**The relationship between agriculture and the environment**

 **Pillar 1 C. specific air pollution reduction practices used by farmers**

(9th – 12th Grade)

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| **Introduction**: <http://extension.uga.edu/k12/science-behind-our-food/environmental-science.cfm> **Website**: <https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture> **Hands On**: <http://www.carolina.com/teacher-resources/Interactive/air-awareness/tr10648.tr>  |

**Air Pollution Awareness Demonstration**

This demonstration is dedicated to raising your students' awareness of the air pollution created by their everyday activities. It costs almost nothing, yet really gets the point across in a dramatic way and prepares elementary through high school students for further studies in air pollution.

 **Background**

Each of your students begins the demonstration with a cup of clean water representing unpolluted air. During the demonstration, you'll read them 6 everyday activities from the [Air Pollution Awareness Sheet](http://www.carolina.com/teacher-resources/Interactive/air-pollution-awareness-sheet/tr21201.tr). Each of the activities generates one or more of the pollutants listed below. When your students recognize an activity that they have participated in, they add a drop of food coloring to their cups to represent the pollutant or pollutants created by that activity. At the end of the demonstration, their cups of colored water provide a striking visual reminder of each student's contribution to air pollution.

Familiarize yourself with the pollutants in the list below so that you can explain them to your students during the demonstration.

**Particulate matter (PM10)**—Particulate matter consists of airborne solids less than 10 micrometers in diameter. These tiny particles are easily inhaled into the lungs, where they can cause damage to lung tissue. Diesel fumes from busses and trucks are a source of airborne [particulate matter](https://www.epa.gov/pm-pollution%22%20%5Ct%20%22_blank).

**Sulfur dioxide (SO2)—** Sulfur dioxide is a toxic gas with a pungent odor. Electric power plants fueled by coal or oil are the primary source of sulfur dioxide pollution. Sulfur dioxide emissions can cause [sulfur dioxide](https://www.epa.gov/so2-pollution%22%20%5Ct%20%22_blank).

**Nitrogen dioxide (NO2)—** Nitrogen dioxide is a toxic, reddish brown gas byproduct of the combustion of fossil fuels (e.g., coal, diesel fuel, and gasoline). Nitrogen dioxide can irritate airways and increase susceptibility to respiratory diseases. It is also a factor in the formation of acid rain. Learn more about [nitrogen dioxide](https://www.epa.gov/no2-pollution%22%20%5Ct%20%22_blank).

**Carbon monoxide (CO)—** Carbon monoxide is a colorless, odorless toxic gas. Motor vehicles are the primary source of carbon monoxide pollution. CO is highly toxic. At low concentrations it causes drowsiness and headache; it is [carbon monoxide](https://www.epa.gov/co-pollution%22%20%5Ct%20%22_blank).

**Volatile organic compounds (VOCs)—** Volatile organic compounds are toxic gases made of carbon, hydrogen, oxygen, and other atoms that form gases easily. They are found in nature as well as in glue, paint, gasoline, tobacco smoke, and clothes that have been dry-cleaned. VOCs form ground level ozone, a main component of smog.

**Materials**

* Clear, plastic, 7-oz cups (one per student)
* Red, green, yellow, and blue food coloring (one set of colors per work group)
* Water

**Procedure (Teacher)**

* Divide your class into work groups of 3–4 students each.
* Give each student a clear plastic cup that is ¾ full of clean water.
* Give each work group a set of red, green, yellow, and blue food coloring.
* Discuss the list of air pollutants with your students, including as much technical detail as is appropriate to their grade level. Write the names and abbreviations of the pollutants on the board so that your students can refer to them during the demonstration, or distribute photocopies of the list to each work group.
* Read the Air Awareness Sheet to your students. They will complete the demonstration as you read from the sheet.

**Air Pollution Awareness Sheet**

We are often unaware of how our everyday activities contribute to air pollution. The purpose of this demonstration is to make you aware of the air pollution you create every day. The cup of clean water in front of you represents unpolluted air. You'll add drops of food coloring to the cup to represent the different types of air pollutants caused by the everyday activities that I'll describe to you. We'll use the following colors to represent these pollutants:

* **Blue—**pollutants from consumer products and paints (VOCs)
* **Green—**pollutants from lawn, garden, and construction machinery (CO, NO2, PM10, SO2, and VOCs)
* **Red—**pollutants from cars and trucks (CO, NO2, PM10, SO2, and VOCs)
* **Yellow—**pollutants from power plants and industrial processes (CO, NO2, PM10, SO2, and VOCs)

Listen carefully while I describe the following activities. If you participated in the activity during the past 24 hours, add one drop of the appropriate color of food coloring to your cup of water. Some activities may not apply to you (for example, applying nail polish or mowing the lawn). That's why you each have your own cup, because each individual's contribution to air pollution is unique.

**The activities**

1. **You showered and got ready for school.** Add one drop of **blue** and one drop of **yellow** food coloring to your cup if this activity applies to you.
**Blue—**VOCs emitted by soap, shampoo, deodorant, hair spray, perfume, and fingernail polish.
**Yellow—**CO, NO2, PM10, and SO2 emitted by combustion used to heat the water for the shower. Remember, electric water heaters often depend on combustion too, because a lot of power plants burn fossil fuels to generate electricity.
2. **You put on your favorite shirt, which your mom had dry-cleaned for you.** Add one drop of **yellow** food coloring to your cup if this activity applies to you.
**Yellow—**VOCs emitted by the dry-cleaning process.
3. **Coming to school, you took the bus or rode in a car.** Add one drop of **red** food coloring to your cup if this activity applies to you.
**Red—**CO, NO2, PM10, SO2, and VOCs emitted by the engine in your school bus or car.
4. **At lunchtime, you bought lunch in the cafeteria.** Add one drop of **yellow** food coloring to your cup if this activity applies to you.
**Yellow—**CO, NO2, PM10, SO2, and VOCs emitted by cooking lunch, Styrofoam trays, and plastic utensils.
5. **Going home, you took the bus or rode in a car.** Add one drop of **red** food coloring to your cup if this activity applies to you.
**Red—**CO, NO2, PM10, SO2, and VOCs emitted by the engine in your school bus or car.
6. **You mowed the lawn with a gasoline-powered lawnmower.** Add one drop of **green** food coloring to your cup if this activity applies to you.
**Green—**CO, NO2, PM10, SO2, and VOCs emitted by your lawnmower's engine.

**Discussion**

Ask your students the following questions:

1. Look inside your cups. If the air pollution around you were this apparent, would you want to breathe the air?
2. What other sources of air pollution, beyond those mentioned in this demonstration, could you think of as being produced in a single day?
3. What could you do to reduce the number of pollutants released each day?

If you have a container large enough, ask your students to pour their water into it, and then ask them to comment on the combined effect of each individual's pollution.

**The Sources and Solutions: Agriculture**



Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce how much fertilizer reaches water bodies.



Keeping animals and their waste out of streams keeps nitrogen and phosphorus out of the water and protects stream banks.

Farming operations can contribute to nutrient pollution when not properly managed. Fertilizers and animal manure, which are both rich in nitrogen and phosphorus, are the primary sources of nutrient pollution from agricultural sources. Excess nutrients can impact water quality when it rains or when water and soil containing nitrogen and phosphorus wash into nearby waters or leach into ground waters.

Fertilized soils and livestock can be significant sources of gaseous, nitrogen-based compounds like ammonia and nitrogen oxides. Ammonia can be harmful to aquatic life if large amounts are deposited to surface waters. Nitrous oxide is a potent greenhouse gas.

There are many ways that agricultural operations can reduce nutrient pollution, including:

* **Watershed efforts:** The collaboration of a wide range of people and organizations often across an entire watershed is vital to reducing nutrient pollution. State governments, farm organizations, conservation groups, educational institutions, non-profit organizations, and community groups all play a part in successful efforts to improve water quality.
* **Nutrient management:** Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce the potential for pollution.
* **Cover crops:** Planting certain grasses, grains or clovers can help keep nutrients out of the water by recycling excess nitrogen and reducing soil erosion.
* **Buffers:** Planting trees, shrubs and grass around fields, especially those that border water bodies, can help by absorbing or filtering out nutrients before they reach a water body.
* **Conservation tillage:** Reducing how often fields are tilled reduces erosion and soil compaction, builds soil organic matter, and reduces runoff.
* **Managing livestock waste:** Keeping animals and their waste out of streams, rivers and lakes keeps nitrogen and phosphorus out of the water and restores stream banks.
* **Drainage water management:** Reducing nutrient loadings that drain from agricultural fields helps prevent degradation of the water in local streams and lakes.