University of Minnesota Extension

Top Industries Affected

Agbioscience companies support employment for 9,444 people in Southwest Minnesota. Of these, 3,364 jobs are with the agbioscience industry itself. Thus, the agbioscience industry supports 6,080 jobs in other businesses in the region. Chart 7 illustrates the top fifteen sectors with jobs supported by the agbioscience industry. These impacts are driven by the local expenditures and vary depending on the 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 transport by truck sectors. Induced effects are generated because employees of agbioscience companies spend wages and salaries in the local economy. Health care is a major expenditure for most households; therefore, it is not surprising to see high induced impacts in the sectors affiliated with the health care industry. Induced effects are also noted in food services and drinking establishments and retail trade.

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

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

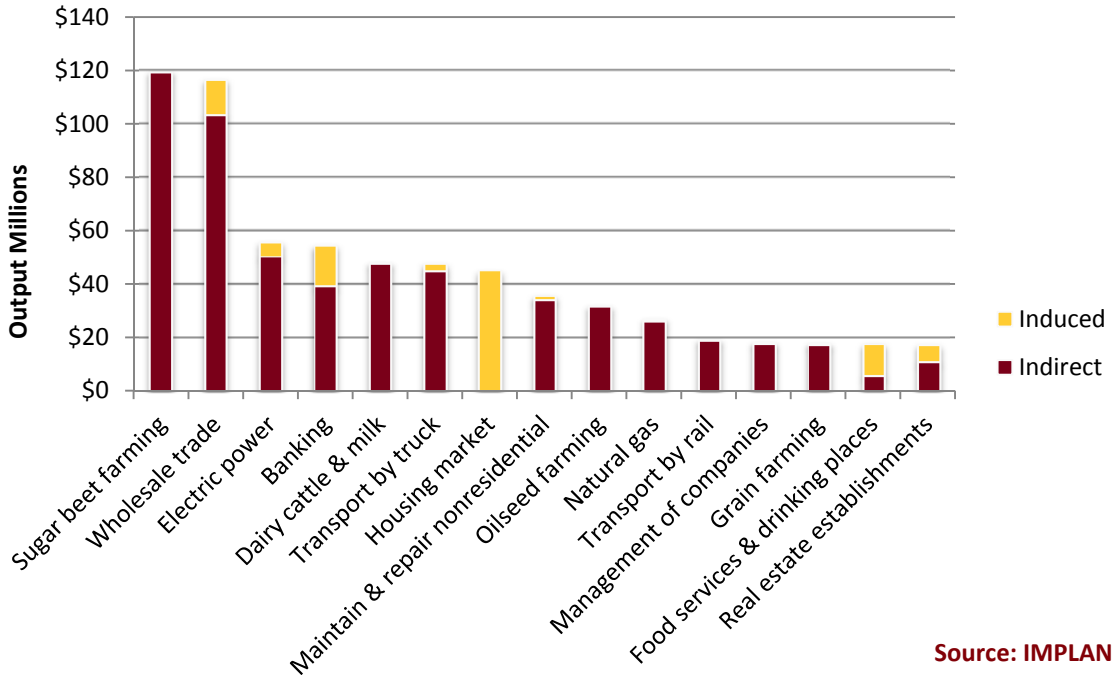


Source: IMPLAN

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, sorted by output. Agbioscience companies contribute $3.6 billion in economic activity to the Southwest region and directly spend $2.6 billion. The remainder, approximately $1.0 billion, is activity at other businesses in the region. Activities by agbioscience companies in the region contribute most to the sugar beet farming, wholesale trade, and electric power sectors.

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



Source: IMPLAN

Contribution of Agbioscience by Region of Greater Minnesota

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

The Southwest region is responsible for 15 percent of Greater Minnesota's total agbioscience output. In comparison, the Southwest region is responsible for 14 percent of Greater Minnesota's total output from all industries. In essence, the Southwest region produces approximately the same percent of Greater Minnesota's agbioscience output as it does Greater Minnesota's total output.

[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/.

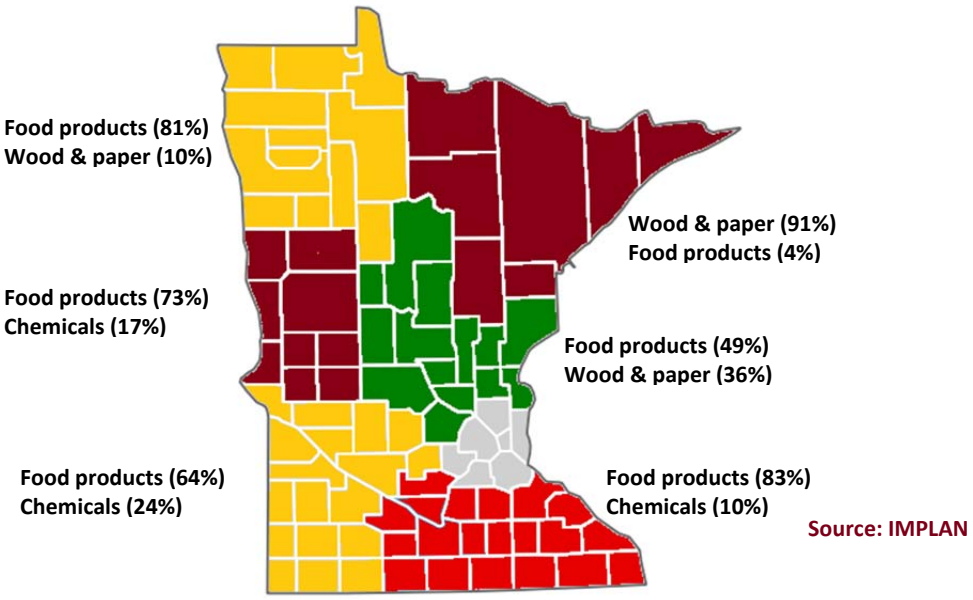
Table 4: Total Economic Contribution of Agbioscience by Region in Minnesota, 2013

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

Estimates by University of Minnesota Extension Center for Community Vitality

The composition of the direct effect of the agbioscience industry also varies by region (chart 9). Food manufacturing is a major component of the agbioscience industry in Minnesota. In Southwest Minnesota, food manufacturing produces 63 percent of all agbioscience output in the region. Food manufacturing composes a significant share of output in all regions, with the exception of the Northeast. The flavor of the food manufacturing industry, however, is different by region. In the Northwest and West Central regions, beet sugar manufacturing is a significant sector, while in the Southeast and Southwest cheese manufacturing is a significant sector.

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



Source: IMPLAN

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

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

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

Future Growth and Development of Agbioscience

The agbioscience industry in Southwest Minnesota is not a stagnant industry; it is expanding, contracting, and changing. Between 2003 and 2013, the total number of jobs in agbioscience in the region grew by 19 percent, despite the Great Recession in 2008-2009. The 2013 Battelle Technology Partnership Practice report identified potential growth in the industry to 2016. Growth rates varied across the industry from a low of 5.9 percent projected in business related to agricultural systems to 10.7 percent projected in business related to microbials. To estimate the potential for the industry in Southwest Minnesota, Extension modeled a conservative 5 percent growth rate across the industry and then a more optimistic growth rate of 20 percent across the industry. These two growth rates are estimates made by University of Minnesota based on historical growth rates in the industry and estimates by Battelle and are provided here for illustrative purposes.

If employment in the agbioscience industry in Southwest Minnesota was to grow at a rate of 5 percent between 2014 and 2016, the total economic contribution of the industry would increase to support an estimated $3.8 billion in output, an estimated 9,920 jobs, and an estimated $582.2 million in labor income (table 5).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$2,729.6	3,530	$303.6
Indirect	$809.7	4,350	$214.9
Induced	$230.9	2,040	$63.7
Total	$3,770.2	9,920	$582.2

Estimates by University of Minnesota Extension

If employment in the agbioscience industry in Southwest Minnesota was to grow at a rate of 20 percent between 2014 and 2016, the total economic contribution of the industry would increase to supporting an estimated $4.3 billion in output, an estimated 11,340 jobs, and an estimated $665.3 million in labor income (table 6). A 20 percent growth rate is consistent with the rate of growth in the region between 2003 and 2013.

Table 6: Total Economic Contribution of Agbioscience Southwest Minnesota, 20 Percent Growth Rate

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$3,119.5	4,040	$346.9
Indirect	$925.3	4,970	$245.6
Induced	$263.9	2,330	$72.8
Total	$4,308.7	11,340	$665.3

Estimates by University of Minnesota Extension

ECONOMIC CONTRIBUTION, TRENDS, AND FUTURE GROWTH AND DEVELOPMENT OF AGBIOSCIENCE IN SOUTHWEST 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 Southwest Minnesota.

In terms of total impacts, the largest platform in the Southwest region is the value-added food and health products platform. In 2013, the platform supported $2.7 billion of output in the Southwest region (table 7). The platform also supported employment for 7,550 workers and paid $398.9 million in wages, salaries, and benefits. The Southwest region also has high output impacts in the resilient, efficient, and productive agricultural systems platform and the biobased industrial products platform.

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

	Output (Millions)	Employment (rounded)	Labor Income (Millions)
Microbial agbioscience	$857.5	2,960	$152.0
Resilient, efficient, & productive agricultural systems	$1,111.8	3,530	$241.1
Biobased industrial products	$1,068.3	2,010	$162.6
Value-added food and health products	$2,709.7	7,550	$398.9

Estimates by University of Minnesota Extension

While value-added food and health products is the largest platform in the region, the biobased industrial products platform was the fastest growing between 2003 and 2013 (table 8). Businesses in the platform added more than 450 jobs, increasing the number of jobs in the platform by 352 percent. Most of that growth was driven by the growth in the ethyl alcohol manufacturing sector.

The number of jobs in the all of the platforms increased between 2003 and 2013. Resilient, efficient, and productive agricultural systems employment increased by 37 percent, microbial agbioscience

employment increased by 26 percent, and value-added food and health products increased by 14 percent. Meanwhile, between 2003 and 2013, the number of jobs across all industries in Southwest Minnesota grew by less than 1 percent.

Table 8: Change in Number of Jobs by Agbioscience Platform in Southwest 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	672	844	26%
Resilient, efficient, & productive agricultural systems	1,307	1,785	37%
Biobased industrial products	133	601	352%
Value-added food and health products	2,344	2,682	14%

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 $857.5 million of output in Southwest Minnesota. The platform also supported an estimated 2,954 jobs, with those jobs paying an estimated $152.0 million of labor income (table 9).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$533.9	844	$63.1
Indirect	$263.4	1,580	$72.3
Induced	$60.2	530	$16.6
Total	$857.5	2,954	$152.0

Estimates by University of Minnesota Extension

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

The Southwest region is the second largest region in the platform in terms of output, with the Southeast region the largest. Within the microbial agbioscience platform in the Southwest region, the largest sectors, measured by output, are beet sugar manufacturing, fats and oils refining and blending, and soybean and other oilseed processing. The highest ripple effects are in beet sugar farming, wholesale trade, and food services and drinking establishments.

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

Given 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 Southwest Minnesota would increase to an estimated $943.3 million, including an estimated 3,250 jobs, and an estimated $167.2 million in labor income.[6]

Resilient, Efficient, and Productive Agricultural Systems

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

In 2013, the resilient, efficient, and productive agricultural systems platform supported an estimated $1.1 billion of output in Southwest Minnesota. The platform also supported an estimated 3,530 jobs, with those jobs paying an estimated $241.1 million of labor income (table 10).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$873.8	1,785	$172.7
Indirect	$142.3	900	$42.0
Induced	$95.7	845	$26.4
Total	$1,111.8	3,530	$241.1

Estimates by University of Minnesota Extension

The Southwest region is the second largest in the platform as measured by output. In comparison, the Southeast region (the largest region) supported $1.2 billion of output. Within the Southwest region, the largest sectors in the agricultural systems platform (measured by output) are ethyl

[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).

alcohol manufacturing and farm suppliers wholesalers. The largest ripple effects are in wholesale trade, the housing market, and electric power generation.

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

If the forecasted rate of growth of 10 percent occurs, the economic contribution of the resilient, efficient, and productive agricultural systems platform would increase to $1.2 billion of output, including 3,880 jobs and $265.2 million in labor income.[7]

Biobased Industrial Products

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

In 2013, the biobased industrial products platform supported an estimated $1.1 billion of output in Southwest Minnesota. The platform also supported an estimated 2,011 jobs, with those jobs paying an estimated $162.6 million in labor income (table 11).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$842.0	601	$96.9
Indirect	$161.9	840	$47.9
Induced	$64.4	570	$17.8
Total	$1,068.3	2,011	$162.6

Estimates by University of Minnesota Extension

The Northeast, Central, and Southwest regions all have significant levels of output in the platform (more than $1 billion in each region), but the Southeast region is the largest source of output in the platform. In the Southwest region, ethyl alcohol manufacturing, and fats and oils refining and blending are major sources within the biobased industrial products platform. The largest ripple effects are in the oilseed farming and wholesale trade businesses.

The Battelle report identifies two primary market components of the biobased industrial products platform – biomaterials and biofuels. The biomaterials market has been growing in the United States,

[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).

and demand for biomaterial is expected to post a yearly growth of 6.9 percent, according to Battelle. As noted, the biofuels market suffered during the Great Recession. The Battelle analysis indicates overall demand will increase by approximately 3 percent, but the market value is expected to decline. Given the forecasts provided by Battelle and the overall decline in the number of jobs in the platform, a growth rate of 5 percent between 2013 and 2016 appears to be reasonable.

If the rate of growth of 5 percent occurs, the economic contribution of the biobased industrial products platform would increase to $1.12 billion of output, including 2,110 jobs and $170.7 million in labor income.[8]

Value-Added Food and Health Products

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

In 2013, the value-added food and health products platform supported an estimated $2.7 billion in output in Southwest Minnesota, including an estimated $398.9 million in labor income and 7,552 jobs (table 12).

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

	Output (Millions)	Employment	Labor Income (Millions)
Direct	$1,898.0	2,682	$184.8
Indirect	$653.5	3,470	$170.4
Induced	$158.2	1,400	$43.7
Total	$2,709.7	7,552	$398.9

Estimates by University of Minnesota Extension

In the value-added food and health products platform, the Southeast region produces the highest amount of output and employment. However, all regions, with the exception of the Northeast, produce more than $1 billion of output. In the Southwest region, large sectors in the value-added food and health products platform include wet corn milling, cheese manufacturing, and beet sugar manufacturing. The largest ripple effects in the Southwest region include beet sugar farming, wholesale trade, housing, 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 Technology Partnership Practice, November 2013). Market

[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).

forces are strong, however, for traditional food and health companies to move into the value-added market, particularly around the concept of increasing nutrition.

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

If the forecasted rate of growth of 5 percent occurs, the economic contribution of the value-added food and health products platform would increase to an estimated $2.8 billion of output, including an estimated 7,930 jobs and an estimated $418.8 million in labor income.[9]

Contribution of Agbioscience Platforms by Region of Greater Minnesota

In comparison to the other regions, the Southwest region is a significant contributor to total economic contribution in each of the platforms. The Southwest region is the second largest region in the microbial agbioscience platform, the resilient, efficient, and productive agricultural systems platform, and the value-added food and health products platform. In the resilient, efficient, and productive agricultural systems platform, the Southwest region supports nearly the same amount of output as the Southeast region.

As a note, the size and scale of the agbioscience industry also depends on the size and scale of the economy in the region. In 2013, businesses and industries in the Southwest region produced $31.6 billion of output. In comparison, the Southeast region produced $76.4 billion and the Central region produced $52.0 billion.

Table 13: Total Economic Contribution of Minnesota's Agbioscience Platforms by Region, 2013
Note: Individual platforms will not sum to total economic contribution of agbioscience since sectors can be classified in more than on platform.

Output in 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

[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).

In addition to variation in the size of the platforms, the rate of growth of each platform also varies. The Southwest region was the fastest growing region in the biobased industrial products platform, with the number of jobs in the platform increasing by 352 percent between 2003 and 2013. The region was also the fastest growing in the resilient, efficient, and productive agricultural systems platform, increasing by 37 percent.

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

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

Source: EMSI

SUMMARY

Given Minnesota's long tradition in agriculture and science, the state is positioned with a strong agbioscience industry. The agbioscience industry is a broad continuum that includes many agricultural, scientific, and research activities. The Agricultural Utilization Research Institute (AURI) recognizes agbioscience's importance in the state's economy. In 2013, AURI 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 focuses on the four platforms, the analysis was on a statewide level. AURI then contracted with University of Minnesota Extension to explore the economic contribution of the industry and the four platforms in each of 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 Southwest region of Minnesota.

The agbioscience industry contributes significantly to the economy of Southwest Minnesota. In 2013, the total economic contribution of the agbioscience industry was an estimated $3.6 billion in Southwest Minnesota. Through its impacts across all industries, the agbioscience industry supported an estimated 9,444 jobs that paid $554.5 million in income to workers in the region.

In Southwest Minnesota, the agbioscience industry is dominated by food processing and ethanol production. Beet sugar manufacturing, wet corn milling, cheese manufacturing, and other food manufacturing combine to produce $1.6 billion of output. Chemical manufacturing, essentially ethanol production, is also a significant portion of the agbioscience industry in the region, producing $600 million of output. Growing agbioscience sectors in the region include: ethyl alcohol manufacturing, farm supplies merchant wholesalers, and testing laboratories. These sectors have added jobs in the past 10 years and have done so at rates faster than expected given national and industry trends. Biological product manufacturing, fruit and vegetable canning, and sawmills are agbioscience sectors that shed jobs between 2003 and 2013 in the region.

Directly, agbioscience companies in the Southwest employ 3,364 individuals. The companies produce $2.6 billion in economic activity including compensation to workers of $289.1 million. The average annual compensation per agbioscience employee was approximately $86,000.

The $2.6 billion of output represents approximately 8 percent of all economic activity in the region. In addition to sales from agbioscience industries, production agriculture also generates output in the region. Production agriculture, which falls outside the agbioscience category, recorded sales of $5.8 billion or about 18 percent of all sales in the region. The Southwest region is responsible for 15 percent of Greater Minnesota's agbioscience output.

Indirectly, industries with strong ties to agriculture and manufacturing are most affected by the agbioscience industry in Southwest Minnesota. The related industries benefiting most from agbioscience industry's impacts include sugar beet manufacturing, wholesale trade, transport by truck, electric power, and banking.

During the past 10 years, the agbioscience industry in Southwest Minnesota has grown by 19 percent. If that trend continues, the economic contribution of the agbioscience industry in the region will increase by 2016 to an estimated $4.3 billion in output, an estimated 11,340 jobs, and an estimated $665.3 million in labor income.

Of the four platforms, the value-added food and health products platform is the largest in the Southwest region. In 2013, the platform supported an estimated $2.7 billion of economic activity in the region, including an estimated 7,550 jobs. This platform is based on Minnesota's strengths in agricultural value-added, particularly around food. The platform involves expanding on historic core competencies of food manufacturing in Minnesota to new markets focused on health and nutrition, including nutritional supplements.

The fastest growing platform was the biobased industrial products platform, which grew by 352 percent between 2003 and 2013 (as measured by employment). The biobased industrial platform supported an estimated $1.1 billion of output in Southwest Minnesota in 2013. The platform also supported an estimated 2,010 jobs. The biobased industrial products 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.

In conclusion, the Southwest region is a major component of the agbioscience industry in Greater Minnesota. The region will clearly be important in the future growth and development of the industry, particularly in the realm of biobased industrial products. The region has a strong base of ethanol production and food manufacturing on which to grow.

APPENDIX 1: METHODOLOGY

Input-Output Models

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

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

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

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

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

impacts are those associated with spending by agbioscience companies for their supplies and inputs.

- **Induced Impact**: The induced impact is the summation of changes in the local economy that occur due to **spending by labor**. For instance, if employment in a manufacturing plant increases by 100 jobs, the new employees will have more money to spend to purchase housing, buy groceries, and go out to dinner. As they spend their new income, more activity occurs in the local economy. Induced impacts also include spending by labor generated by indirect impacts. So, if the bio-based businesses purchase services from a local tax preparer, spending of the tax preparer's wages would also create induced impacts. Primarily, in this study, the induced impacts are those economic changes related to spending by employees of agbioscience companies in the region.
- **Total Impact**: The total impact is the summation of the direct, indirect, and induced impacts.

Quarterly Census of Employment and Wages (QCEW)

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

Shift-Share Analysis

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

- **National Growth**: National growth indicates how many jobs a local economy would have gained (or lost) as a result of the growth (or decline) of employment at the national level. For example, consider a local economy with 100,000 jobs at the beginning of the time period. If during the period under consideration, the number of jobs in the United States grew by a rate of 2 percent, then at the end of the time period under consideration, the local economy would be expected to have 102,000 jobs.
- **Industrial Mix**: Industrial mix indicates how many jobs a particular industry within the local economy would have gained (or lost) if the local industry grew (or declined) at a rate similar to the industry as a whole in the United States. For example, if 1,000 people were employed in the finance industry in the local economy at the beginning of the period, and the finance industry as a whole in the U.S. grew at a rate of 10 percent, then at the end of the time period under consideration, the local finance industry would be expected to have 1,100 jobs.
- **Competitive Share**: Competitive share is the remainder of change in employment for the region examined. From our example, 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 the 2013 document "Agbioscience as a Development Driver: Minnesota's Agbioscience Strategy." Find the study here: (http://www.auri.org/assets/2013/12/Minnesotas+Agbioscience+Strategy+-+Final+Report-1.pdf).

Table A1: All Agbioscience Sectors and NAICS Codes

115112	Soil Preparation, Planting, and Cultivating
311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311313	Beet Sugar Manufacturing
311411	Frozen Fruit, Juice, and Vegetable Manufacturing
311421	Fruit and Vegetable Canning
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing
311513	Cheese Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311942	Spice and Extract Manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
321113	Sawmills
321114	Wood Preservation
321211	Hardwood Veneer and Plywood Manufacturing
321212	Softwood Veneer and Plywood Manufacturing
321213	Engineered Wood Member (except Truss) Manufacturing
321219	Reconstituted Wood Product Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
322110	Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
325191	Gum and Wood Chemical Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing

325212	Synthetic Rubber Manufacturing
325221	Cellulosic Organic Fiber Manufacturing
325222	Noncellulosic Organic Fiber Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325411	Medicinal and Botanical Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325620	Toilet Preparation Manufacturing
424910	Farm Supplies Merchant Wholesalers
541380	Testing Laboratories
541620	Environmental Consulting Services
541711	Research and Development in Biotechnology
562910	Remediation Services

Table A2: Microbial Agbioscience Platform Sectors and NAICS Codes

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

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

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

541711	Research and Development in Biotechnology
562910	Remediation Services

Table A4: Biobased Industrial Products Platform Sectors and NAICS Codes

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

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

311211	Flour Milling
311212	Rice Milling
311213	Malt Manufacturing
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311313	Beet Sugar Manufacturing
311411	Frozen Fruit, Juice, and Vegetable Manufacturing
311421	Fruit and Vegetable Canning
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing

311513	Cheese Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311942	Spice and Extract Manufacturing
312120	Breweries
312130	Wineries
312140	Distilleries
325411	Medicinal and Botanical Manufacturing
325620	Toilet Preparation Manufacturing
424910	Farm Supplies Merchant Wholesalers
541711	Research and Development in Biotechnology

APPENDIX 3: COMPOSITION OF AGBIOSCIENCE OUTPUT BY REGION

Chart A1: Agbioscience Output by Industry, Central Minnesota

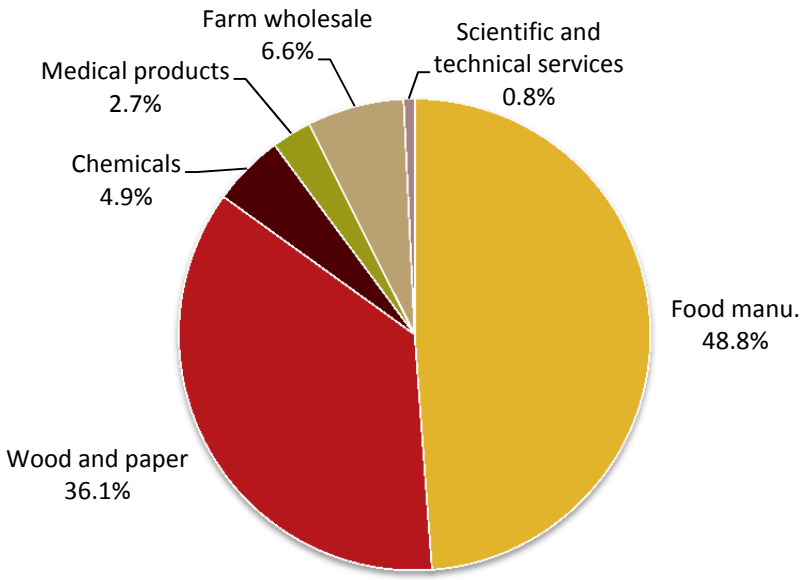


Chart A2: Agbioscience Output by Industry, Northeast Minnesota

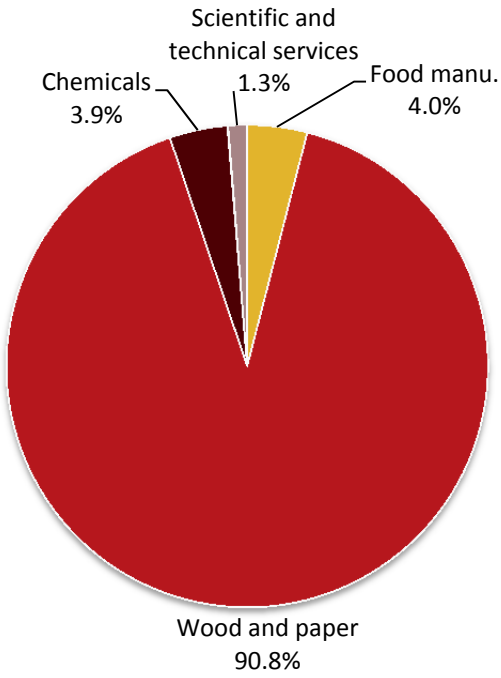


Chart A3: Agbioscience Output by Industry, Northwest Minnesota

Source: IMPLAN

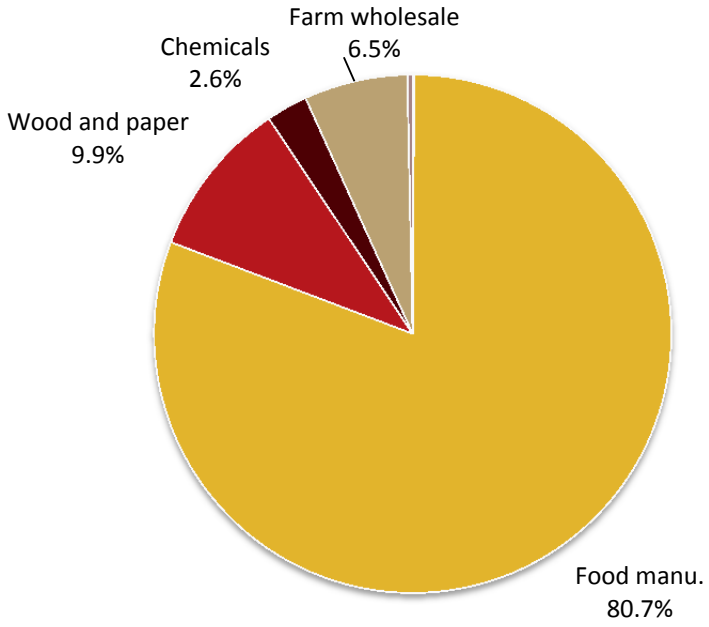
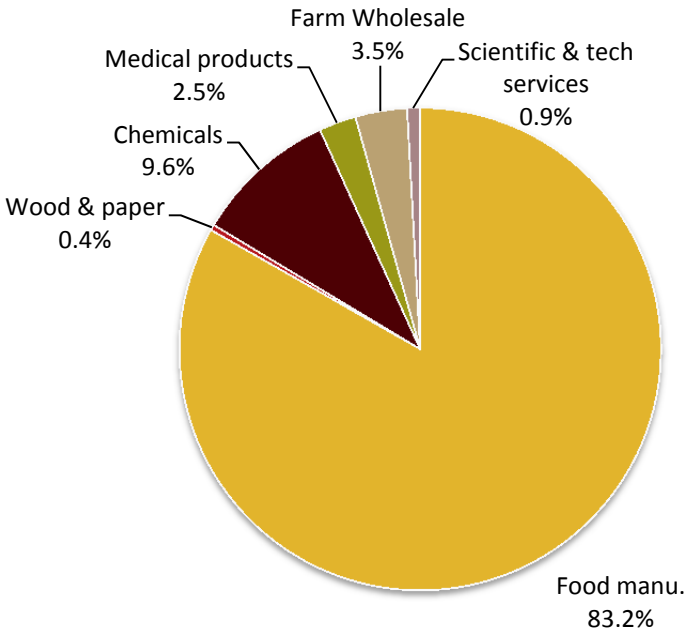


Chart A4: Agbioscience Output by Industry, Southeast Minnesota



Source: IMPLAN

Chart A5: Agbioscience Output by Industry, Southwest Minnesota

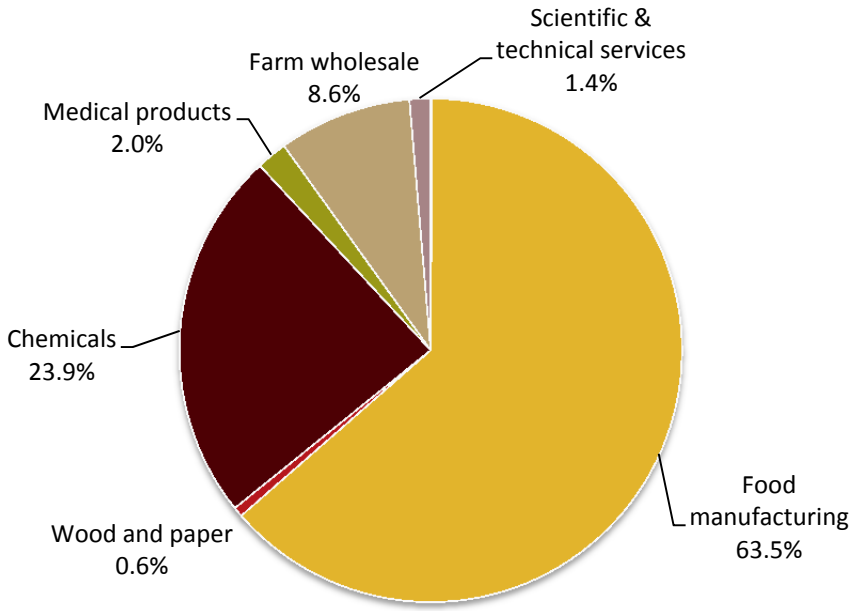
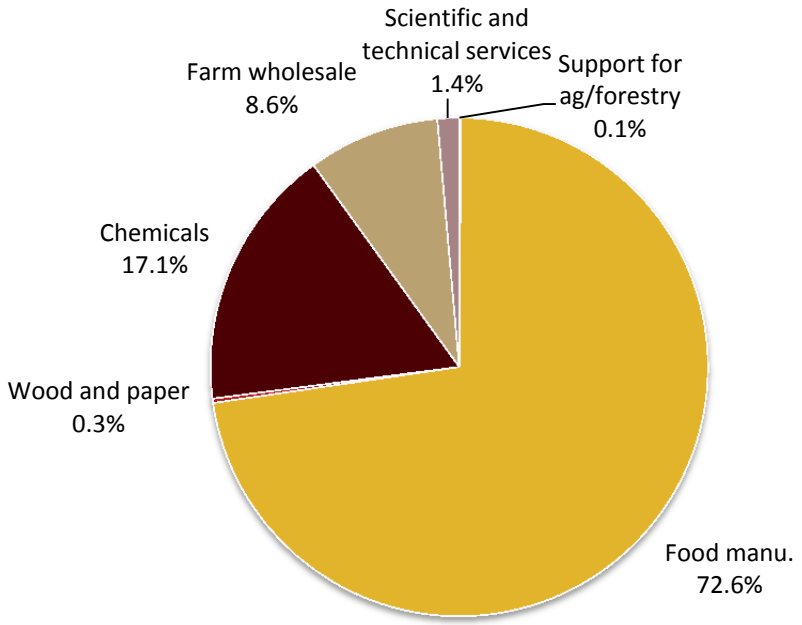


Chart A6: Agbioscience Output by Industry, West Central Minnesota



Source: IMPLAN

APPENDIX 4: REFERENCES

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

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

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

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

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

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

Description	2003 Jobs	2013 Jobs	2003-2013 Change	2003-2013 % Change
Farm Supplies Merchant Wholesalers	1,077	1,172	95	9%
Beet Sugar Manufacturing	369	356	-13	-3%
Fruit and Vegetable Canning	366	340	-26	-7%
Ethyl Alcohol Manufacturing	16	326	310	1905%
Wet Corn Milling	263	310	46	18%
Cheese Manufacturing	254	270	16	6%
Research and Development in Biotechnology	5	149	144	2884%
Soil Preparation, Planting, and Cultivating	127	111	-16	-13%
Testing Laboratories	25	81	56	220%
Biological Product (except Diagnostic) Manufacturing	128	72	-56	-44%
Sawmills	52	34	-18	-34%
Soybean and other oilseed processing	62	31	-31	-50%
Wood Preservation	18	30	12	64%
Fats and Oils Refining and Blending	0	26	26	NA
Remediation Services	17	18	1	6%
Wineries	5	17	12	247%
Breweries	0	11	11	NA
Environmental Consulting Services	22	5	-17	-78%
Fertilizer (Mixing Only) Manufacturing	24	5	-19	-79%
Total	2,829	3,364	534	19%

Source: EMSI