17. Impact of Distance on Agribusiness

Overview
Many factors are taken into consideration by businesses when determining the location of their production facility/factory or store. One of the biggest considerations in regards to these items is the distance the factory/store is from the market and natural resources used. Use Weber’s least cost model to determine which counties in Minnesota would be the best location to build production facilities that support Minnesota agriculture. Students will consider many factors in determining their location, especially distance and transportation.

Grade Levels: 9 – 12
Time: Two to Three 50-minute class periods.

Minnesota State Standards: Geography
Benchmark: 9.3.2.4.1
Apply geographic models to explain the location of economic activities and land use patterns in the United States and World.

Benchmark: 9.3.2.4.2
Identify the primary factors influencing the regional pattern of economic activities in the United States and the world.

Benchmark: 9.3.2.4.3
Explain how the technological and managerial changes associated with the third agricultural revolution, pioneered by Norman Borlaug, have impacted the regional patterns of crop and livestock production.

Benchmark: 9.3.2.4.4
Describe patterns of production and consumption of agricultural commodities that are traded among nations.

Benchmark: 9.3.3.5.7
Describe how changes in transportation and communication technologies affect the patterns and processes of urbanization of the United States.

Key Words
• Weber’s Least Cost Theory Model, transport, commodity, processing operations, distribution, markets, production facility

Prior Knowledge
• Basic map reading skills and knowledge of Minnesota regions.

Objectives
• To apply the concepts of the model developed by Alfred Weber to make decisions on where to locate processing and shipping facilities for crop and livestock agriculture.
• To apply the concepts of data layering to determine the best locations for agribusiness production.
• To predict the changes in the distribution of agricultural processing operations that will result from technological changes in agriculture and transportation.

Materials
• Food for Thought Maps found at http://www.mda.state.mn.us/fft
  ➢ Wheat in MN Counties (2012) (Map 2)
  ➢ Corn for Grain in MN Counties (2012) (Map 4)
  ➢ Soybeans in MN Counties (2012) (Map 6)
  ➢ Alfalfa in MN Counties (Map 7)
  ➢ All Hay in MN Counties (Map 8)
Background Information

Weber's model of impact of transport costs:

This model is intended to help geographers determine where to locate factories based on the costs of shipping goods. This model is used to help predict what other factors might be important in the location of economic activities.

Explaination of Weber's Model:

1. The model is used to analyze a single isolated country that is homogeneous in terms of climate, topography, population, and under one political authority.
2. Some natural resources (for instances water and sand) are ubiquitous (found everywhere) whereas others (such as coal and iron ore) occur only in fixed locals (found only in a set location).
3. Available workers are not ubiquitous; rather they are fixed in specific places.
4. Transportation costs are a function of weight and distances increasing in direct proportion to the length of shipment and weight of cargo.
5. Manufacturing plants will be located in response to three forces: relative transport costs, labor costs, and agglomeration (a collection of industries, factories, etc. in one location).

Case 1 – One Market and One Raw Material

- If the raw material is ubiquitous, then the factory will locate at the market.
- If the raw material is fixed and no weight is lost in the manufacturing process, the factory can locate at either the market or the source of raw material.
- If the raw material is fixed and weight is lost in the manufacturing process, the factory will locate at the source of raw material.

Case 2 - One Market and two Raw Materials (R1 and R2)

If customers for a product are in only one place and the product is manufactured from two raw materials (R1 and R2) then manufacturing will tend to locate in one of the following ways:

- If both R1 and R2 are ubiquitous, then manufacturing will be at the market.
- If R1 is ubiquitous and R2 is fixed elsewhere than at the market, and if both are pure (no weight loss),
then manufacturing will be at the market.

- If both raw materials are fixed and pure (neither resource has other materials in it which results in no weight loss), the factory will be at the market.
- If both raw materials are fixed and gross (contains other materials which have to be removed resulting in weight loss), the solution is complex and Weber introduced his famous locational triangle. (See diagrams below).

Suppose R1 and R2 lose 50% of their weight in the manufacturing process and 2000 tons of each are required a year. If the factory were located at M the total transportation costs would be (A) 2,000 tons X 100 miles = 200,000 ton miles on R1 from R1 to M, plus (B) 200,000 ton miles on R2 from R2 to M or 400,000 ton miles in all.

However, if the factory were located at Point X, midway between R1 and R2, the transportation burden would be as follows: (A) 2,000 tons X 50 miles = 100,000 ton miles on R1 from R1 to X, plus (B) another 100,000 ton miles on R2 from R2 to X, plus (C) 2,000 tons X 87 miles = 174,000 ton miles on finished product from X to M or a total of 374,000 ton miles. This is less than the burden facing an industry at either M or R1 or R2.

If the two raw materials do not have the same weight loss or if different amounts are required, the factory would tend to locate nearer one of the raw materials sources so as to lessen the burden of transportation costs.

See Handout: Case 2, for use with additional clarification on calculations.

When applying the model to Minnesota agriculture and agribusiness it is important to remind students that most processes involve weight loss and bulk reduction. However, bottling liquid milk for direct consumption is bulk gaining, and in addition, it must be delivered quickly to both the bottling plant and consumers. Grain shipping does not involve loss of weight or bulk. Ethanol involves weight and bulk loss but the byproduct (corn mash) can be sold for animal feed and so has a separate set of transport variables.

**Procedure**

Setting: Students have been selected to serve on a state-wide task force to determine what counties are interested in developing industrial facilities to support Minnesota agriculture.

In developing their opinions the students should make the following assumptions:

1. There will be enough labor in each of the interested communities or labor will move to the communities to take the new jobs created. Labor costs will be essentially the same in all locations.
2. There is both a state and national market for the goods produced.
3. The basic geography of the production of crops and livestock will not change during the time the task force is deliberating.

**PART 1**

In order to facilitate the students resolving this issue, the teacher should lead the entire class through an example of how to determine the effects of transport on the processing operations using the map layering techniques. Teachers should select any commodity in which they have a special interest. The example of milk is provided because most students will have some familiarity with it.

1. Activate prior knowledge by asking the students what they know about the production of milk and how it is processed. Discussion should include:
   a. Milk comes from cows.
   b. Milk can spoil or turn sour quickly.
   c. Milk is sold in small volumes directly to the consumers – bottle, carton, etc.
   d. The number of dairy farms is decreasing due to the economies of scale (cost advantages due to size of farm) that can be realized by large producers. Note: Large producers milk 700 to 1000 cows thus producing more milk than farmers with 50 cows.
   e. Milk is shipped from farm to processing plant in tanker trucks.
   f. Milk must be kept chilled between the time it leaves the cow until it is processed to prevent spoilage.
2. Show the following maps to the students and ask the students to explain the distribution of cows in Minnesota: Dairy Cows (Map 9), Corn for Grain (2012) (Map 4), Soybeans (2012) (Map 6), All Hay (Map 8), Alfalfa (Map 7) and Major Cities and Waterways (Map 40).
   a. Dairy farms are concentrated in areas that are not primary production zones for grain because the cattle can graze on hilly pastures unsuitable for grain.
   b. Dairy farms are generally near the urban areas.
   c. Most dairy farms are not found in the cold forested region of northern Minnesota.
3. Compare the map of Milk Production (Map 10) with the map of Dairy Cows (9) and ask the students to explain what correlations exist between the two maps.

4. Compare the map of Dairy Product Processing Sites (Map 29) to the map of Milk Production (Map 10) and the Major Cities and Waterways (Map 40). Next, using the discussion of Weber’s Model, ask the students to explain the distribution of bottled milk plants.
   a. Students should note that of the 13 bottling plants in the state 10 are located near markets. This can be explained by using the model and what they know about the production and processing of “bottled” milk.
      • If the raw material is ubiquitous (found everywhere), then the factory will be located at the market.
      • If the raw material is fixed (only in one location), and no weight is lost in the manufacturing process, the factory can locate in either the market or at the source of raw material.

5. Using the map of Dairy Product Processing Sites (Map 29) and your discussion of Weber’s Model, ask the students to explain the distribution of butter, cheese, or ice cream plants.
   a. Students should note that of the 24 plants in the state, 4 are obviously located near markets. This can be explained by the students using the model and what they know about the production of these products. Because all three of these products reduce the bulk of the fresh milk and the product is less perishable than milk, they may locate plants in locations that will reduce the transportation costs of the fresh liquid milk. The refrigerated products can then be shipped great distances.
      • If the raw material is fixed (in one location) and weight is lost in the manufacturing process, the factory will locate at the source of raw material.

PART 2
1. Divide the class into “task force subcommittees”.
2. Assign each subcommittee a commodity (agricultural product) and processing operation from those listed below to analyze. Instruct students to use the appropriate maps and aspects of the model to identify the counties that are NOT efficient location sites and also, the county that best meets the locational criteria.
3. After analyzing their maps, the students are to prepare a one page report which summarizes how they came to their conclusion and makes reference to the maps they used to develop their conclusion. Students should also use principles of Weber’s model in defending their location in their conclusion.

The task force subcommittee assignments are as follows:
   Group 1: Koochiching, Stearns, Brown, Norman, Kandiyohi, and Houston counties have applied for a grant to build an ethanol plant with a capacity of thirty million gallons per year. In which of these counties would such a facility be most likely to succeed and why?
   Group 2: The counties of Polk, Pine, Sherburne, Stearns, Anoka and Cottonwood have applied for a grant to develop an apple processing plant. In which of these counties would such a facility be most likely to succeed and why?
   Group 3: The counties of Morrison, Crow Wing, Martin, Clearwater, Pipestone, and Faribault have applied for a grant to develop a beef processing plant. In which of these counties would such a facility be most likely to succeed and why?
Group 4: The counties of Rock, Chippewa, Meeker, Houston, Blue Earth, and Hennepin have applied for a grant to have a pork processing plant. In which of these counties would such a facility be most likely to succeed and why?

Group 5: The counties of Hennepin, Ramsey, Carlton, Isanti, Chisago, and Martin have applied for a grant to establish a turkey processing plant. In which of these counties would such a facility be most likely to succeed and why?

Group 6: The counties of Hennepin, Ramsey, Carlton, Isanti, Chisago, and Martin have applied for a grant to establish a chicken processing plant. In which of these counties would such a facility be most likely to succeed and why?

Group 7: The counties of Carver, St. Louis, Hennepin, Yellow Medicine, Benton, and Stevens have applied for a grant to establish a vegetable canning and freezing plant. In which of these counties would such a facility be most likely to succeed and why?

Extensions

Two maps in the packets facilitate a discussion of the von Thuen Model of land use: Population Change 2000 - 2010 (Map 32) and Nurseries (Map 18). Have students analyze these two maps to explain the distribution and location of nurseries in Minnesota. Students will need to have an understanding of von Thunen's model in order to conduct this analysis.

Answers: von Thunen indicates that intensive agriculture (high inputs of labor and capital) will be located close to the market. This explains the distribution of Nurseries on Map 18 because the plants are expensive, easily damaged when shipping, and perishable. The great profitability of this agriculture enables farmers to maintain themselves in the face of the expanding urban population. The map showing population change indicates that eventually this pattern of nursery crops will have to shift outward.

Assessments

1. Each subcommittee will select a representative to report back to the task force at-large (class). Each subcommittee will prepare a map of the location they selected for their production facilities and share their with the task force at-large (class). The representatives of each subcommittee with explain to the task force at-large the rationale behind the location of their production facilities. After each committee’s presentations, the teacher will show the current map of the production facilities for their specific product and the class will analyze how close the subcommittee’s selected county is to the current production centers. If the subcommittee’s selection and the existing pattern are different, have the students discuss why the difference exists. This discussion should help to clarify for the students how Weber’s industrial location model was used.

2. If time allows, ask students to individually come up with a rebuttal statement against one of the sites selected which includes at least three specific reasons why the selected location is not the best location for that production facility.

Resources

Readings

Answer Key for Handout: Case 2

- Factory at M
  Resource 1 from R1 to M: 100 miles x 2000 tons= 200,000 ton miles
  Resource 2 from R2 to M: 100 miles x 2000 tons= 200,000 ton miles
  Total at M: 400,000 ton miles

- Factory at X
  Resource 1 from R1 to X: 50 miles x 2000 tons=100,000 ton miles
  Resource 2 from R2 to X: 50 miles x 2000 tons=100,000 ton miles
  Final product from X to M: 87 miles x 2000 tons=174,000 ton miles
  Total at X: 374,000 ton miles;

- Factory at R1
  Resource 2 from R2 to R1: 100 miles x 2000 tons=200,000 ton miles
  Resource 1 from R1 to R1: not necessary to transport to site

- Final product from R1 to M
  100 x 2000 tons=200,000 ton miles
  Total at R1: 400,000 ton miles

- Factory at R2
  Resource 1 from R1 to R2: 100 miles x 2000 tons=200,000 ton miles
  Resource 2 from R2 to R2: not necessary to transport to site

- Final product from R2 to M
  100 miles x 2000 tons=200,000 ton miles
  Total at R2: 400,000 ton miles
Handout: Case 2

FACTORY AT M

Resource 1 from R1 to M: __________ miles x __________ tons = ________________

Resource 2 from R2 to M: __________ miles x __________ tons = ________________

Total at M: __________________________________________________________

FACTORY AT X

Resource 1 from R1 to X: __________ miles x __________ tons = ________________

Resource 2 from R2 to X: __________ miles x __________ tons = ________________

Final product from X to M: __________ miles x __________ tons = ________________

Total at X: __________________________________________________________

FACTORY AT R1

Resource 2 from R2 to R1: __________ miles x __________ tons = ________________

Final product from R1 to M: __________ miles x __________ tons = ________________

Total at R1: _________________________________________________________

FACTORY AT R2

Resource 1 from R1 to R2: __________ miles x __________ tons = ________________

Final product from R2 to M: __________ miles x __________ tons = ________________

Total at R2 _________________________________________________________