Greenhouse Gases

Soil
Water
Air
Air Quality Impacts
Greenhouse Gases
Odors
Ozone Precursors
Particulate Matter
Plants
Animals
Energy

Air Quality Impacts - Greenhouse Gases

Emissions increase atmospheric concentrations of greenhouse gases.

What is it?

Direct and indirect emissions of greenhouse gases (GHGs - primarily CO_2, CH_4, N_2O for agriculture) cause increased concentrations of GHGs in the atmosphere and can cause resultant changes in climate. Greenhouse gases from activities such as crop fertilization (natural and synthetic), tillage and agricultural soils management, manure management, livestock enteric fermentation, internal combustion engines, rice cultivation, and land use conversion contribute to excess agricultural greenhouse gas (GHG) emissions to the atmosphere. A portion of nitrogen fertilizer that is applied to crops and grasslands is volatilized through a complex microbial process (nitrification and denitrification) and emitted to the atmosphere as nitrous oxide (N_2O). Methane (CH_4) is produced as part of the normal digestive processes in animals and through the anaerobic (without oxygen) decomposition of manure and managed waste. The combustion of fossil fuels as an energy source results in direct carbon dioxide (CO_2) emissions to the atmosphere. Soil tillage increases soil organic matter decomposition and releases soil carbon, in the form of carbon dioxide (CO_2), to the atmosphere.

Why is it important?

Greenhouse gas, primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), accumulation in the atmosphere can have a potent impact on the climate. Greenhouse gases absorb and emit infrared radiation resulting in the "greenhouse effect," and can cause changes in climate.

What can be done about it?

There are many opportunities to reduce GHGs in agriculture. Planting and growing trees can provide long term solutions to sequester carbon dioxide (CO_2) from the atmosphere. Reducing tillage increases the ability of the soil to store carbon in the form of organic matter and reduces the release of nitrous oxide (N_2O). The efficient use of nitrogen fertilizer through split applications, soil injections and side-dressing can reduce nitrous oxide (N_2O) emissions. Anaerobic manure handling facilities, such as methane digesters or biogas recovery systems, can capture methane emissions from manure and supply renewable energy. Increasing on-farm energy efficiency and the use of renewable energy sources (solar, wind, and biofuels) can reduce greenhouse gas emissions.

Greenhouse Gases at a Glance

Problems / Indicators - Greenhouse gas emissions	
Causes	Solutions
• CO_2 emissions from the use of fossil fuels • CH_4 production from animal operations • CO_2 and N_2O from soil tillage • Loss of carbon from soils and plants • Excessive N_2O emissions from cropping systems	• Renewable energy (solar, wind, biofuels), and better combustion processes and efficiencies • Anaerobic manure handling facilities • Conservation tillage and reduced soil disturbance • Riparian forest buffers • Tree and shrub planting • Nitrogen fertilizer management

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Soil
Water
Air
Air Quality Impacts
Greenhouse Gases
Odors
Ozone Precursors
Particulate Matter
Plants
Animals
Energy

Air Quality Impacts - Odors

Emissions of odorous compounds - VOCs, ammonia, and odorous sulfur compounds - cause nuisance conditions.

What is it?

Agricultural odors are a complex mixture of gases that can evoke a wide range of emotional and physiological responses when encountered via the sense of smell. Many different compounds can be the potential cause of odors from agricultural operations. These compounds can generally be classified as VOCs, ammonia, or odorous sulfur compounds. The three primary sources of odor are manure storage facilities, animal housing, and land application of manure. Other sources can include burning, silage storage, and fertilizer and pesticide applications.

Why is it important?

Odors are mainly a community or individual perception issue; although some odorous compounds can cause health problems when encountered in high concentrations. Greater emphasis on addressing odors is likely to occur in areas that have negative community and individual perceptions of odors, especially in areas with a strong rural/urban interface.

What can be done about it?

Many common practices and management activities can help reduce the likelihood of odor impacts from animal operations. Among them are maintaining appropriate moisture content in and on open lot surfaces and using manure management techniques that minimize, recover, or control emitted gases. Windbreaks can be used to diffuse odor from animal confinement areas, and prescribed grazing can be used to minimize manure accumulation. Prescribed grazing and/or development of biofuels can be used as alternatives to burning excess biomass on rangelands. When rangeland burning is necessary, the development and implementation of prescribed burning and smoke management plans promote an efficient and effective burn.

Odors at a Glance

Problems / Indicators - Manure storage facilities, animal housing, manure and land application	
Causes	Solutions
• Confined animal areas • Manure application • Burning	• Moisture management to control dust and odors associated with livestock confinement areas • Manure injection for land application • Managing manure applications to reduce odor impacts • Manure treatments to control ammonia • Prescribed burning management • Windbreaks

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Resource Concerns

Air

Ozone Precursors

Soil
Water
Air
Air Quality Impacts
Greenhouse Gases
Odors
Ozone Precursors
Particulate Matter
Plants
Animals
Energy

Air Quality Impacts - Ozone Precursors

Emissions of ozone precursors - NOx and VOCs - resulting in formation of ground-level ozone that cause negative impacts to plants and animals.

What is it?

Agriculture can be a source of ozone precursor gases, oxides of nitrogen (NOx) and volatile organic compounds (VOCs), which chemically react in the atmosphere producing ground-level ozone (O_3) that can cause negative impacts to plants and animals. Ozone is not directly emitted into the atmosphere. It is formed in the atmosphere through chemical reactions of NOx and VOCs in the presence of sunlight. Biological organisms emit VOCs naturally. The breakdown or decomposition of biological materials such as manure, feed, or mortalities can produce VOCs (through incomplete breakdown/decomposition) and NOx (mainly from the nitrification/denitrification processes). Combustion in on-farm equipment or the burning of biological material produces NOx, and VOCs. Pesticide application can also emit VOCs.

Why is it important?

Although ozone in the upper atmosphere forms a layer that provides protection from ultraviolet radiation, ozone in the lower atmosphere and at ground level can be harmful. Since ozone is an allotrope of oxygen, its similar structure allows it to displace oxygen in the lungs, causing respiratory issues. Ozone is also an eye irritant causing red, itchy eyes. Plants are also affected by ozone. During the gas exchange process, ozone enters the leaves, causing chlorosis and necrosis. This reduces the plant's photosynthetic ability and can result in yield reductions.

What can be done about it?

Activities associated with integrated pest management decrease the use of chemical pesticides and resulting VOC emissions. New or retrofitted engines that offer more complete combustion of fuel can reduce NOx and VOC emissions. Fuels, chemicals, and pesticides should be properly stored. Prescribed burning can be implemented to minimize NOx and VOC emissions from incomplete combustion of fuels, to manage fuel load, and to prevent or reduce wildfires. Alternatives to burning will also reduce VOC and NOx emissions. A comprehensive nutrient management plan can be used to reduce emissions of nitrogen oxides. For animal operations, implementing housecleaning techniques, maintaining moisture content in open lot surfaces, using a liquid manure management system, covering the surface of storage piles, and using feed management or feed additives to minimize intestinal and manure VOC production can reduce the production and emission of ozone precursor gases.

Ozone Precursors at a Glance

Problems / Indicators - Engines, pesticides, burning, tillage, and animal operations	
Causes	Solutions
• Chemical storage and application • Combustion (engines, burning) • Animal operations • Manure handling	• Proper chemical storage and integrated pest management • Engine replacement and retrofit • Prescribed burning and alternatives, wildfire risk reduction • Animal housing and surface lot moisture maintenance • Liquid manure systems, manure covers, feed management • Comprehensive nutrient management planning

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Natural Resources Conservation Service

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Air

Particulate Matter

Soil

Water

Air

Air Quality Impacts

Greenhouse Gases

Odors

Ozone Precursors

Particulate Matter

Plants

Animals

Energy

Air Quality Impacts - Particulate Matter

Direct emissions of particulate matter (PM) – dust and smoke – as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions – ammonia, NOx, and VOCs.

What is it?

Particulate matter is classified by its size where PM2.5 and PM10 have an aerodynamic diameter less than 2.5 and 10 micrometers, respectively. PM2.5 is directly emitted to the atmosphere by combustion processes (vehicles, fire) and to a lesser degree by mechanical means such as dust from roads or tillage. PM2.5 is also formed in the atmosphere by chemical reaction of PM precursor gases; oxides of nitrogen (NOx), volatile organic compounds (VOCs) and ammonia (NH_3). Sources of these PM precursor gases can be engines, fertilizer application, and animal operations. Much of PM10 is mechanically generated and directly emitted to the atmosphere by actions that disaggregate the soil such as tillage operations, road and field travel, animal movement, harvesting and wind erosion. Larger PM is typically geologic in origin.

Why is it important?

Particulate matter in the atmosphere can be a human health issue and lead to visibility degradation. It can also impact ecosystems when it deposits out of the atmosphere. The body's natural defenses can filter out larger particles, but smaller particles can get past the nasal passageways getting into the lungs. PM can also create poor visibility which affects transportation (ex. dust or smoke) and federally protected scenic vistas. Deposition may adversely affect ecosystems by causing nuisance dusting, changing pH balance, damaging plants or by adding additional nitrogen to the environment.

What can be done about it?

Reducing field operations by using residue management and precision farming reduces PM. Plants protect soil from disturbance and intercept PM after it is lifted into the atmosphere. Reducing vehicular miles and speed or treating unpaved roads with a suppressant can reduce dust. For combustion sources, smoke management, alternatives to burning, wildfire risk reduction, engine replacement and retrofits reduce PM and PM precursor emissions. For animal operations, cleaning and ventilating livestock houses, maintaining moisture content in open lot surfaces, periodically removing manure, covering the surface of storage piles, and removing feed and manure from storage piles in a manner that minimizes surface disturbance can all reduce PM and PM precursor emissions. Windbreaks can intercept airborne PM and modify the wind patterns such that PM entrainment and transport are reduced.

Particulate Matter at a Glance

Problems / Indicators - Dust, smoke, chemical and fertilizer use, animal activities	
Causes	Solutions
• Unpaved roads • Bare/exposed agricultural fields • Operations on agricultural fields • Chemical applications • Combustion (engines, burning) • Animal operations	• Reduce travel/speed and treat unpaved roads • Residue management, precision farming • Wind barriers • Smoke management, wildfire risk reduction • Engine replacement and retrofit • Open lot manure harvesting/removal and coverage • Animal housing maintenance and ventilation

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