

High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 1 – The Science of Soybean Production



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Videos or Distributing the Soybean Uses Fact Sheet.....	4
IV.	Viewing, Discussion or Reading Guide.....	4
V.	Discussion Guide.....	5
VI.	Suggestions for Lab/Active Learning.....	5
VII.	Assessment and Evaluation.....	6
VIII.	Suggestions for Extended Learning and Research.....	6
	Student Proficiency Standards.....	7



I. Knowledge Base:

Arkansas is among the top 10 producers of soybeans in the United States. Soybeans are not native to Arkansas or to the Midwest. A brief history of soybeans in Asia and the United States will be explored. Students will learn how soybeans are grown and produced, including their many uses in the food, fuel and feed industries. Soybean production and use play an important and beneficial role in the Arkansas agricultural industry and economy.

Learning Objectives:

As a result of completing this module students will:

- Learn how soybeans are grown and produced in Arkansas.
- Know that soybeans are used in the food, fuel and feed industries.
- Understand the importance of soybeans to the Arkansas agricultural industry and its economy.
- Know how George Washington Carver, a world-renowned agricultural scientist, discovered the important role that soybeans have in preserving soil through nitrogen fixation, which helps to improve soil and brought the South out of the dust bowl of the 1930's.

II. Teacher Background Materials:

All of the videos and other materials in this module can be used as a separate activity during your science classes.

Soy Bean Science Challenge Overview

The Soybean Science Challenge Opening Video provides an overview of the Soybean Science Challenge and its goals. This educational project is funded by the Arkansas Soybean Promotion Board was developed by the University of Arkansas Cooperative Extension Service. The video covers module content, video lessons and activities, quizzes and additional resources included in the course. High school students who successfully complete the course will be eligible to compete for cash awards at participating Arkansas science fairs. The video covers soybean facts, uses, products, and a brief history.

History

Nitrogen Fixation is a short video which emphasizes the significant role that George Washington Carver, a world-renowned agricultural scientist, played in revolutionizing agriculture in the United States. Carver, who earned a Master's Degree in bacterial botany and agriculture, made the important discovery that fields could be fertilized with nitrogen. This fertilization was done by rotating cotton planting every other year with soybeans and other legumes. This discovery helped increase soybean production in the United States. Soybeans are now used in abundance for a variety of products, including animal food, human food, and industrial products.



Soybean Industry in Arkansas

The Arkansas Soybean Promotion Board Educational Video provides an overview of the soybean industry in Arkansas and discusses the large economic impact that the soybean industry has in Arkansas. The very significant role that the Arkansas Soybean Promotion Board serves in assisting large and small farms is emphasized. This board is responsible for managing the check-off funds provided by Arkansas soybean farmers. The impact of soybean usage products in Arkansas and around the world is a major focus of the video. Arkansas is the third largest consumer of soybean meal in the nation. Because of its versatility in food, fuel, and feed, soybeans are often referred to as The Miracle Bean. Harvesting the potential of soybeans is a continuous theme in this video.

Soybean History, Facts and Uses

Soybean Uses is a four-page fact sheet that defines soybeans, gives the pertinent soybean-related vocabulary and details briefly the history of soybean production in the United States. This fact sheet also spotlights careers in agriculture related to soybeans, along with listing soybean oil and soybean meal consumption in the United States through 2011. Some examples of products made from soy are:

- Animal feed
- Cooking oils
- Diesel fuel
- Plastics
- Tofu
- Insulation
- Bread

This fact sheet can be used as a handout in your science class as a separate activity to generate discussion on soybean related topics.

Vocabulary

crop rotation: the practice of growing different crops in succession on the same land chiefly to preserve the productive capacity of the soil.

cultivar: a variety of plant that has been created or selected intentionally and maintained through cultivation.

embryo: part of a seed that develops into a new plant, including the stem, leaves and roots.

exports: products or items that the U.S. sells and sends to other countries. Exports include raw products like whole soybeans or processed products like soybean oil or soybean meal.



fertilizer: any substance used to fertilize the soil, especially a commercial or chemical manure.

flowers: small purple or white flowers appear on the plant and can grow into small pods of soybeans.

George Washington Carver: United States botanist and agricultural chemist who developed many uses for peanuts, soybeans and sweet potatoes (1864-1943).

hilum: the scar on a seed marking the point of attachment to its seed vessel (the brown spot).

leaflets: sub-part of leaf blade. All but the first node of soybean plants produce leaves with three leaflets.

leaves: grow in groups of three called trifoliates.

legume: a legume is a plant in the family Fabaceae, or the fruit or seed of such a plant bearing nodules.

nitrogen fixation: the chemical processes by which atmospheric nitrogen is assimilated into organic compounds, especially by certain microorganisms as part of the nitrogen cycle.

nodules: place on stem where leaves, branches and flowers are attached.

pods: a structure that holds seeds. Each pod typically holds 3-4 beans.

radicle: the lower part of the axis of an embryo, the primary root.

rhizobium bacteria: microorganisms involved in nitrogen fixation; a rhizome is a plant that has a continuously growing underground system.

roots: the underground part of a seed plant body.

seed coat: outside cover that protects the seed.

soybean: a leguminous plant native to Asia, *Glycine max*, widely cultivated for its edible seeds.

soybean oil: a pale yellow oil derived from soybeans by expression or solvent extraction. Used as a food and in the manufacture of soap, candles, inks, paints, varnishes, etc.

stem: the main trunk of the soybean plant which supports the leaves, flowers and pods

taproot: a main root descending downward from the radicle and giving off small lateral roots.

trifoliolate: having three leaflets.



III. Before Viewing the Videos or Distributing the Soybean Uses Fact Sheet:

1. Have students take the soybean knowledge pre-test before starting this lesson.
2. Choose which soybean-related educational materials you will use during your science class.
3. Ask students what they know about soybeans and soybean production in Arkansas.
 - Facilitate a general discussion based on student responses to questions.

IV. Viewing, Discussion or Reading Guide:

Soy Bean Science Challenge Overview:

1. Ask students if they understand the Soybean Science Challenge course and how to complete the course in order to be eligible to have their projects judged at the regional or state science fair. Clarify and correct any misinformation for those students who might be interested in completing the course and submitting a soybean-related science project for judging at a regional fair.

Soybean History

1. Ask students to share what they know about George Washington Carver.
 - If so, ask for details about his discoveries or life.
2. Ask students to name two famous people who contributed to the discoveries of the uses of soybeans (George Washington Carver and Henry Ford.)
3. Ask students how nitrogen fixation works.
4. Ask students to detail the introduction of soybeans to the United States.

Soybean Industry in Arkansas

1. Ask students why the soybean is often referred to as The Miracle Bean.
2. Ask students why soybeans are so important to Arkansas farmers and our state economy.
3. Ask students how many jobs in Arkansas are related to agriculture.
4. Ask students to identify how many science-based careers are available and necessary to support Arkansas' agriculture industry. Examples include: Agronomist, Bio-Pharmaceutical Engineer, Entomologist, Extension Agent and Specialist, Food Scientist, Nutritionist, and Plant Pathologist.



Soybean Facts and Uses

1. Ask students to define soybeans and identify the structure and functions of a soybean plant.
2. Ask students to identify soybean uses in their everyday life.
3. Have students take notes on videos or use the “Soybean Uses” fact sheet as a reference.
 - Note specific information on soybeans and their production and use in Arkansas and the United States.
 - Note that soybeans are used in the food, fuel, and feed industry.
 - Note the importance of soybeans to the Arkansas agricultural industry and its economy.
 - If using the Nitrogen Fixation Video, note the significant role that George Washington Carver played in discovering how important soybeans are in preserving soil through nitrogen fixation.

V. Discussion Guide:

1. Review the pre-test with students to see how they did and what the correct answers are to questions they missed.
2. As a group or individually, review the information students noted about soybean production and use in Arkansas and the United States.
3. If using the “Nitrogen Fixation” video, ask students what they noted about George Washington Carver. If there is any misinformation about him or the nitrogen fixation process, correct this.

VI. Suggestions for Lab/Active Learning:

1. Teach the students about “nitrogen fixation.” Use a sample rhizome in the classroom or draw a picture of a main (radical) root of a legume plant then point to the nodules. Students could copy your module and then explain the process to each other in pairs.
2. Use the “Science at Home – Mighty Seeds” lab activity in the Soybeans – Description, Uses, Production, Careers, Statistics handout in the Teacher In-Service course or Resources Guide in Module 1 under Lesson Activity.



VII. Assessment and Evaluation:

1. Have students take the pre-test at the beginning of the module.
2. Have students take the quiz at the end of the module.

VIII. Suggestions for Extended Learning and Research:

Below are additional opportunities for students to work individually or in small groups:

1. Research the statistics on how many acres of soybeans are raised in their county in Arkansas and in the United States. Determine how many soybeans from Arkansas are exported.
2. Research the dollar value of the soybean crop to Arkansas farmers.
3. Research additional discoveries of George Washington Carver that are related to agriculture; share findings with class.
4. Find an Extension agricultural specialist or Arkansas Soybean Promotion Board member in your area to come into your class and talk about the soybean production process and other related soybean topics.



Student Proficiency Standards – The Science of Soybean Production

The Arkansas student education core proficiency standards below can be met by teaching “**The Science of Soybean Production.**”

Biology: Grades 9-12

Classification & Diversity of Life

Content Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.17: Describe the structure and function of the major parts of a plant.

CDL.7.B.19: Evaluate the medical and economic importance of plants.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

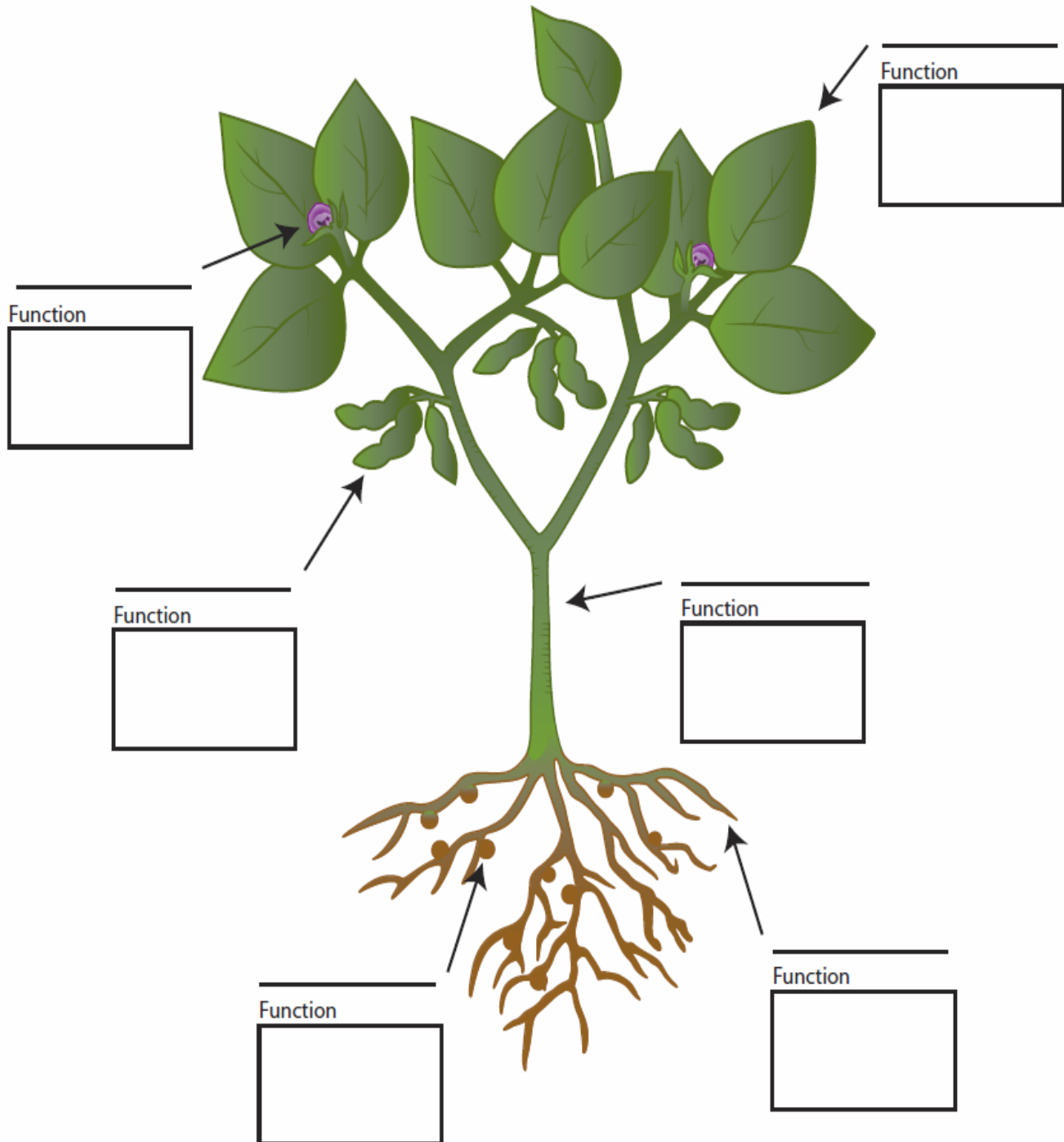
Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

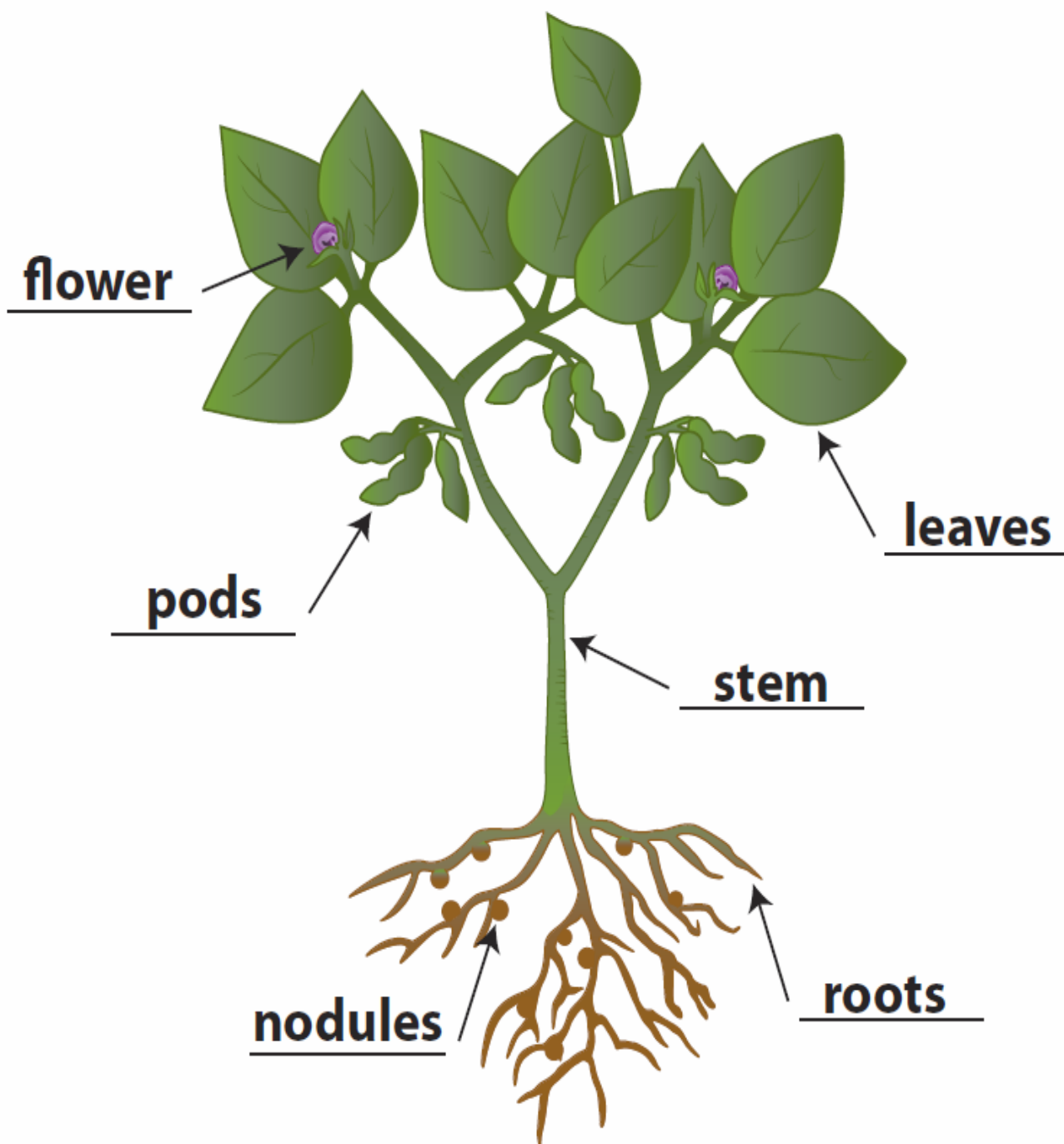
NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 2 – The Miracle Bean: Food



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Videos, Using the Power Point or Interactive Lessons.....	3
IV.	Viewing, Discussion or Reading Guide.....	3
V.	Discussion Guide.....	4
VI.	Suggestions for Lab/Active Learning.....	4
VII.	Assessment and Evaluation.....	4
VIII.	Suggestions for Extended Learning and Research.....	5
	Student Proficiency Standards.....	6



I. Knowledge Base:

Soybeans are a very important crop to the Arkansas economy. Soybeans are a food source for humans and also help to preserve the soil. Humans consume soybean products such as soy milk, edamame, salad dressings, miso, soy bars, soy nuts, soy sauce and tofu. Soy is also used in mayonnaise, high fiber breads such as pizza crust, and in many other recipes. Soybeans are an excellent source of protein and have been grown and consumed by other cultures for thousands of years. Soybeans are also 18-20% oil, so the oil can be extracted and used in salad or cooking oil and other edible products.

Learning Objectives:

As a result of completing this module, students will:

- Know the history and importance of soy as a human food source.
- Be able to identify soy products for human consumption.
- Recognize the health benefits of consuming soy products.
- Understand the value of soy.
- Understand projections for future food requirements.
- Understand the current value of soy in addressing world hunger.

II. Teacher Background Materials:

All of the videos and other materials in this module can be used as a separate activity during your science classes.

Instruction Plan for PowerPoint Soybean Lesson: Food provides the instructions for using the PowerPoint lesson on food, including the pre-test and post-test quizzes and activity. Both quizzes are in the **Lesson Quiz** section, along with the answer keys. The activity plan and handout is under **Additional Resources**.

The Soybean Lesson: Food is a PowerPoint designed to be used in class by the teacher. There are presentation notes at the bottom of each slide with directions for various student classroom activities and discussions. The lesson provides a brief explanation of the soybean planting process and emphasizes the diversity of soybean usage in food/human consumption, the health benefits of eating soy and how soy products can be used as substitutes for other items in recipes.



National Soybean Research Laboratory Presentation on World Hunger (SOY NSRLhunger) is a PowerPoint produced by NRSL in collaboration with WISHH (World Initiative for Soy in Human Health). These organizations help fill the world's growing protein requirement through soy. The program describes the dire condition of hunger around the world and depicts the important role that soy plays as a protein supplement in foods. This program can be used individually or as part of a classroom lesson on world hunger and soy.

Food for the Future: Interactive Lesson is another activity which can be self-directed or used as part of a classroom assignment. Students can build the soy products used to make a stir fry and also will learn about how soybeans are planted and processed into a variety of foods for people and animals.

Harvesting the Potential: Food for the Future Video is presented by the Arkansas Soybean Promotion Board and produced by the Agricultural Education, Communications and Technology Department, U of A Division of Agriculture. The focus is on Arkansas soybeans and how they are processed, produced and used as food. Dr. Cindy Moore, a clinical assistant professor in dietetics at the University of Arkansas explains why soy foods are part of a healthy diet. This video can be used individually or in the classroom.

Have Your Bean and Eat It Too is a podcast featuring Shawn Peeples, an Arkansas edamame producer. Peeples explains the process of growing organic edamame and says that growing edamame is not much different than growing soybeans, but it is more intensive so in that respect it is more like growing a vegetable crop. He talks about how the harvesting process for edamame is different from soybeans and advises edamame growers to be very proactive when identifying problems such as insects. This podcast was produced by the U of A System Division of Agriculture and was funded in part by the Arkansas Soybean Promotion Board.

Soy Food: Fabulous Food for Fueling Future Freshmen is a podcast featuring Dr. Navam S. Hettiarachchy, researcher at the University of Arkansas, who talks about research on food products which can be made from soybeans. Dr. Hettiarachchy's focus is on the use of soybeans in providing health benefits. She reviews several varieties of soybean seeds and covers the antioxidant benefits of each. This podcast was produced by the UofA System Division of Agriculture and was funded in part by the Arkansas Soybean Promotion Board.

Additional Resources provides a supplemental instruction plan and activity, recipes and soy substitutions handouts for further study on the use of soybeans as food. UofA, Cooperative Extension Service Podcasts and other related materials are also included.



Vocabulary

edamame: a dish of green soybeans boiled or steamed in their pods.

isoflavones: a phytoestrogen produced chiefly by plants of the legume family, especially soybeans, potentially useful in lowering cholesterol and in treating some cancers.

miso: a fermented soybean paste with a rich, complex flavor. Some people liken the flavor to mushrooms or wine. Grains, such as barley or rice, may also be used when making miso. Generally, a lighter color miso has a milder flavor. Red miso is a rich red-brown color and is traditionally used as the base for miso soup.

protein: a component of all living cells that is necessary to the function of an organism, essential for the growth and repair of tissue.

soy flour: made from soybeans that have been processed into flakes then ground into flour. Because soy flour does not contain gluten, it is usually used with wheat flour.

soy milk: a plant milk produced by soaking dry soybeans and grinding them with water.

soy nuts: actually mature soybeans that have been soaked and roasted. These crunchy “nuts” are often salted or flavored.

soy protein: the highest nutrient component (36%) of the soybean which makes soybeans such a valuable food source.

tofu: bean curd made from mashed soybeans, widely used in Asian cooking.

III. Before Viewing the Videos, Using the PowerPoint or Interactive Lessons:

1. Ask students what they know about how soybeans or soy products are used in food.
2. List their responses on the blackboard or other venue so the responses can be referred to after the videos, PowerPoint presentation, or interactive lessons.

IV. Viewing Guide:

1. Have students make a list of the way “The Miracle Bean” is used in food.
2. Have students who view the SOY NSRLhunger PowerPoint make a list of how soy protein is being used around the world as a food supplement. Students could complete an additional research project individually or in groups on hunger world-wide and the possible solutions soy protein might present.



V. Discussion Guide:

1. Ask students which foods they regularly eat that have soy in them based on what they have learned from the PowerPoint presentation, the videos, or the interactive lessons.
2. Ask students to look at the foods they have at home and bring back a list of those that have soy products in them.
3. Ask students what they knew about the world-wide hunger issue before viewing the PowerPoint and what they have now learned about the use of soy protein as a food supplement.
4. Have students identify where the countries are located which are mentioned in the SOY NSRlhunger PowerPoint and discuss what they learned about the severity of the hunger issue there.
5. Ask students to discuss what types of science projects could be conducted related to soy foods.

VI. Suggestions for Lab/Active Learning:

1. Instruct students on how to make soy milk using the video “Milk without the Cow...the Smell...How to Make Homemade Soy Milk.” This relatively simple process can be replicated using a fairly basic array of tools, sugar, water, and soybeans.
2. Research www.ChooseMyPlate.gov for the USDA dietary guidelines. Soy foods can fit nutritionally in all food groups. Investigate the process and design a good plate alternative.

VII. Assessment and Evaluation:

1. Have students take the pre-test and the quiz in Module 2.
2. Assign and grade essays or individual or group projects on the uses of soy products in food for human consumption.
3. Assign research on the countries with hunger-related nutritional issues in the SOY NSRlhunger PowerPoint.
4. An informal assessment of student comprehension can be made based on student participation in discussions and completion of interactive lessons.



VIII. Suggestions for Extended Learning and Research:

1. Have a farmer who grows soybeans visit the class and talk about how soybeans are grown and processed for food.
2. Take a field trip to a soybean farm with a farmer to discuss the growing process and how soybeans are used.
3. Provide samples of edamame to class. Have students bring in examples of soy products they have at home.
4. Research the use of soybean as food or food supplements.
5. Try some of the soy recipes that are provided in the lessons and the Additional Resources section.
6. Research the world food requirements over the next 20/50/100 years and identify and discuss what role soybean production might play in sustainability strategies.



Student Proficiency Standards – The Miracle Bean: Food

The Arkansas student education core proficiency standards below can be met by teaching “**The Miracle Bean: Food.**”

Biology: Grades 9-12

Classification & Diversity of Life

CDL.7.B.19: Evaluate the medical and economic importance of plants.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 3 – The Miracle Bean: Fuel



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Videos or Using Other Resource Materials.....	2
IV.	Viewing or Reading Guide.....	3
V.	Discussion Guide.....	3
VI.	Suggestions for Lab/Active Learning.....	3
VII.	Assessment and Evaluation.....	3
VIII.	Suggestions for Extended Learning and Research.....	4
	Student Proficiency Standards.....	5



I. Knowledge Base:

Soy Biodiesel is an alternative fuel playing an increasingly significant role in agriculture, manufacturing and other fields. Soy biodiesel is a high performing diesel fuel made from soybeans. It contains no petroleum, but can be blended at any level to create a soy biodiesel blend. Soy diesel is clean, non-toxic and 100% bio-degradable, renewable and made in the United States. Soy biodiesel can help America reduce its dependence on foreign oil and create more jobs.

Learning Objectives:

As a result of completing this module, students will:

- Know the benefits of using soy biodiesel fuel when possible.
- Understand the future impact of using soy biodiesel fuel as an energy source.
- Explore further uses of soy biodiesel.
- Recognize how soy products can be processed into biofuel.

II. Teacher Background Materials:

All of the videos and other materials in this module can be used as a separate activity during your science classes.

Instruction Plan for PowerPoint Soybean Lesson: Fuel provides the instructions for using the PowerPoint lesson on fuel, including the pre-test and post-test quizzes and activity. Both quizzes are in the **Lesson Quiz** section, along with the answer keys. The activity plan and handout is under **Additional Resources**.

PowerPoint Soybean Lesson: Fuel covers the environmental, engine and economic benefits of using soy-based biofuels. The lesson describes the composition of biodiesel fuel and explains how soy products are processed into biofuel. It also demonstrates how conventional fuels can be harmful to the environment and provides environmental incentives for using alternative fuel sources. The lesson also explains the basic transesterification process which is how methanol and a catalyst are converted into biodiesel fuel. There is a small group classroom activity which is included at the end of the lesson.

Fueling the Future: Interactive Lesson focuses on the benefits of using biodiesel fuel. It includes a short video, “Pumped Up on Biodiesel.” The video showcases the positive attributes of biodiesel fuel and was produced by the Illinois Soybean Association. Interactive activities on making biodiesel fuel are included.

Harvesting the Potential, Fueling the Future is a short video presented by the Arkansas Soybean Promotion Board and produced by the Agricultural Education, Communications and Technology Department at the U of A Division of Agriculture. This video explains the production and use of



soy oil for biodiesel. Dr. Don Johnson, a biodiesel researcher at the U of A shares information about soybean-based biodiesel. The process for making biodiesel using transesterification is also described, along with the advantages and benefits of bio diesel.

Biodiesel Production Process is a graphic diagram of the process developed by the National Soybean Research Laboratory and the University of Illinois at Urbana. It can be used as a handout in class.

Additional Resources:

Classroom Instruction Plan Activity is a supplemental group classroom exercise on biodiesel fuel, which is a complement to the power point lesson on fuel.

Oil Crops: Oil Production Table can be used as a handout to show which oil comes from what crop and how many gallons of oil per acre can be produced.

Vocabulary

biodiesel: a clean-burning, renewable fuel produced from domestic resources like soybeans and other vegetable oils and animal fats. It is non-toxic, 100% biodegradable and renewable.

biofuel: a fuel derived directly from living matter.

catalyst: a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

glycerine: Made by combining soybean oil (ester) and methanol (alcohol) with a catalyst

lecithin: a yellow, fatty substance which is a by-product of refined soybean oil. Lecithin has many uses in food and medicine.

transesterification: the main chemical reaction used to convert soybean oil into biodiesel. It is the process whereby one ester/one alcohol combine to form two new compounds.

methanol: a toxic, colorless, volatile flammable liquid alcohol, originally made by distillation from wood and now chiefly by oxidizing methane.

III. Before Viewing the Videos or Using Other Resource Materials:

1. Ask students what they know about biodiesel fuel and how it can be used.
2. Ask students if they know what advantages/benefits there are to using biodiesel fuel instead of conventional fuel, such as gasoline.



IV. Viewing or Reading Guide:

1. Have students list the uses and benefits of biodiesel fuel as they watch the videos.
2. Distribute the handout on the “Biodiesel Production Process” and compare it with the process as described in the PowerPoint lesson and the “Harvesting the Potential, Fueling the Future” video.

V. Discussion Guide:

1. Put students in small groups to compare their lists of uses and benefits of biodiesel fuel.
2. Create a blank “Biodiesel Production Process” diagram and have the students fill in the blanks in pairs.
3. Use the “Oil Crops: Oil Production Table” and ask students questions regarding the different crops and how many gallons of oil per acre each crop produces. You can ask specific questions about the lowest and highest yield crops.
4. Ask students to discuss ideas for science projects related to soy fuel.

VI. Suggestions for Lab/Active Learning:

1. Demonstrate the process of making biodiesel in the classroom if your lab is equipped for this process.

VII. Assessment and Evaluation:

1. Give students the pre-test that goes with the **PowerPoint Soybean Lesson: Fuel**.
2. After reviewing the pre-test, use the power point lesson and other videos and handouts as desired and then give the quiz to see how much more the students now know about how biodiesel fuel is processed and its advantages and benefits.



VIII. Suggestions for Extended Learning and Research

Below are additional opportunities for students to work individually or in small groups:

1. Have students research the crops in Arkansas which can be used for making biodiesel.
2. Have an Extension biodiesel fuel researcher visit your classroom and talk to students about the process. Have this researcher bring samples of crops used to make biodiesel if available.
3. Have students research and identify the viability and implications for production and use of biodiesel verses fossil fuels. Ask students to discuss the environmental implications for this energy strategy.
4. Have students research careers in biodiesel fuel. Examples are: Chemists, microbiologists, soil and plant scientists, agricultural, chemical, civil, electrical, environmental, industrial and mechanical engineers, construction managers and laborers, equipment operators and farmers.



Student Proficiency Standards – The Science of Soybean Production

The Arkansas student education core proficiency standards below can be met by teaching **The Miracle Bean: Fuel** lesson.

The Arkansas student education core proficiency standards below can be met by teaching “The Miracle Bean: Food.”

Biology: Grades 9-12

Classification & Diversity of Life

CDL.7.B.19: Evaluate the medical and economic importance of plants.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 4 – The Miracle Bean: Feed



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Videos or Distributing Handouts.....	3
IV.	Viewing or Reading Guide.....	3
V.	Discussion Guide.....	4
VI.	Suggestions for Lab/Active Learning.....	4
VII.	Assessment and Evaluation.....	4
VIII.	Suggestions for Extended Learning and Research.....	4
	Student Proficiency Standards.....	5



I. Knowledge Base:

Poultry and livestock and other animals consume about 98% of U.S. soybean meal. The United States also exports soybean meal to other countries. The animal agricultural industry is the number one customer for soybean producers in Arkansas. Because of soybean's high protein content (36% plus), it is accepted worldwide as the most important supplemental protein in livestock feed. Arkansas soybean producers have a mutually profitable relationship with the livestock producers.

Learning Objectives:

As a result of completing this module, students will:

- Know the importance of soybean meal to the animal agriculture industry.
- Recognize the mutually beneficial relationship between soybean and animal agriculture producers.
- Understand why soybeans are such a significant part of the animal agriculture industry in Arkansas, the United States and worldwide.

II. Teacher Background Materials:

All of the videos and materials in this module can be used as a complete lesson or as a separate activity during your science classes.

Importance of Soybean Meal to Agriculture Industry

Instruction Plan for PowerPoint Soybean Lesson: Feed provides the instructions for using the PowerPoint lesson on feed, including the pre-test and post-test quizzes and activity. Both quizzes are in the **Lesson Quiz** section, along with the answer keys. The activity plan and handout is under **Additional Resources**.

PowerPoint Soybean Lesson: Feed explains the importance of soy meal to animal agriculture and the ties between the animal agriculture industry and Arkansas soybean production. The lesson also summarizes the processes involved in manufacturing soy-based feedstuffs for livestock and companion animals. The benefits of using soy for animal consumption are emphasized.

Feeding the Future Interactive Lesson is a soybean feed slide program which can be used individually or in a classroom. The teacher in the classroom or individual student goes through the interactive slides to learn more about how soybeans provide significant protein nutrients for farm animals.



Harvesting the Potential, Feeding the Future is a short video showing the very important role that soybean meal plays in the feeding of livestock and poultry. The video features an interview with Professor Craig Coon, University of Arkansas Poultry Nutritionist, who talks about the content of soymeal and explains how soymeal is an important ingredient in poultry feed. This video is presented by the Arkansas Soybean Promotion Board and produced by the Agricultural Education, Communications and Technology Department at the U of A Division of Agriculture.

Research on Nutritional Value of Feeding Arkansas Catfish Soy Feed

Soy Feed Enhances the Nutritional Value of Arkansas Fish is an Extension podcast with Dr. Rebecca Lochmann, a professor of Aquaculture and Fish Nutrition at the Arkansas Aquaculture and Fisheries Center at the University of Arkansas at Pine Bluff. Professor Lochmann talks about her research in fish nutrition and how she tests different food recipes to determine the best nutritional content for feeding fish. She explains the research process and points out that soymeal has always been a major ingredient in the catfish diet, commonly providing over half of its required nutrients.

Additional Resources includes:

- **Classroom Activity Instruction Plan: Feed.** Instructions for the PowerPoint Feed Activity Game.
- **PowerPoint Feed Activity Game** which can be used as a classroom or individual activity.
- **Classroom Activity Instruction Plan: Feed** gives instructions for the Power Point Feed Activity Game.
- **PowerPoint Feed Activity Game** can be used as a classroom or individual activity.
- **Soya' Think Ya Know Your Customers?** is a Beyond the Elevator short game to see how much you know about soybean customers.
- **United Soybean Board - 2011 Soybean Meal Usage by Species in Each State** is a handout which lists states alphabetically and shows soybean meal usage in 1,000 short tons per species.
- **United Soybean Board Article – Fishing for Answers** shares the international travel experience of soy check-off farmer-leader Delbert Christensen, a soybean farmer from Audubon, Iowa. Christensen recently visited a tilapia farm in the South American nation of Colombia. Christensen discusses the importance of the soybean check-off program and how it helps Colombian fish farmers use more U.S. soy and what effect the program has on the U.S. soy industry.



Vocabulary

aquaculture: the cultivation of aquatic animals like fish or shellfish; aquaculture environments may be either natural or controlled and either marine or freshwater.

animal agriculture: raising of livestock for food or breeding purposes.

companion animals: an animal that someone keeps for company and enjoyment (e.g. cats, dogs, etc.)

complete protein: a protein source that contains all of the essential amino acids for the dietary needs of animals.

crushing facility product flow: the different processes and phases soybeans go through in a processing facility to make soybean meal.

feedstuff: any material used as a food for animals.

livestock: the cattle, sheep, pigs, poultry and other similar animals raised and kept on a farm or ranch.

poultry: domesticated fowl that are valued for their meat and/or eggs, such as chickens, turkeys and ducks.

soybean meal: a primary protein component in many feedstuffs because of its efficiency and a major ingredient in the daily diet of both livestock and companion animals.

III. Before Viewing the Videos or Distributing Handouts:

1. Ask students what they know about Arkansas's animal agricultural industry.
2. Ask students what they know about the use of soybeans processed into soymeal and used as protein in feed products for farm animals.
3. Ask students what they know about the benefits of using soymeal in animal feed.
4. Ask students what they know about the benefits of using soymeal as a nutrient in fish food.

IV: Viewing or Reading Guide:

1. Have students take notes on the various processes involved in manufacturing soy-based feedstuffs for livestock, poultry and fish.



2. Have students take notes on the benefits of using soymeal as a protein nutrient in animal feed.
3. Have students take notes on what they learned about the animal agricultural industry in Arkansas.

V. Discussion Guide:

1. As a group or individually, review the information students noted on the various processes involved in manufacturing soy-based feedstuffs for livestock, poultry and fish.
2. As a group or individually, review the information students noted on the benefits of using soymeal as a protein nutrient in animal feed.
3. As a group or individually, have students share what they learned about the animal agricultural industry in Arkansas.
4. Ask students to discuss ideas for science projects related to soy feed.

VI. Suggestions for Lab/Active Learning:

1. Have students form teams to research and argue opposing perspectives regarding the competing values for use of soy for food, fuel, or feed.
2. Have students research and identify scientific careers that support the aquaculture animal feed industry.
3. Have students analyze the ingredient labels of their pet food and compare and contrast the feed quality to unit cost. What % protein? Was soybean a listed ingredient?

VII. Assessment and Evaluation:

1. An informal assessment can be made of students' notes and participation in discussion.
2. Have students take the pre-test and quiz and discuss the results with the class.

VIII. Suggestions for Extended Learning and Research

1. Have an Extension specialist in cattle, poultry or aquaculture come to the classroom and talk to students about the animal agricultural industry in Arkansas.
2. Research how much soymeal is produced and used in Arkansas as animal feed and what economic impact it has on the agricultural industry in Arkansas.
3. Research the importance of using soymeal as a nutrient in fish food.



Student Proficiency Standards – The Science of Soybean Production

The Arkansas student education core proficiency standards below can be met by teaching **The Miracle Bean: Feed**.

Biology: Grades 9-12

Classification & Diversity of Life

CDL.7.B.19: Evaluate the medical and economic importance of plants.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 5 – The Faces and Challenges of Farming: Emerging Issues



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Videos, Listening to the NPR feature or Distributing the Handout.....	4
IV.	Viewing, Listening or Reading Guide.....	4
V.	Discussion Guide.....	4
VI.	Suggestions for Lab/Active Learning.....	5
VII.	Assessment and Evaluation.....	5
VIII.	Suggestions for Extended Learning and Research.....	5
	Student Proficiency Standards.....	6



I. Knowledge Base:

Arkansas is heavily invested in soybean production. Good roads and the Arkansas and Mississippi Rivers make the state an ideal and efficient delivery system for soybeans, which are grown and transported with relative ease throughout the state, the nation and universally. The weather, invasive insects, the growth of technology in farming and “family farm” sustainability issues continue to impact the Arkansas soybean and agricultural industry as a whole. Arkansas soybean producers are well-equipped to face the emerging challenges of farming.

Learning Objectives:

As a result of completing this module, students will:

- Know how invested Arkansas is in soybean production.
- Understand the issues currently affecting the industry.
- Learn how Arkansas soybean producers plan for the future.
- Understand and be able to use the simplified formula for estimating soybean yields

II. Teacher Background Materials:

All of the videos and other materials in this module can be used as a separate activity during your science classes.

Soybean Farming from Different Points of View

Welcome to the Bennett Family Farm Video was produced by the University of Arkansas, Cooperative Extension Service and Blake Bennett AG Productions. As a youngster, Blake began working on his family’s farm and started producing videos on soybean farming. This video focuses on farming as Blake’s way of life, even though he is currently in college. Students should be able to identify with Blake as a peer and understand why he is so passionate about farming.

Growing Season: Bennett Family Farm video was produced by the University of Arkansas, Cooperative Extension Service and Blake Bennett AG Productions. Blake explains the soybean production process, emphasizing the significance of the weather along with integrated pest management practices (IPM) during the growing season. Irrigation techniques and practices are reviewed which makes it possible to grow soybeans when Mother Nature is not cooperative.



Through the Eyes of a Farmer features Arkansas soybean farmer, Robert Stobaugh. Stobaugh raises soybeans on his over 5,000 acre farm near Atkins, Arkansas. He describes how soybeans are used, the process for growing them and what time of year soybeans are usually planted in Arkansas. Stobaugh says a great equalizer in growing soybeans is the weather so irrigation is important. Also insects and other problems can affect the harvest. The impact of the use of technology in planting soybeans is also discussed. This video was produced by the University of Arkansas Dale Bumpers College of Agricultural, Food and Life Sciences, U of A Cooperative Extension Service and funded by the Arkansas Soybean Promotion Board.

A Way of Life gives a brief history of the evolvement of soybean farming in Arkansas and points out that the Delta region of Arkansas grows 80% of the soybeans in the state. The video showcases Shannon Davis of Davis Farms who farms over 8,000 acres in the Delta region in Bono, Arkansas near Jonesboro. Davis talks about the history and success of his farm, which is primarily due to working together as small family farms sharing resources. Past and current farming practices are discussed, along with how technology has improved production today. This video was produced by the University Of Arkansas Dale Bumpers College of Agricultural, Food and Life Sciences, the U of A Cooperative Extension Service and funded by the Arkansas Soybean Promotion Board.

In the Making of Megafarms, A Mixture of Pride and Pain is a National Public Radio feature by Dan Charles aired on June 16, 2014. It covers the increasing decline of small farms across the United States and why big farms are more common. There are over two million farms in American with four percent of those farms accounting for two-thirds of all agricultural production. The impact of technology plays a major role in managing multiple farms from one site. A top grain grower in Kansas and the vice president of the National Farmers Union are interviewed about this issue.

Soybean Yield and Replanting Research

Soybean Maximum Yield Research Underway Video is a University of Arkansas Division of Agriculture podcast featuring Ryan Van Roekel, a Ph. D. graduate student in Crop, Soil and Environmental sciences at the University of Arkansas. Roekel is conducting research to determine the maximum yield at a soybean field in Newport, Arkansas. He talks about the various processes and products being used in this research to help potentially increase the yield. One of the ways his research is looking at increasing the yield is by planting the soybeans earlier in late March instead of April or May. The results of the research will be released on Arkansascrops.com. This podcast was funded in part by the Arkansas Soybean Promotion Board.



Responding to Production Needs: The Hundred Bushel Yield Challenge is another podcast produced by the University of Arkansas Division of Agriculture with Ryan Van Roekel, a Ph. D. graduate student in Crop, Soil and Environmental sciences at the University of Arkansas. Roekel is at a large soybean production field near England, Arkansas. The goal is to break a hundred bushels per acre. Roekel is looking at possible challenges in the field, such as insects. Estimating the number of seeds in a pod per acre is the best way to determine yield. Roekel gives the formula for estimating yield.

Estimating Soybean Yields video with Dr. Shawn Casteel, Purdue Extension Soybean Specialist, talks about a simplified way to estimate soybean yields. All one needs to remember is 21 inches. He explains and demonstrates how to do this by using 21 inches as the main factor in the formula. This podcast was produced by the Purdue University Pest Management Program.

Plants Gone Bad: The Arkansas Story is a podcast with Jeremy Ross, Extension soybean agronomist with the University of Arkansas Division of Agriculture. Ross discusses the factors which determine if a soybean crop in a field in Lonoke County needs to be replanted. One of the factors is stand count; 80,000 plants would be the minimum stand count for maintaining a field. The second factor is the uniformity of the stand count. The third factor is the cut-off date to make a decision to replant.

Additional Resources – Son Begins Managing Family Business – Delta Farm Press Article tells how Garrett Qualls, 24, is running things on the Qualls Farm today, a 2,200 acre farm around Lake City, AR. His father, Kenny, decided Garrett was ready and promptly turned over the reins to him several years ago. The article talks about the advantages of having Garrett manage the farm while his father is still readily available to mentor him on the tough decisions.

Kenny studied estate planning to assist him in the process of making the decision to have Garrett manage the farm and the article covers some of the issues Kenny had to keep in mind in order to pass the management responsibilities to Garrett.

Vocabulary

Gross Domestic Product (GDP): the total value of goods produced and services provided in a country during one year.

integrated pest management (IPM) : An effective and environmentally sensitive long-term approach to pest management that relies on a combination of common-sense practices (“pests” can include insects, pathogens causing plant disease, and weeds that cause economic damage to crops). IPM programs use current, comprehensive information on the life cycles of pests and their interaction with



the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means and with the least possible hazard to people, property, and the environment. The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to cultural, mechanical, and the judicious use of pesticides (Source: US Environmental Protection Agency).

megafarms: large-scale farms that account for two-thirds of all agricultural production in the United States. (June 2014) Four percent of all U.S. farms are considered megafarms, are still primarily family-owned, are often multi-generational, and frequently support multiple families.

stand counts: the number of soybean plants in a row used to help determine the need for a replant.

yield: the crop measurement often used for a cereal, grain or legume normally measured in metric tons per hectare defined as 10,000 square meters.

III. Before Viewing the Videos or Distributing the Handout:

1. Ask students to identify some of the challenging issues that Arkansas farmers face today.
2. Ask students if they know of some factors that could affect the soybean yield per acre.
3. Ask students about some of the major sustainability issues facing small family farms.

IV. Viewing, Listening or Reading Guide:

1. Have students list the various challenges presented in the three videos about Arkansas soybean farmers and the NPR audio feature.
2. Identify some of the similarities and differences in Arkansas farmers' perspectives.
3. If using the soybean yield estimation and research videos have students:
 - Identify factors which affect the soybean yield per acre.

V. Discussion Guide:

1. Ask students to compare the points of views of the three Arkansas farmer videos.
2. Ask student to identify the factors which affect the soybean yield per acre and discuss how research is trying to maximize that yield.



3. How does the use of 21 inches help to simplify soybean yield estimations?
4. What factors are used to determine if a soybean field needs to be replanted?

VI. Suggestions for Lab/Active Learning

1. Have an Extension agent visit the class and demonstrate how soil testing is done if possible.
2. Students could bring samples of soil from their homes to be sent to the University of Arkansas Soil Diagnostic Lab.
3. For classes that submit soil samples for analysis, have students compare results and identify deficiencies in the soil that could impact crop production.
4. If feasible, visit a soybean farm before the crop is harvested and determine the estimated yield.

VII. Assessment and Evaluation:

1. Have students take the quiz at the end of the module. Evaluate the results.
2. An informal assessment can be made by evaluating student discussion participation and notes.

VIII. Suggestions for Extended Learning and Research

1. Conduct additional research into the factors which affect soybean yield per acre.
2. Conduct research into the significance of the Hundred Bushel Yield Challenge.
3. Find out more information on how Arkansas compares to the United States in average soybean yield per acre.
4. Have the students identify careers associated with agricultural research. Examples are Extension agents and specialists, nematologist, plant biologist, and soil scientist just to mention a few professions.
5. Find out how many acres of soybeans are raised in Arkansas and see if students can figure out the value of the soybeans to the GDP (**gross domestic product**) of Arkansas.
6. Research what percentages of soybeans grown in Arkansas are exported nationally and internationally.



Student Proficiency Standards – The Science of Soybean Production

The Arkansas student education core proficiency standards below can be met by teaching **The Faces and Challenges of Farming: Emerging Issues**.

Biology: Grades 9-12

Classification & Diversity of Life

Content Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.17: Describe the structure and function of the major parts of a plant.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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High School

Science Curriculum Resource Guide



Soybean
science challenge

Homegrown Curriculum for Arkansas Students

Module 6 – Ready...Set...Research!



I.	Knowledge Base.....	1
II.	Teacher Background Materials.....	1
III.	Before Viewing the Interactive Lessons, Videos or Distributing Handouts.....	3
IV.	Viewing Interactive or Reading Guide.....	3
V.	Discussion Guide.....	3
VI.	Suggestions for Lab/Active Learning.....	4
VII.	Assessment and Evaluation.....	4
VIII.	Suggestions for Extended Learning and Research.....	4
	Student Proficiency Standards.....	5



I. Knowledge Base:

Scientific research plays a vital role in the successful growth and production of Arkansas soybeans. The Arkansas Soybean Promotion Board spends a majority of its resources on research such as studying the effects of certain types of insects on the plants, identifying the best water and soil conditions for effective growth, how to utilize integrated pest management, strategies for optimal production and environmental outcomes, identifying the best combination of soymeal for feeding purposes, developing new products from soy, and soy biodiesel research just to mention several areas. Students will explore how research contributes to more effective and efficient production of soybeans and identify scientific careers in agriculture that contribute to the knowledge of soybean production and use as food, fuel and feed.

Learning Objectives:

As a result of completing this module, students will:

- Learn how research contributes to the soybean agricultural industry.
- Identify significant areas of current research in the field.
- Explore careers in science related to soybeans.

II. Teacher Background Materials:

All of the videos and other materials in this module can be used as a separate activity during your science classes.

Ready...Set...Research – Interactive is an introductory video lesson with a goal of inspiring young scientists to become part of soybean-related research. This interactive lesson was created by David Moseley, a Ph. D. student in the Department of Soil, Crops and Environmental Sciences at the University of Arkansas and an Arkansas Soybean Promotion Board Fellowship recipient. His applied research supports the work of the Cooperative Extension Service. Moseley's emphasis is in soybean breeding and edamame production. He describes his interest in science and the career path which led him to his current position. Other student researchers and their scientific interests are included in other parts of this module. Soil sampling, crossing soybeans, data collection, identification of the parts of the soybean flower as well as an emphasis on the production and use of edamame are covered in this module.

Getting to the Root of the Problem is a podcast on root-knot nematodes with Terry Kirkpatrick, Professor and Nematologist of Plant Pathology at the Cooperative Extension Service. Dr. Kirkpatrick defines root-knot nematodes and explains the options for controlling them. Crop producer Felix Smart tells about his plan for controlling nematodes for the next several years.



We Put the Fun in Fungi podcast features Kimberly Cochran, Arkansas Soybean Promotion Board 2012 fellowship recipient. Cochran is a Ph. D. candidate in plant science. Her research has been funded by the Arkansas Soybean Promotion Board and is on soybean seeds. She conducts a variety of tests, including microflora plating on the seeds in order to determine how the fungi affect the soybean seeds.

Playing in the Dirt podcast showcases Faye Smith, another 2012 fellowship recipient who is a master's student in the Department of Soil, Crops and Environmental Science. Her research studies the long-term effects of residue and water management practices on soil respiration and on aggregate stability in a wheat and soybean double rotation.

Getting Dirty for Research is a podcast on soil sampling techniques with Randy Chlapecka, an Arkansas county Extension agent in Jackson County. Chlapecka discusses how to choose the best soil probe, when to take the soil sample and the soil sample proper depth. The number of sample cores to take in order to ensure a good composite sample is also covered.

Additional Resources include:

- Articles and fact sheets from the United Soybean Board
- University of Arkansas Division of Agriculture performance results on a series of topics.
- University of Arkansas Division of Agriculture and Cooperative Extension Service podcasts.
- Ready...Set...Research Folder with additional handouts and materials from the University of Illinois.

Vocabulary

biological control: a method of reducing or eliminating plant pests by introducing predators or microorganisms that attack the targeted pests but spare other species in the area.

lab assay: a lab assay determines the types and numbers of plant-parasitic nematodes in soil and plant samples.

microflora: the community of microorganisms, including algae, fungi, and bacteria that live in or on another living organism or in a particular habitat.

nematology: the branch of zoology that deals with nematodes.

nematode: nematodes are a diverse group of worm-like animals. microscopic roundworms that live in the soil. Most of the nematodes that inhabit the soil are microbial feeders or predators of other soil organisms, but some parasitize plants and are called plant-parasitic nematodes.

parasite: a living organism that obtains its nutrition by feeding off another organism.



root-knot: a microscopic nematode that lives in the soil and feeds on host vegetation.

soil aggregate: structures or bits of soil particles that are held together tightly.

soil probe: a tool used to remove a deep core from turf areas to examine root development, thatch depth, topsoil depth, soil arrangement and soil moisture.

soil sampling: soil sampling and testing is an important management practice for all farms. It is almost impossible to determine what a soil needs to be productive without a soil analysis. There are different kinds of soil analysis, including analysis for nutrient content as well as what organisms are in the soil (such as nematodes).

soybean fungi: any number of fungal diseases affecting the soybean plant.

stylet: nematode feeding is accomplished through a hollow, needlelike mouthpart called a spear or stylet. The nematode pushes the stylet into plant cells and injects liquid containing enzymes, which digest plant cell contents. The liquefied contents are then sucked back into the nematode's digestive tract through the stylet.

ubiquitous: existing everywhere at once.

III. Before Viewing the Interactive Lesson, Videos or Distributing Handouts:

1. Have students speculate on the value of research to agriculture.
2. Then ask students if they have heard of or know about any specific research related to soybeans.
3. Ask students who might conduct this research at the national and state level.
4. Ask your students which scientific field currently interests them the most.

IV. Viewing, Interactive or Reading Guide:

1. Have students note the various types of soybean and plant research being conducted by University of Arkansas Division of Agriculture graduate students.
2. Have students note different career paths identified in the podcasts.

V. Discussion Guide:

1. Have students discuss the various agricultural careers featured in the podcasts. Ask students if any of those scientific fields interest them. Why or why not?
2. Have students discuss the importance of soybean-related research.



3. Ask students to identify and discuss critical science-based issues for agricultural production.
4. Ask students to describe and discuss the function and impact of nematodes on soybean crops.

VI. Suggestions for Lab/Active Learning:

1. Invite an Extension specialist/scientist to your class to discuss a soybean-related research project if possible.
2. Organize a field trip to a University of Arkansas research center.
3. Have students form teams to research and argue opposing perspectives on major scientific and environmental issues faced by soybean producers, including biotechnology; water uses; integrated pest management, and/or use of technology.

VII. Assessment and Evaluation:

1. Have students take the module quiz and evaluate the results in class or individually.

VIII. Suggestions for Extended Learning and Research

1. Invite one of the current research fellows from the Arkansas Soybean Promotion Board conduct a teleconference with your class to talk about his/her current projects and their career path.
2. Encourage students to conduct their own student research related to agricultural sustainability and to compete in the local/regional state science fair, Soybean Science Challenge student research competition.
3. Have students research and chart input costs for soybean production from field preparation to harvest.
4. Have students research and identify the value of soybeans as a renewable resource to address major international issues.
5. Have individuals or groups research and identify scientific careers supporting the soybean industry including: educational requirements, salary, availability of jobs and working conditions. Assign students a range of production and processing career focus areas including: crop production, food product development, fuel production, environmental sustainability, engineering and technology applications, etc.
 - Have individual students or student teams document the significance of that career to the agricultural industry in general and to Arkansas.



Student Proficiency Standards – The Science of Soybean Production

The Arkansas Student Education core proficiency standards below can be met by teaching **Ready...Set...Research!**

Biology: Grades 9-12

Classification & Diversity of Life

Content Standard 7: Students shall demonstrate an understanding that organisms are diverse.

CDL.7.B.17: Describe the structure and function of the major parts of a plant.

CDL.7.B.19: Evaluate the medical and economic importance of plants.

Ecology & Behavioral Relationships

Content Standard 9: Students shall demonstrate an understanding of the ecological impact of global issues.

EBR.9.B.3: Assess current world issues applying scientific themes.

Environmental Science: Grades 9-12

Nature of Science

Content Standard 6: Students shall describe various environmental science careers and the training required for the selected careers.

NS.6.ES.1: Research and evaluate science careers using the following criteria:

- Educational requirements
- Salary
- Availability of jobs
- Working conditions

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