HIGH SCHOOL
AP CLASSES
INTRO COLLEGE COURSES

Into the Outdoors

# LESSON AND DISCUSSION GUIDES FOR:

## SEARCHING FOR SUSTAINABILITY
## FARMING PRACTICES AND SUSTAINABILITY

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**GRADE LEVELS**
High School, Grades 9-12, AP Classes
Introductory College Classes

**CONTENT AREA**
Environmental Science;
Agricultural Science

**UNIT THEME**
Soil and Water, Sustainable Farming

**TOPIC**
Examine sustainable farming practices in terms of soil and water impacts.

**TIME REQUIRED**
Two, Fifty Minute Classes

## OVERVIEW

People view agricultural sustainability in many different ways. This teaching lesson finds common ground where good agricultural practices mean there is less impact from farming on the ecosystem; and where both farmers and ecologists can agree upon that. This lesson examines the 'best practices' and explores the sustainability tools available to modern farmers who want to be good land stewards.

Environmentalist typically look at farming as producing negative effects on the environment. Agriculturists tends to look at the environment as something they already think they are careful with, however, because of gross misconceptions they must continually defend their business. The truth is somewhere in the middle. Farming does have significant impacts on the native ecosystem AND farmers are generally good caretakers of the land…AND…there are better ways to farm that have lower impacts. In the film, viewers meet a dozen farmers who explain what they do.

The documentary film uses the specific watersheds around the Green Bay, Wisconsin area to show the problems agricultural runoff can create, as well as to showcase the sustainable solutions farmers are using to change the paradigm that Agriculture and Ecosystems cannot co-exist. The segments of the film viewed for this lesson focus on the solutions more than the problems.

Here is some background on the problems for teachers:

In the bay of Green Bay (Fox-Wolf river basin) studies done over ten years show that agriculture contributes 63% of the total suspended solids (sediments) to receiving water body. Agriculture contributes 44% of the total phosphorus.
(Data Sources: Integrated Watershed Approach Demonstration Project: A Pollutant Reduction Optimization Analysis for the Lower Fox River Basin and the Green Bay Area of Concern. August 2007; prepared by the Cadmus Group for the U.S. EPA, with contributions from the University of Wisconsin-Green Bay, 26 pp. Solids data from P. Baumgart, UW-Green Bay, 2008.)

Sediment is soil. Specifically, soil that leaves farm fields and tends to stay suspended in water for a long time. It clouds water, and when it finally does settle it coats the bottom of the lake or bay with sediment that chokes out aquatic life, including fish eggs. Sediment scours the gills of fish and impairs their breathing. Sediment ruins aquatic ecosystems.

Phosphorus is an elemental nutrient that plants need in order to grow. It is abundant in cow manure. When either manure or phosphorus fertilizer are applied to soil to help grow crops it may actually leave the farm field if rains hit unprotected or bare soil. Phosphorus runs off when it is attached to soil particles or still in manure that has been spread. Once phosphorus gets in water it is a nutrient for algae and fuels blooms of this aquatic plant. When the algae die, they sink to the bottom and as they decay, the bacteria in the water use up all the oxygen and create a hypoxia zone. Fish and other aquatic species cannot exist in hypoxia zones.

Most of the runoff from farm fields occurs in just 17 days in the spring and fall when farm fields are uncovered and newly plowed. If the fields can retain some plant cover, sediment & phosphorus pollution is mitigated. When annual crops begin to grow, they protect the soil. Perennial crops, which are present year-round, are protective all year.

Some may say that sustainability means having the same quality of resources over time, while others may look more towards a balance between humans and other natural organisms. The Environmental Protection Agency (2017) notes that sustainability means, "to create and maintain conditions under which humans and nature can exist in productive harmony to support present and future generations."

Sustainability can be rather complicated, especially when considering the balance of impacts (both positive and negative) on the environment, society, and the economy. Many regions in the United States are currently facing the question of how to sustain profitable agriculture along with water quality and quantity.

Farmers have produced food sustainably for thousands of years. As the world's population increases to 8 billion people, agricultural productivity has increased significantly in America's Midwest farming regions. There have been enormous changes in agricultural practices in the last 20 years. We will explore how those farming practices can be modified to lower their impact on the land and water. We will review conservation practices farmers can use to become more sustainable. Teachers should know that the Federal Government (USDA) provides cost-share money to farmer through the NRCS (Natural Resources Conservation Service) EQIP program to help farmers afford to use or install some of the practices. (see resources to a link for more info).

In this lesson students explore the methods farmer are using to farm more sustainably and lessen the impact of agriculture on the land and water. Students will watch segments of a documentary film and be led on a guided discussion by the instructor. Students will complete a worksheet assessing the vocabulary of the content and do group work to re-enforce learning about the sustainable practices.

# CONCEPT Agricultural Sustainability, Healthy Soil and Water

### ENDURING UNDERSTANDING:

Students will understand how farming affects soil and water. Students will understand that conservation practices and technologies can minimize the agricultural impacts on land and water. Finally, students will discover how farming is becoming more sustainable.

### CONTENT OBJECTIVES:

Students will be able to describe sixteen conservation practices depicted in the film. They include; 1) contour farming, 2) managed grazing, 3) portable fencing, 4) perennial crops & crop rotation, 5) increasing organic matter, 6) composting manure, 7) cover cropping, 8) no-till planting, 9) conservation tillage, 10) buffer strips, 11) precision planting, 12) CAFOs, 13) manure separation, 14) manure lagoons, 15) manure injection, 16) bio-digesters. Students will see that farmers have a toolbox of conservation practices available to them.

### LEARNER OBJECTIVES:

Students will learn about a variety of conservation practices. Students will explore farming practices and modern farm management styles ranging from Managed Grazing to CAFOs. Students will be able to explain the impacts of farming practices on land and water quality and understand conservation practices available to farmers who are trying to take care of the land while earning a living

### PROCESS OBJECTIVES:

The instructor will familiarize students with the practices they will see in the films. Students will watch the films and work individually to fill out a worksheet to re-inforce an understanding of the conservation practices. Students will then work in pairs and then small groups of four to process new information and answer critical thinking questions.

### MATERIALS NEEDED (each group, each student):

1. Student worksheets
2. Writing utensils

## PROCEDURES

Class One: *(50 minutes)*

1. *20 minutes:* The instructor will use "still" photo sheets and explain each of the conservation farming techniques shown in the film. Students will be on the lookout for these practices as the film runs.
2. *30 minutes:* Students will view the following segments of the Searching for Sustainability video.
   #3 - Our Unsustainable History - 3:15 Seconds
   #11 - Soil Science - 7:17 Seconds
   #13 - Grazing Options - Minutes 0-6:53
   #10 - Turning The Tide - 2:29 Seconds
   #15 - Sustainable Solutions - 4:24 Seconds

Class Two: *(50 minutes)*

1. *20 minutes:* Students will recall and review the farm conservation practices by completing a worksheet. (Alternatively, the worksheet can be done as homework if students want to review the film clips at home.) Then, the teacher just reviews the correct answers at the start of the second class.
2. *35 minutes:* Discussion using a pair-square-share technique. The teacher has a list of discussion questions to help students explore the techniques they just learned about more in-depth. The teacher should have students pair up. Each pair of students will get a couple of questions to think about, discuss, and answer together. There are two pairs of students with the same set of 4 questions. These pairs get together in a "square" to again discuss the questions and get a second set of perspectives. Next the "squares" of four students share their questions and answers with the whole class. All students get to hear the summary of the smaller group discussion of important questions. See the discussion guide for more info on this technique.

## ASSESSMENTS:

1. **Worksheet** - The teacher can conduct the worksheet assessment at the beginning of the second class or send it home as homework. The worksheet and key are attached: WorksheetKey.doc and Worksheet.doc
2. **Discussion** - Below is a rubric for the discussion. The actual discussion questions are attached as a file: DiscussionConservationFarming.doc

| AN EXCELLENT STUDENT: | AVERAGE STUDENT: | BELOW AVERAGE STUDENT: |
|---|---|---|
| Is fully engaged | Is somewhat responsive | Is uninterested |
| Understands discussion questions | Understands some questions | Can't grasp the questions |
| Understands all practices | Can identify some practices | Can't list practices |
| Takes the lead | Shares when asked | Doesn't add information |
| Checks with partner/group | Shares when asked | Dominates or retreats |
| Has original ideas | Can add to ideas | Doesn't contribute |
| Can evaluate farm practices | Can review practices | Can't describe practices |
| Articulates thoughts | Communicates well | Is silent |
| Summarizes answers well | Can name a few key points | Is unorganized with answers |
| Reflects discussion points in detail to large groups | Can review discussion to a moderate extent | Cannot describe what the group discussed |

## TO LEARN MORE, VISIT THESE RESOURCES

**Practical Soils Essays for Farmers and Gardeners**
By Valerie Dantoin
Northeast Wisconsin Technical College
Graphic Book available at www.NWTC.edu

**The Free E-book: Building Soils for Better Crops: Sustainable Soil Management**
by Fred Magdoff, 3rd edition, 2009
Chapter 9, Managing for High Quality Soils
SARE Outreach Publications. ISBN 978-1-888626-13-1
Available at: www.sare.org/Webstore

**USDA-NRCS Environmental Quality Incentives Program**
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Into the Outdoors

# SEARCHING FOR SUSTAINABILITY:

## FARMING PRACTICES AND SUSTAINABILITY

## TEACHER'S GUIDE: MAJOR CONCEPTS

# SOIL CONSERVATION PRACTICES ON FARMS

### 1. Contour Cropping

Farmers plant horizontally across the ridgelines to hold water back from running down the slope. They alternate strips of grassy sod/hay and corn. Sod is left in place to protect soil in winter because annual crops, like corn or soybeans, do not grow tall enough to deflect the impact of rainstorms until June and these crops are harvest off the field by November.

### 2. Managed Grazing

Farmers keep the soil covered year-round with thick grass and legumes (clover or alfalfa). Cows eat a paddock (small part of a field) of forage each day and then move off the paddock so they do not damage the sod or cause erosion. The plants re-grow quickly, just like a household lawn, and are ready to be grazed again by the cows in a few weeks. Perennial plants are kept in the vegetative state for maximum nutrition.

### 3. Portable Fencing

Although a very simple technology, portable fencing is makes managed grazing possible. It consists of a plastic string that has electric current conducting wire woven into it. The cows get a shock if they try to cross over the wire. This "polywire", which rolls up on a large reel, allows farmers to create small paddocks to control cow movements through the field. Giving cows only a specific amount of fresh feed each day for grazing makes sure they utilize the feed well while not degrading the soil beneath the field. Farms can use solar powered energizers to power the fence.

### 4. Perennial Cropping

Alfalfa (a perennial) on the left and soybeans (an annual) on the right. More soil is exposed in an annual field compared to a perennial field. The alfalfa stays in place all year long, for five or six years, while corn and soy need to be re-planted in a plowed field every single year. The increase in corn and soybean acreage (annual crops) and the loss of hay and pastureland (perennial crops) has led to more land being exposed to rain events and thus, more soil runoff.

### 5. Crop Rotation

When crops are rotated between different species and especially between annuals and perennials many disease and pest cycles are broken and fewer herbicides and pesticides are required. This photo shows two different crops, side-by-side. A wheat or barley planting is on the left and a perennial hay field with alfalfa & grasses is on the right.

### 6. Increasing Organic Matter & Composted Manure

Organic matter (OM) is like a good sponge in the soil. For every increase of 1% OM, farmers can store an additional 16,500 gallons of water in the field. Many farm fields in Wisconsin that have annual crops growing on them have about 2.5% OM. Many farm fields that have perennial crops growing on them have 3.5 % OM. Excellent farm fields have as high as 5.5% OM while degraded fields have about 1.5% OM. The difference in the ability of these two fields to hold water is a difference of about 66,000 gallons per acre.

### 7. Cover Cropping

Cover cropping means that after the corn crop is harvested in the fall, new seed of a fast growing plant like rye grass or barley is planted on the now-bare field. The cover crop gets about a month or two of growth before winter sets in. This practice help lessen the impact of winter snow melt and spring rain because the soil has a "blanket" or cover to help protect it. In the spring, the cover crop is plowed down and a new crop (corn, soy) can be planted.

### 8. No-Till Planting

The ground in this picture is covered with corn crop residue from the previous year. The residue helps keep soil in place. The crop residue remains on the surface of the field all winter. The field is not plowed or turned in the spring for planting. Rather, specialize wheels open a narrow grove into which the crop seed is dropped. Trailing wheels press the soil shut over the seed. The crop grows up through last year's protective mulch or trash. Often used with conservation tillage.

### 9. Conservation Tillage

Conservation Tillage is a way of preparing a seedbed for planting by disking and "crumbling" the soil that has been protected by residue while leaving some residue in place. Tillage radishes are a leafy green, deep rooted crop (shown in the picture here) that has a long tap root that helps water infiltrate or soak into the field. The crop is planted in the fall along with winter wheat and it grows with the wheat in the spring. The grain crop (winter wheat) has been harvested.

### 10. Buffer Strips

A buffer strip is a strip of land that is left unplowed and unfarmed. Its job is to stop water from running off the field quickly. If the strip had no grassy cover and was just bare soil, a gully would form in sloped areas. Buffers are often placed on level ground near streams to keep soil out.

### 11. Precision Planing Using GPS - Global Positioning Satellite

Farmers test the soil to determine the amount of nutrients the crop needs in every specific area of a field. A map of the field is created and a computer adjusts the fertilizer that is delivered, depending on where the tractor is in the field as determined by GPS. The yellow tanks are full of liquid nitrogen fertilizer. It will be placed in the row where the corn will be planted. This limits potential nutrient run-off from too much fertilizer.

### 12. CAFOS - Confined Animal Feeding Operations

These farms are full of technology that allows many cows to be housed in one place to produce large amounts of milk. The barns are well lit and well ventilated. Cows are able to move around freely and they can lie down in comfortable stalls filled with sand bedding or rubber mats. Water is mixed with the manure so that the manure can be scraped every hour or so into a pit. Cows stay on concrete so they do not create mud or runoff problems. They have access to feed at all times.

### 13. Manure Separation

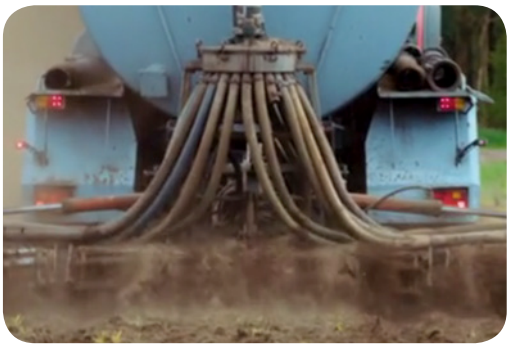
Manure from the barns is separated into either solids or liquids. The liquid portion is spread back on the fields as fertilizer. The solids are recycled and reused as bedding for the cows to lay on in the barns. Most CAFO farms use sand as bedding. This also is separated, cleaned, and recycled to be used again.


### 14. Manure Storage Lagoons

This is a collection point for all the liquid manure from a confinement barn. The lagoons, also called pits, typically are cement basins that hold 6 months of liquid manure from hundreds or thousands of cows. Lagoons are typically emptied in the spring just prior to planting or in the fall after the crops have come off the field. The liquid manure can be spread on hay fields in the summer time if a farm's nutrient management plan calls for the extra fertility.

### 15. Manure Injection/Incorporation

Liquid manure from lagoons or pits is pumped into tankers that are pulled through fields behind a tractor. The manure is injected into the ground rather than spread on the surface of the soil. This lessens the potential for the manure to run off the soil surface in a rainstorm. It also decreases the smell of manure. Sometimes tanker trucks remain on the shoulder of the road and large hoses are attached to a tractor which incorporates the manure.



### 16. Manure Digesters

Liquefied manure is collected and used to feed bacteria which digest the material and make methane gas. The gas is burned and powers a turbine that produces electricity. Studies conclude that digesters become "break even" technologies only when enough manure from approximately 700 cows can be pooled to feed the machinery. Digesters help keep the smell of dairy manure out of neighborhoods. Liquids and solids are separated after digestion is completed and they are recycled.

Into the Outdoors

# SEARCHING FOR SUSTAINABILITY:

## FARMING PRACTICES AND SUSTAINABILITY

## DISCUSSION QUESTIONS

# FACILITATOR'S GUIDE TO PAIR-SQUARE-SHARE DISCUSSION ON SEARCHING FOR SUSTAINABILITY

HERE IS A LIST OF THE SIXTEEN FARMING PRACTICES OR TECHNOLOGIES REVIEWED:

1. Contour or Strip Cropping
2. Managed Grazing
3. Portable Fencing
4. Planting Perennial Crops
5. Crop Rotation
6. Increasing Organic Matter; Manure Composting
7. Cover Cropping
8. No-Till Planting
9. Conservation Tillage
10. Buffer Strips
11. Precision Planting
12. CAFO Farming
13. Manure Seperation
14. Manure Lagoons
15. Manure Injection
16. Manure Digesters

The facilitator may wish to watch the appropriate segments of the film ***Searching for Sustainability***, ahead of time, although this is not necessary. This discussion is meant to follow the viewing of the film plus the completion of the worksheet by the students. Many of the questions are reflections and opinions so there is not necessarily a right or wrong answer. Check out the "KEY" to the discussion for ideas on appropriate or suggested responses to look for.

1. Pair up 2 people. Use whatever rationale makes sense to you – pair weak and strong students together, two shy students together, two loud students together, etc.
2. Give each pair a set of discussion questions (A, B, C, or D).
3. Let's assume there are 16 people in class. This means there are 8 pairs. (Of course you have to adjust this according to how many people there actually are in class)
4. Assign the questions in the following way:
   Pair 1 and Pair 2 - Set A Questions
   Pair 3 and Pair 4 - Set B Questions
   Pair 5 and Pair 6 - Set C Questions
   Pair 7 and Pair 8 - Set D Questions
5. Each pair answers/discusses the four questions in their set. (Give them about 10 minutes.)
6. Each pair then joins with another pair of 2 people who have the same set of questions. Now there are four people in the new group, all looking at the same set of questions. (give 10 minutes)
7. After more discussion/reflection each group of four will "report out" to the entire group. It often works out that each student takes a question and summarizes it for the whole class – in effect, they present or teach what they have learned in reflecting about the question, they summarize the thoughts of other people in their group as well. The whole class gets to hear a "committee" report answer to the critical questions that were asked. (give 20 minutes for this; 5 minutes each group)

## SET "A" QUESTIONS

1. Which 2 farming practices or technologies do you think offer the most protection for the soil? Why?

2. If you listed all 16 farming practices from most technologically advanced to least advanced what would be the top two most advanced and require the most skilled labor?

3. Speculate on what percentage of all farmers in Wisconsin are required to use at least some conservation practices? What do you think would be the result if 90% of all farmers adopted at least a couple of the practices/technology described in this lesson?

4. Speculate on why some farms adopt expensive technologies while some farms adopt a more "low input"approach to sustainable farming.

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## SET "B" QUESTIONS

1. If a farmer is trying to increase organic matter in his or her soil discuss which of these methods would most likely be the best way to do it?

a. Add composted manure to the field

b. Use conservation tillage

c. Use liquid manure

d. Use managed grazing in summer

2. Speculate on which technologies/practice are most dependent on fossil fuels and which are least dependent. What might be the carbon footprint of a grazing farm compared to a CAFO?

3. Wintertime in Wisconsin – what do grazing farms do since the pastures are covered with snow?

4. Do you think farmers who adopt these new practices/technologies should be rewarded for meeting certain environmental standards? Do you think paying farmers to keep phosphorus on their land and out of the water can work? If so, how would you do that?

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## SET "C" QUESTIONS

1.Which practices/technology offer the most opportunity for people who want to be hired on a farm?

2. If you were a new farmer, starting from scratch, without a great big budget, which conservation practices would you be most likely to try or adopt or suggest to another farmer? Why?

3. Do you think farmers who are causing soil loss & sediment runoff or phosphorus run-off should be fined or punished if they exceed certain levels or standards? How much? how would you do that?

4. Currently, only CAFOs are regulated farms, which means they must comply with certain nutrient management practices. Should all farms be regulated or licensed, or only just the large farms?

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## SET "D" QUESTIONS

1.Rank the practices/technologies from least expensive to most expensive. And from the least complicated to the most complicated.

2. If you were a research scientist, which practices/technology would you most want to explore or develop further and to learn more about?

3. Farmers and landowners get to decide what they will, or won't, do on their land. They decide whether or not they will adopt any of the conservation practices listed in this lesson on the land they own and manage. In general, the public does not get a say in what happens on private agricultural lands. What do you think about that? Is there a different approach to private land management we should consider?

4. Do you think consumers of meat or milk have a preference for which technologies/practices they'd like to see used in making food they eat? Explain your reasoning.

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Into the Outdoors

# SEARCHING FOR SUSTAINABILITY:

## FARMING PRACTICES AND SUSTAINABILITY

## WORKSHEET KEY

# IDENTIFICATION AND DESCRIPTION OF SUSTAINABLE FARMING PRACTICES

| PICTURE OF THE PRACTICE OR TECHNOLOGY | NAME IT/ GIVE IT A BRIEF DESCRIPTION | HOW DOES IT IMPROVE SUSTAINABILITY OF A FARM |
|---|---|---|
|  | **Manure Separation**<br>Liquids are separated from solids. | Solids can be recycled. Only the liquids have to be hauled to the field to be used as fertilizer. Allows concentration of animals in one place. |
|  | **Conservation Tillage**<br>The seed-bed is prepared for planting by disking and rolling through old crop residue. | Rather than turn the soil over and exposing it, this method leaves residue on the surface to act like a mulch and mitigate the effect of rainfall. |
|  | **Perennial Cropping**<br>Grasses and legumes keep the ground covered all year, for many years before they need to be replanted. | Rather than exposing the soil to rainfall events like annual row crops do, the soil is protected every month of the year, including spring and fall when most runoff occurs from farm fields. |
|  | **Contour or Strip Cropping.**<br>Farming perpendicular to a slope. | A permanent grassy strip keeps water from forming gullies even when the annual crop is harvested and removed. |

# WORKSHEET KEY

| PICTURE OF THE PRACTICE OR TECHNOLOGY | NAME IT/ GIVE IT A BRIEF DESCRIPTION | HOW DOES IT IMPROVE SUSTAINABILITY OF A FARM |
|---|---|---|
|  | **Managed Grazing**<br>Cows are rotated around the farm and eat fresh, living pasture during the growing season. | Living plant cover keeps the soil blanketed all year round and erosion is reduced or eliminated in well managed pastures. Animals do not make a muddy mess and ruin the soil. They poop in the field and spread their own manure. |
|  | **CAFO**<br>Large numbers of cows are kept in barns and concrete yards all year round. | Animals do not make a muddy mess and ruin the soil. Their manure is collected every day for spreading later. |
|  | **Portable fencing**<br>A reel with polywire that conducts electricity and gives a cow a shock if she tries to cross the wire. | Allows the farmer to control or manage how much a group of cows will eat in one day. This keeps them from making a muddy mess and over-grazing the land. |
|  | **Cover cropping**<br>A secondary, quick growing, crop is planted after the main crop has been harvested in the fall. The cover crop is plowed down in the spring just before planting time. | Living plant cover keeps the soil blanketed all year round and erosion is reduced. |
|  | **No-till planting**<br>The residue from the crop from the previous fall is left on the soil to protect it. Planting of the new spring crop takes place by opening a row space right through the residue. | Reduces the need for tillage while still allowing new crops to be planted. Reduces erosion from open, unprotected soil. |