

# NORTH DAKOTA Ag Mag

A Magazine about Agriculture for North Dakota Students



Fall 2021

# Soybeans

## Teacher Guide

This issue of the North Dakota Ag Mag focuses on soybeans. The information and activities are geared primarily toward the state's third, fourth and fifth graders. The Ag Mag is distributed three times per year. Subscriptions are free, but if you're not on the mailing list or if you know someone else who wants to be added, contact the North Dakota Department of Agriculture at 800-242-7535 or [ndda@nd.gov](mailto:ndda@nd.gov).

The magazine also is on the N.D. Agriculture in the Classroom website at [www.ndaginclassroom.org](http://www.ndaginclassroom.org).

This magazine is one of the N.D. Agriculture in the Classroom Council activities that helps K-12 teachers integrate information and activities about North Dakota agriculture across the curriculum in science, math, language arts, social studies and other classes. It's a supplemental resource rather than a separate program.

## Introduction

**Idea:** Before sharing this Ag Mag, ask students if they know what soybeans are and any of the things they're used for. Share the Agriculture Cycle of production, processing, distribution and consumption, and how you'll use this cycle to learn about soybeans.

## Answers to Soybean History

- 1100 B.C.** Chinese farmers raised soybeans
- 2002** On the International Space Station, soybean seeds were grown to become the first crop to complete a growth cycle in space
- 2021** Soy-based product to reduce dust on gravel roads developed at North Dakota State University
- 1765** Chinese soybean seeds were planted by a Georgia colonist
- 1992** Purdue University students invent soy crayons in a contest to develop new uses for soybeans
- 1940s** Soybean production grew because of the need for oils, lubricants, plastics and other materials during World War II
- 1937** Researchers at a university in Belgium develop a process for transforming vegetable oils, such as soybean oil, into fuels, such as biodiesel
- 1941** Henry Ford built a car with the body made primarily from soybeans rather than steel
- 1987** The Newspaper Association of America was looking for new ways to make ink beyond standard petroleum-based ink and came up with the solution of using soybean oil
- early 1900s** George Washington Carver studied growing soybeans and developed many products made from them

# Production

**Idea:** Grow soybeans in plastic cups or milk cartons to have students learn about the plant. Use the Bean Seed Cycle lesson plan from the National Agriculture in the Classroom at [www.agclassroom.org/matrix/lesson/79/](http://www.agclassroom.org/matrix/lesson/79/). This lesson also includes dissecting the seed and creating a bean book.

**Idea:** Grow soybeans in milk cartons or plastic cups under different growing conditions: light and dark; fertilized and unfertilized; watered too much, not enough and just the right amount; etc. Chart plant growth and compare plants grown under different conditions. Also, study the root systems to identify nodules that capture nitrogen for the plant.

## Answers to Soybean Math

1. If one 50-pound bag of soybean seed costs \$35 and a farmer needs 9 bags of seed to plant his field, how much will he spend on seed?

$$\text{\$35/bag} \times 9 \text{ bags} = \text{\$315}$$

2. If a farmer can plant 46 acres of soybeans in 1 hour, how many acres can she plant in an 11-hour day?

$$46 \text{ acres/hour} \times 11 \text{ hours} = 506 \text{ acres}$$

3. A soybean farmer can harvest 20 acres per hour. How many acres can a farmer harvest in 12 hours?

$$20 \text{ acres/hour} \times 12 \text{ hours} = 240 \text{ acres}$$

4. A farmer has 98 acres of soybeans and harvests 38 bushels per acre. How many bushels does he produce?

$$98 \text{ acres} \times 38 \text{ bushels/acre} = 3,724 \text{ bushels of soybeans}$$

5. The farmer takes 900 bushels of soybeans to elevator and sells them for \$9.83 per bushel. How much was he paid?

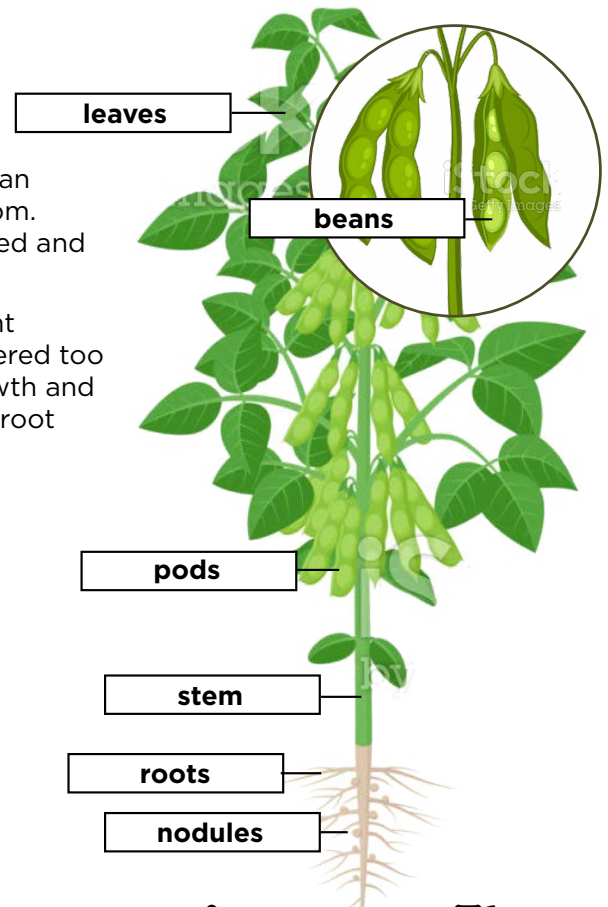
$$900 \text{ bushels} \times \$9.83/\text{bushel} = \$8,847$$

6. Another farmer harvested 2,260 bushels of soybeans from 72 acres. How many bushels per acre did she harvest?

$$2,260 \text{ bushels} \div 72 \text{ acres} = 31.4 \text{ bushels per acre}$$

7. A farmer's tractor uses 5.6 gallons of biodiesel per acre. How many gallons of biodiesel does he need to plant his 97 acres of soybeans?

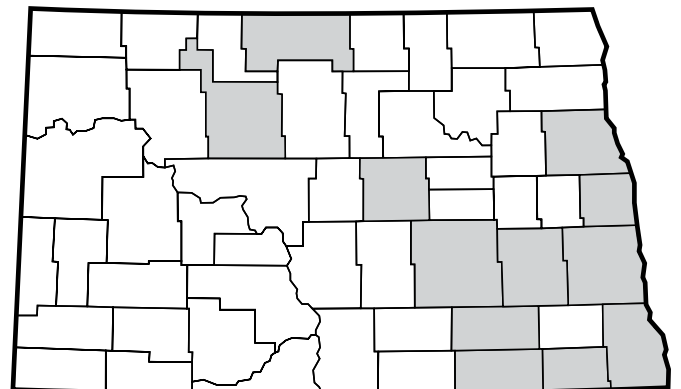
$$97 \text{ acres} \times 5.6 \text{ gallons per acre} = 543.2 \text{ gallons}$$



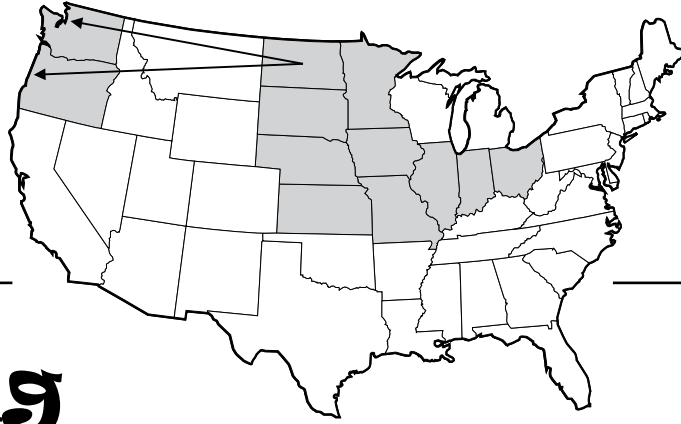
## Answers to The Soybean Plant

# Production

## Answers to North Dakota Soybean Production



## Answers to U.S. Soybean Production



# Processing

## Answers to Oil or Meal?

- Salad dressing
- Biodiesel
- M** — Chicken feed
- Shoe soles
- Paints
- M** — Dairy Cattle feed
- Lubricants
- Cleaners
- M** — Dog food
- Mayonnaise
- Carpet backing
- Tires
- M** — Textured vegetable protein

## Answers to Biodiesel

Biodiesel is fuel for many vehicles, including **trucks**, buses and tractors. It is usually made from soybean oil.

Biodiesel produces less air **pollution** than **petroleum** diesel. It reduces **smog** and makes our air **healthier** to breathe.

Biodiesel is **renewable**, which means we can always make more. Petroleum diesel comes from crude **oil**, a fossil fuel, and some day it may run out. Since biodiesel is made in the U.S., it also helps our country become energy **independent**.

## Answers to Soy Innovations

A soy innovation that:

1. Provides durability for long-lasting wear, excellent grip on a variety of surfaces and under different weather conditions, and enhanced traction. **F. Tires and running shoes**
2. Makes artificial turf backing strong and not affected by moisture. **A. Football fields and mini golf courses**
3. Reduces dust on gravel roads, construction sites and farms so improves air quality. **I. Soy-based dust suppressant**
4. Is used in all car seats the Ford Motor Company manufactures. **D. Soy foam**
5. Restores the flexibility and water-repelling qualities of shingles to extend roof life. **B. Soy-based sealer**
6. Requires less drying time, uses less water and produces less waste than conventional plywood glues. **G. Soy-based adhesive**
7. Removes oil, grease and other materials from different surfaces. **E. Soy cleaners and degreasers**
8. Burns longer and cleaner than many paraffin versions. **H. Soy candle**
9. Is used to print more than 90% of the nation's daily newspapers because it provides more accurate colors and makes it easier to recycle paper. **C. Soy ink**

**Idea:** Use the Generate Some Positive Energy with Biodiesel resources at <https://bit.ly/NBBHomeschoolResource>, which includes an energy curriculum, fact sheets, videos and an activity book.

**Idea:** Have students make their own soy lip balm. See instructions at <https://bit.ly/SoyLipBalm>.

**Idea:** Have students research George Washington Carver or Henry Ford and some of the products each developed.

**Idea:** Download pages of the USDA George Washington Carver Coloring and Activity Book from <https://bit.ly/CarverColoringBook>.

**Idea:** Make salad dressing to reinforce the idea that oil and water don't mix and to create a food product using both oil and water. This activity is used with permission from the Soybean Science Kit: Polymers and Oil, copyright 1997, Indiana Soybean Board and Purdue Research Foundation.

### Materials

For each student:

- clear or translucent film container
- vegetables for dipping

For each group of 4 to 6 students:

- 2 tablespoons (28 g) sugar
- 1 tablespoon (15 ml) vinegar
- 3 tablespoons (45 ml) soybean oil
- 2 tablespoons (30 ml) water
- 1.5 teaspoons (7.5 ml) ketchup

### Vocabulary

**mixture** — matter that can be separated into its parts by physical means

**solution** — a mixture that looks the same throughout

**soluble** — able to form a solution

### Activities

Divide the class into small groups of 4-6 members per group. Discuss the terms mixture and solution. Tell the students that they will each be making a small amount of salad dressing that they will use as a dip for vegetables after finishing the experiment. The recipe has many ingredients, including soybean oil and water. Ask the students what they predict will happen when the ingredients are combined or mixed. Will this mixture be a solution?

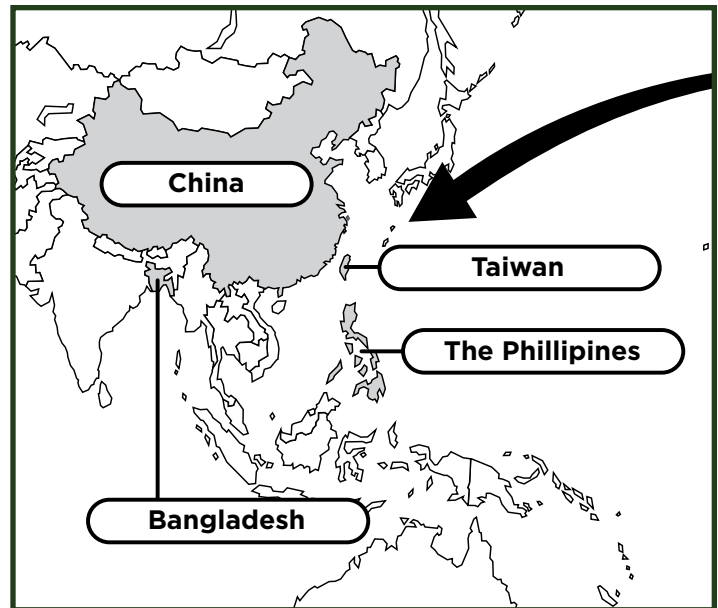
Allow the students to begin making the salad dressing according to the recipe given. Each student should add all the ingredients directly to his/her container. After adding each ingredient, the students should observe the mixture, shake 10 times and discuss whether they have made a solution.

The students first add sugar, then vinegar. After shaking, the sugar dissolves in the vinegar, creating a solution. The students then add oil to the container and shake. Is this a solution? (No.) The students should see a line of separation because vinegar and oil are immiscible (will not mix). Oil droplets also can be seen as a sign of insolubility. The students then will add water. They should now be able to see that there are three ingredients that have not mixed. After shaking, the vinegar will mix with the water because vinegar is water-based. The students will then add the ketchup and shake. What happened to the ketchup? It too is water-soluble, so it mixed with the other water-soluble ingredients. If the containers are left to sit a minute or so, the oil will again separate, and the students will see the water-soluble ingredients on the bottom of their containers and the soybean oil on the top. The students are now ready to shake up their salad dressing, dip their vegetables and enjoy eating this recipe of immiscible liquids.

**Idea:** Learn about Henry Ford's soybean car — <https://bit.ly/HenryFordSoyCar>

# Distribution

1. If a farmer produces 35 bushels per acre and the semi holds 1,200 bushels, the soybeans from how many acres will fill that semi? **1,200 bushels divided by 35 bushels per acre = 34 acres**
2. One train car can hold the soybeans from 4 large semi-trucks. A train that moves soybeans from North Dakota usually is 110 cars. How many semi-trucks of soybeans would it take to fill the 110-car train? **4 trucks/train car X 110 train cars = 440 semi-trucks**
3. A 110-car train can move more than 403,000 bushels (12,100 tons) of soybeans from North Dakota to the Pacific Northwest (ocean ports in Washington and Oregon). There the soybeans are transferred to an elevator then to a huge ocean-going freighter. The freighter holds 57,000 tons of soybeans. How many shuttle trains does it take to fill a freighter? **57,000 tons ÷ 12,100 tons/train = 4.7 110-car shuttle trains**
4. About 25% of North Dakota's soybeans are shipped to other states and about 4% stay in the state. The rest are exported to other countries. What percentage is exported? **25% + 4% = 29%, 100% - 29% = 71% of North Dakota's soybeans are exported**



**Idea:** Invite a local farmer or elevator manager to visit your classroom or visit their farm or elevator to learn how soybeans are grown, transported and stored. Call your NDSU Extension county office ([www.ndsu.edu/agriculture/extension/county-extension-offices](http://www.ndsu.edu/agriculture/extension/county-extension-offices)) or North Dakota Soybean Council (<https://bit.ly/NDSCstaff>) if you need assistance with connecting with local farmer or elevator.

# Consumption

1. The cooking oil labeled as (**vegetable** or vegetable) oil in the store probably is made from soybeans.
2. Read ingredients on the (Nutrison or **Nutrition**) Facts label to see if it says soybean oil.
3. Textured soy (proteen or **protein**) adds nutrition to spaghetti sauce, chili and other foods.
4. Soy sauce is a dark brown (**liquid** or likwid) made from soybeans that have undergone a fermenting process.
5. Soybeans that are soaked, ground fine and (straaned or **strained**) produce soy milk, which can be poured on cereal or used in a smoothie.
6. Edamame beans are soybeans that are harvested while they're still (**immature** or imachure) so they are softer and sweet tasting. Boil or steam them then eat the beans out of the pod.
7. Soy nuts can be (**sprinkled** or spinkeld) over salad to add crunch.
8. Bean curd, which is called (tofoo or **tofu**), often is included in Chinese foods.
9. Soy is an excellent source of (iurn or **iron**).
10. Soyfoods reduce the risk of heart (**disease** or dizeese).
11. Animals eat soybeans, too. About half of the soybean meal is fed to (poletry or **poultry**), such as chickens and turkeys.
12. About ¼ of the U.S. soybean meal is fed to (**swine** or swein), the scientific name for pigs.

**Idea:** Use the Simply Soy lesson at <https://bit.ly/NDSC-NDSUSimplySoy>. This educational program can be adapted to any age group, and it includes background information, a PowerPoint with notes, a bingo game, recipes and more.

**Idea:** Ask students to read food labels and bring to class foods that include soy products.

## Answers to Soybean Careers

1. Prepares fields, plants the seeds, provides nutrients and pesticides for the plants, harvests and sells the soybeans — **farmer**
2. Conducts research to improve soybean production or works with a farmer to improve their farm's production — **agronomist**
3. Studies insects that might harm soybean crops — **entomologist**
4. Purchases soybeans from local farmers to store until selling them to an exporter or processor — **elevator manager**
5. Transports soybeans from farm to elevator or elevator to processor — **truck driver**
6. Purchases soybeans from elevator or sometimes directly from farmers for processing or exporting — **buyer**
7. Runs the soybean processing plant to make sure the meal and oil are processed correctly — **crushing plant manager**
8. Combines soybean meal with other ingredients to make a nutritious feed for animals — **livestock nutritionist**
9. Sells soybeans to international customers — **exporter**
10. Cooks soy and other foods — **chef**

## General Soybean Resources

- Soybean Science, South Dakota Soybean Association – includes online interactive activities, student worksheets and teacher notes, on-farm field trip guide — <https://bit.ly/SDSoybeanScience>
- Spin into Agriscience, Ohio Soybean Council – includes leader's guide for germinating soybean seed necklaces, exploring why Nesquik is so quick, experiencing the colorful chemistry of soybeans, investigating soybean oil in microwaveable cakes, discovering the nature of soy ink, engineering a mock oil spill cleanup using EcoBots and soy chemistry — <https://bit.ly/GrowNextGenSpinIntoAgriscience>
- National Ag in the Classroom's National Agricultural Literacy Curriculum Matrix – search for soybeans to find Topsy-Turvy Soybeans, From Soybeans to Car Parts and other lessons, plus books, infographics and videos — <https://www.agclassroom.org/matrix/> – and student activities in the student section — <https://www.agclassroom.org/student/>
- Missouri Soybean Merchandising Council soybean activity booklet — <https://bit.ly/MOSoybeanSimonSoybean>
- GrowNextGen, Ohio Soybean Council – provides real-world educational tools to engage the next-generation workforce — <https://gownextgen.org/>
- Pod to Plate: The Life Cycle of Soybeans booklet — <https://bit.ly/ILsoyPodtoPlate>

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## Soybean Ag Mag Standards and Benchmarks

### English Language Arts and Literacy Content Standards for Reading Informational/Nonfiction Text

**Gr. 3, RI.1** Ask and answer questions to demonstrate understanding of a text (textual evidence), referring explicitly to the text as the basis for the answers.

**Gr.3, RI.2** Determine the main idea of a text and recount the key details to explain how they support the main idea.

**Gr.3, RI.3** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

**Gr.4, RI.1** Refer to details and examples in a text (textual evidence) when explaining what the text says explicitly and when drawing inferences from the text. Summarize the text.

**Gr.4, RI.2** Determine the main idea of a text and explain how it is supported by key details.

**Gr.4, RI.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

**Gr.5, RI.1** Quote accurately using textual evidence when explaining what the text says explicitly and when drawing inferences from the text. Summarize the text.

**Gr.5, RI.2** Determine two or more main ideas of a text and explain how they are supported by key details.

**Gr.5, RI.3** Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

## Craft and Structure

**Gr.3, RI.4; Gr.4, RI.; Gr.5, RI.4** Determine the meaning of general academic and domain specific words and phrases in a text relevant to a grades 3,4 and 5 topics or subject areas.

## North Dakota Mathematics Content Standards

### Operations and Algebraic Thinking

Understand properties of multiplication and the relationship between multiplication and division.

**3.OA.5** Apply properties of operations as strategies to multiply and divide (without the use of formal terms).

Number and Operations in Base Ten:

Use place value understanding and properties of operations to perform multi-digit arithmetic.

**4.NBT.5** Using strategies based on place value and the properties of operations, multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers.

Understand the place value system.

**5.NBT.1** Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.

Perform operations with multi-digit whole numbers and with decimals to hundredths.

**5.NBT.5** Fluently multiply multi-digit whole numbers using strategies flexibly, including the standard algorithm.

## Social Studies Content Standards

### Economics Standards:

Exchange and Markets

**E.3\_5.1** Utilize fundamental principles and concepts of economics to understand economic activity (e.g., needs and wants, goods and services, opportunity cost).

**E.3\_5.2** Describe how goods and services are produced and distributed.

National Economy

**E.3\_5.5** Describe and analyze how North Dakota's location, culture, and natural resources influence its economic decisions and development.

**E.3\_5.8** Describe how economics have changed over time.

### Geography Standards:

#### Geographic Representation

**G.3\_5.3** Use maps, satellite images, photographs, and other representations to explain relationships between the locations of places, regions, and their environmental characteristics.

Human and Environment Interactions

**G.3\_5.4** Explain how North Dakota regions have been influenced by physical and human characteristics.

### History Standards:

#### Cause, Effect, and Current Events

**H.3\_5.5** Describe multiple causes and effects of contemporary global events and developments in relation to North Dakota.

Connections, Contributions, Historical Sources, and Evidence

**H.3\_5.9** Explain how individuals and groups contributed to North Dakota.

## North Dakota Science Content Standards

### From Molecules to Organisms: Structures and Processes

**Performance Standard 3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all experience birth, growth, reproduction, and death.

**LS1.B:** Growth and Development of Organisms -Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.

**Performance Standard 4-LS1-1** Construct an argument that plants, and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

**LS1.A: Structure and Function** -Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Earth and Human Activity

**Performance Standard 4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

**ESS3.A: Natural Resources** -Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

**Matter and its Interactions** (Standard if making salad dressing from the Processing section in Teacher Guide)

**Performance Standard 5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

**PS1.B: Chemical Reactions** -When two or more different substances are mixed, a new substance with different properties may be formed.

### Ecosystems: Interaction, Energy, and Dynamics

**Performance Standard 5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

#### LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

-Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die.

Earth and Human Activity

**Performance Standard 5-ESS3-1** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

**ESS3.C: Human Impacts on Earth Systems** -Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. However, individuals and communities are doing things to help protect Earth's resources and environments.

### Health Education Content Standard (Using Consumption Resources)

**Standard 3:** Demonstrate the ability to access valid health information, products, and services.

**3.5.1** Identify characteristics of valid health information, products, and services

# North Dakota Agriculture in the Classroom Activities

This **Ag Mag** is just one of the North Dakota Agriculture in the Classroom Council projects. Each issue of the Ag Mag focuses on an agricultural commodity or topic and includes fun activities, bold graphics, interesting information and challenging problems. Send feedback and suggestions for future Ag Mag issues to:

Becky Koch  
NDSU Agriculture Communication  
701-866-6162  
becky.koch@ndsu.edu

Another council teacher resource is **Project Food, Land & People** (FLP). Using the national FLP curriculum, N.D. Ag in the Classroom provides 600-level credit workshops for teachers to instruct them in integrating hands-on lessons that promote the development of critical thinking skills so students can better understand the interrelationships among the environment, agriculture and people of the world. Teachers are encouraged to adapt their lessons to include North Dakota products and resources.

Project Food, Land & People's 55 lessons include:

- Amazing Grazing
- Cows or Condos?
- By the Way
- Seed Surprises
- Schoolground Caretakers
- Could It Be Something They Ate?
- What Piece of the Pie?
- and many more.

For information, contact:

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N.D. Farm Bureau Foundation  
701-799-5488  
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The N.D. Geographic Alliance conducts a two-day **Agricultural Tour for Teachers**. The tour includes farm and field visits, tours of agricultural processing plants to see what happens to products following the farm production cycle, and discussions with people involved in the global marketing of North Dakota farm products.

For information, contact:

Jeffrey Beck  
North Dakota Geographic Alliance  
701-240-9231  
jeff.beck@minot.k12.nd.us

Educators may apply for **mini-grants for up to \$500** for use in programs that promote agricultural literacy. The Agriculture in the Classroom Council, working with the N.D. FFA Foundation, offers these funds for agriculture-related projects, units and lessons used for school-age children. The mini-grants fund hands-on activities that develop and enrich understanding of agriculture as the source of food and/or fiber in our society. Individuals or groups such as teachers, 4-H leaders, commodity groups and others interested in teaching young people about the importance of North Dakota agriculture are welcome to apply.

Examples of programs that may be funded: farm safety programs, agricultural festivals, an elementary classroom visiting a nearby farm and ag career awareness day. Grant funds can be used for printing, curriculum, guest speakers, materials, food, supplies, etc. More ideas and an application are at [www.ndaginclassroom.org](http://www.ndaginclassroom.org).

For information, contact:

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Agriculture Commissioner  
Doug Goehring