

Soybeans

Teachers 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. Three issues of the Ag Mag are developed each school 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.

The magazine also is on the N.D. Agriculture in the Classroom website at www.ndda.nd.gov/aitc.

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

- 2002** On the International Space Station, soybean seeds become the first crop to complete a growth cycle in space.
- 1765** Chinese soybean seeds are first planted in North America by a Georgia colonist.
- 2024** SoyFoam, a biodegradable product that can extinguish fires, hits the market for firefighters.
- 1992** Purdue University students invent soy crayons in a contest to develop new uses for soybeans.
- 1940s** Soybean production grows 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 comes up with the idea of using soybean oil to make ink instead of petroleum during the oil crisis.
- early 1900s** George Washington Carver studies growing soybeans and develops many products made from them.
- 1100 B.C.** Chinese farmers raise soybeans.

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/. 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. A farmer has one soybean field that's 220 acres, another that's 380 acres and another that's 290 acres. How many total acres of soybeans does he have?

$$220 \text{ acres} + 380 \text{ acres} + 290 \text{ acres} = 890 \text{ acres}$$

2. A farmer has a 530-acre soybean field, but grass grows in an 11-acre wash that flows through the field. On how many acres can she grow soybeans?

$$530 \text{ acres} - 11 \text{ acres} = 519 \text{ acres}$$

3. If one unit of soybean seed (about 140,000 seeds) costs \$56 and a farmer needs 8 units of seed for his field, how much will he spend on seed?

$$\$56 \text{ per unit of seed} \times 8 \text{ units} = \$448$$

4. If a farmer can plant 6 acres of soybeans in 1 hour, how many acres can she plant in 13 hours?

$$6 \text{ acres per hour} \times 13 \text{ hours} = 78 \text{ acres}$$

5. A soybean farmer can harvest 15 acres per hour. How many acres can he harvest in 9 hours?

$$15 \text{ acres per hour} \times 9 \text{ hours} = 135 \text{ acres}$$

6. A farmer has 112 acres of soybeans and harvests 38 bushels per acre. How many bushels does the farmer produce?

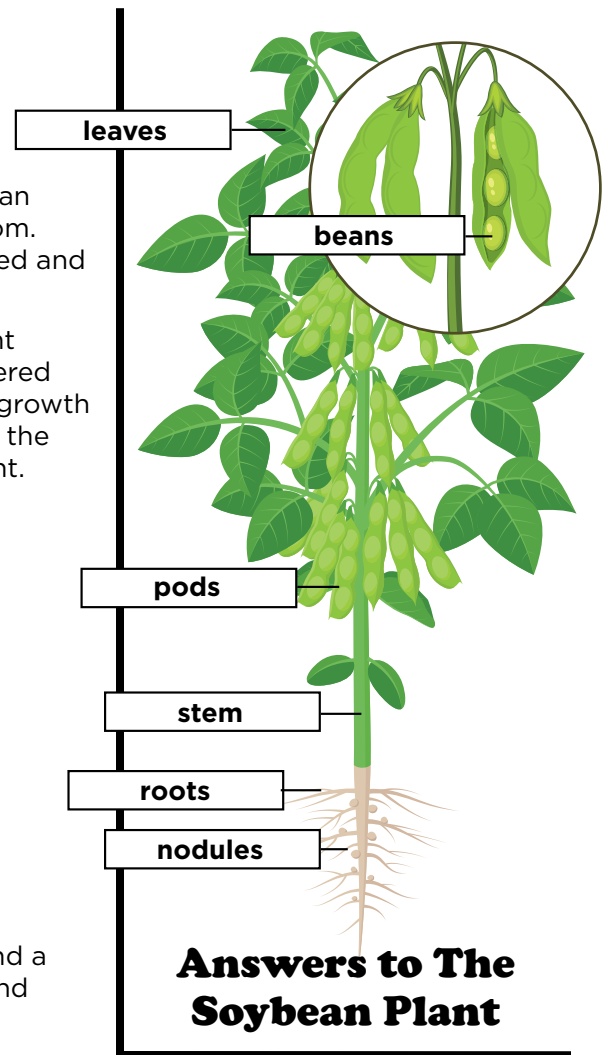
$$112 \text{ acres} \times 38 \text{ bushels per acre} = 4,256 \text{ bushels}$$

7. The farmer takes 950 bushels of soybeans to the elevator and sells them for \$9.77 per bushel. How much was the farmer paid?

$$950 \text{ bushels} \times \$9.77 \text{ per bushel} = \$9,281.50$$

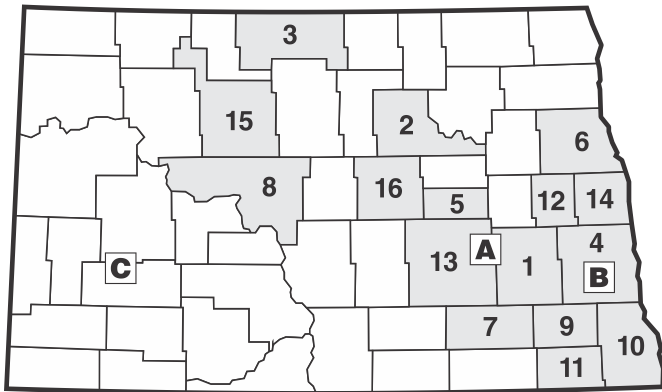
8. A farmer harvested 2,580 bushels of soybeans from 80 acres. How many bushels per acre did that farmer harvest?

$$2,580 \text{ bushels} \div 80 \text{ acres} = 32.25 \text{ bushels per acre}$$

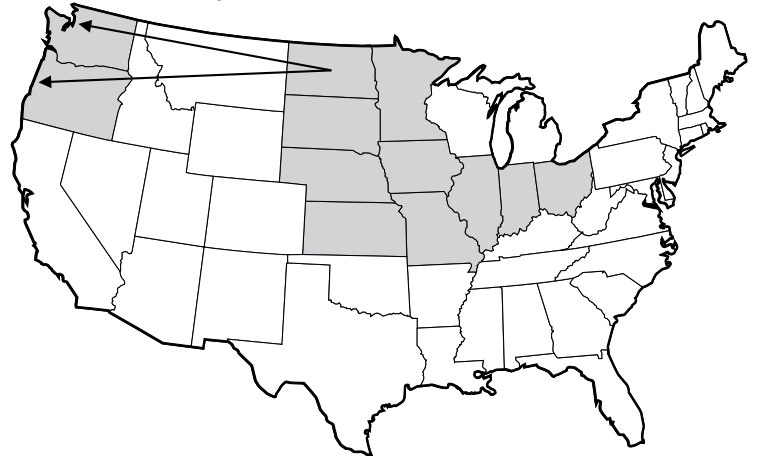


Production

Answers to North Dakota Soybean Production



Answers to U.S. Soybean Production



Processing

Answers to Soybean Processing

North Dakota has two soybean processing plants: the Green Bison Soybean Processing plant at Spiritwood and the North Dakota Soybean Processors plant at Casselton. They're called 1. **crush** plants because soybeans are crushed to break down the 2. **whole** soybeans into soybean oil and soybean meal.

The oil is used in 3. **cooking** and food production; in industry such as for 4. **printing inks**, paints, plastics, cleaners and candles; and to make 5. **renewable diesel**, a fuel that can replace petroleum diesel. The soybean meal is used to make 6. **animal feed**, soy flour and firefighting SoyFoam.

The oil from Green Bison is processed into renewable diesel at the Marathon 7. **refinery** in Dickinson.

These new crush plants allow North Dakota farmers to sell their soybeans closer to home to reduce 8. **transportation** costs and help meet the growing 9. **demand** for animal feed and renewable fuel.

Answers to Soy Innovations

1. This bio-based foam made from soy helps put out wildfires in a safe, eco-friendly way.
F. Firefighting SoyFoam
2. Many NFL and college teams use soy-based materials for this surface.
C. Football field turf
3. Automakers and athletic brands use soy to create durable rubber-like materials for these items.
E. Tires and running shoes
4. This cleaner, longer-burning alternative to paraffin wax is made from soy oil.
H. Soy candle
5. An alternative to petroleum-based glues, this soy product is used in making wood products like plywood.
G. Soy-based adhesive
6. This safe biodegradable option breaks down grease and grime in industrial and household settings.
A. Soy-based cleaners and degreasers
7. By sealing and waterproofing rooftops, this soy product protects homes and buildings.
D. Soy-based sealer
8. This sustainable lubricant made from soy oil keeps chainsaws running smoothly.
B. Soy-based bar and chain oil

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: 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.

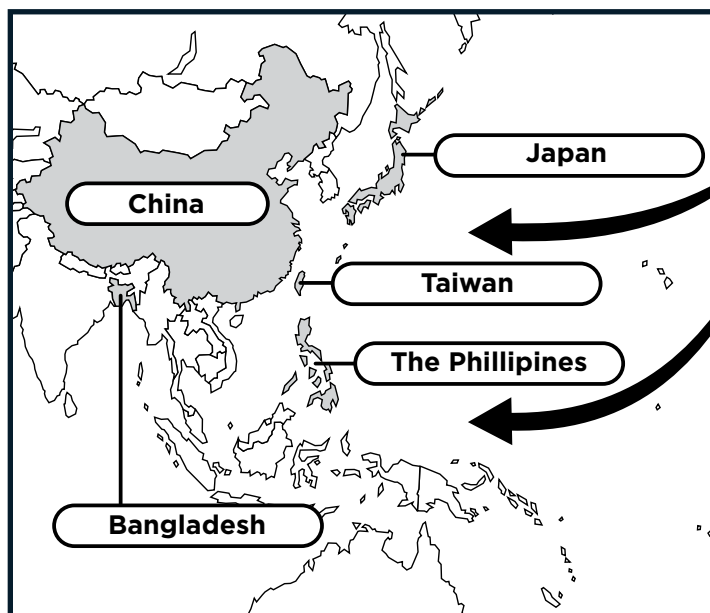
The students first add sugar, then vinegar. After shaking, the sugar dissolves in the vinegar, creating a solution. The students then add oil to the container and shake. Is this a solution? (No.) The students should see a line of separation because vinegar and oil are immiscible (will not mix). Oil droplets 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

Answers to Exporting Soybeans

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) or North Dakota Soybean Council (<https://bit.ly/NDSCstaff>) if you need assistance.



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 nachos, 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**), is used in a variety of Asian foods.
 9. Soy is an excellent source of (iurn or **iron**).
 10. Soy lecithin is an emulsifier, meaning it helps combine ingredients that (**typically** or typicly) don't mix well, like oil and water.
 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), another name for pigs or hogs.
- 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.
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Answers to Soybean Careers

- H** Prepares fields, plants the seeds, provides nutrients and pesticides for the plants, harvests and sells the soybeans — **farmer**
- B** Conducts research to improve soybean production or works with a farmer to improve their farm's production — **agronomist**
- E** Studies insects that might harm soybean crops — **entomologist**
- A** Purchases soybeans from local farmers to store until selling them to an exporter or processor — **elevator manager**
- D** Transports soybeans from farm to elevator or elevator to processor — **truck driver**
- G** Purchases soybeans from elevator or sometimes directly from farmers for processing or exporting — **buyer**
- I** Runs the soybean processing plant to make sure the meal and oil are processed correctly — **crush plant manager**
- F** Combines soybean meal with other ingredients to make a nutritious feed for animals — **livestock nutritionist**
- C** Sells soybeans to international customers — **exporter**

General Soybean Resources

- Soybean Science, South Dakota Soybean – includes online interactive activities, student worksheets and teacher notes, on-farm field trip guide — <https://sdsoybeanscience.org>
- 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://agclassroom.org/ag-games/>
- GrowNextGen, Ohio Soybean Council — provides real-world educational tools to engage the next-generation workforce — <https://gownextgen.org/>
- Nourish the Future — STEM curriculum developed by science teachers for science teachers — <https://nourishthefuture.org>
- EducationProjects.org — science lessons, connections with industry experts, free supplies and more — <https://educationprojects.org/teachers>
- North Dakota Soybean Council Resources: <https://ndsoybean.org/educational-resources/>
 - The Spectacular Life of a Soybean
 - A Day with Captain Soybean
 - Where Do They Go? The Story of Suzie Soybean
- ND Agriculture in the Classroom — resources, partnerships, programs and more — www.ndda.nd.gov/aitc

Soybean Ag Mag Standards and Benchmarks

Math Standards

4.NO.NBT.5 Multiply a whole number of up to four digits by a one-digit whole number and multiply two two-digit numbers. Show and justify the calculation using equations, rectangular arrays, and models.

4.AR.OA.3 Solve multi-step authentic word problems using the four operations, including problems with interpreted remainders. Represent problems using equations, including a symbol as an unknown.

English Language Arts Standards

4.F.8 Decode words using the combined knowledge of syllabication patterns and morphology in context and out of context: a. multisyllabic word construction and division that includes: • open syllables • closed syllables • complex closed syllables • long vowel: VCe • vowel-r syllables • vowel team syllables • consonant -le syllables • syllable division principles (VC/CV, V/CV, etc.) b. inflectional endings c. Latin and Greek roots

4.F.9 Encode words using the combined knowledge of syllabication patterns and morphology in context and out of context: a. multisyllabic word construction and division that includes: • open syllables • closed syllables • complex closed syllables • long vowel: VCe • vowel-r syllables • vowel team syllables • consonant -le syllables • syllable division principles (VC/CV, V/CV, etc.) b. common Latin roots c. inflectional and derivational endings d. schwa

4.F.10 Determine the meaning of unknown and multiple-meaning words and phrases, choosing from a range of strategies with varying texts (e.g., synonyms, antonyms, homophones, and homographs).

4.F.11 Accurately interpret general academic and domain-specific words and phrases. Fluency Learners will read with sufficient accuracy, rate, and expression to support comprehension.

4.F.12 Read accurately and automatically a variety of fourth-grade texts using expression, phrasing, purpose and understanding.

4.R.5 Determine the meaning of unknown and multiple-meaning words and phrases within a text.

4.R.1 Comprehend information during and after listening to a grade-level text.

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:

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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.

For information, contact:

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Feeding and Fueling the World is a two-day immersive professional learning event for high school and middle grade science teachers. This farmer-funded program in Fargo in June 2026 teaches science through agriculture with curriculum materials on plant science, animal science, water/soil quality and more. The program features the hands-on workshop, field trip and dinner with industry experts. Free registration includes meals, hotel stay and hundreds of dollars' worth of classroom supplies. Visit www.nourishthefuture.org this spring to register or send an email to connect@nourishthefuture.org

For information, contact:

Zack Bateson
National Agricultural Genotyping Center
701-239-1452
zack.bateson@genotypingcenter.com

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.

For information, contact:

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