



MIGHTY



Mystery Meat II:

The Industry Behind the Quiet
Destruction of the American Heartland



Meat defines the American diet. In 2015, the average American ate 211 pounds of meat,¹ and the United States leads the world in meat production. The scale and environmental impact of the meat industry is enormous: more than a third of all land in the continental U.S. is dedicated to growing feed crops and providing the pastures to raise meat.

What Americans may not know is that feed is the primary source of meat's growing environmental impact. Demand for feed crops is driving widespread water contamination across the country, destroying America's last native prairies, and releasing potent greenhouse gases.

For instance, when excess fertilizer and manure wash off fields that grow feed, they contaminate local drinking water and create toxic algae blooms that cause vast Dead Zones that are toxic to aquatic life in the Gulf of Mexico, Chesapeake Bay, and Great Lakes. As demand for meat grows, America's last native grassland prairies are being destroyed to make room for new industrial fields that exacerbate water pollution across the Heartland and take a heavy toll on the climate.

While there has been significant research into the vast environmental and public health impacts of the meat industry, there has been little exploration of who exactly is responsible. This investigation attempts to fill that gap by shedding light on the industries and specific companies driving meat's environmental impact in America. We undertook an in-depth investigation of the supply chains of America's largest meat companies. We mapped the meat and feed companies' extensive infrastructure, including grain silos, feed mixing facilities, feedlots, and slaughterhouses, and overlaid the maps with data showing both natural grassland clearance for corn and soy, and water nitrate concentrations linked to fertilizer pollution.

Our research found that these impacts are driven primarily by the large agribusinesses that comprise America's meat industry. At the pinnacle of this concentration of power is Tyson Foods, America's largest meat company, which

produces one out of every five pounds of all meat raised in the United States. Tyson is renowned for pioneering and consolidating our modern industrial meat system.

Our analysis also found Tyson to be the dominant meat company in all the regions suffering the worst environmental impacts from industrial meat and feed production – from grassland clearing in Nebraska, Iowa, and Kansas, to manure and fertilizer pollution pouring into waterways from the Heartland down to the Gulf states.

The scale and concentration of the meat industry's market power means that decisions made at the top shape the entire industry. Tyson drives the demand for huge quantities of feedⁱ without applying any known sustainability screen to its purchases – essentially, normalizing a no-questions-asked approach to the environmental impact of meat production. The company's market dominance means that it has standardized many of the practices and market incentives contaminating our water and destroying our landscape today. But it also means that Tyson has the ability to lead the transformation of America's agriculture industry to end these harmful practices.

Sustainable, regenerative agriculture is already being used to produce food with fewer negative impacts. This report concludes with a roadmap for what companies can and should do to live up to the environmental and ethical expectations of their customers – the American public. With demand for meat projected to rise dramatically and consumers increasingly concerned about the sustainability of our food system, the stakes could not be greater.

ⁱ For instance, Tyson and its suppliers buy enormous quantities of corn and soy for from grain traders like ADM, Cargill, and Bunge which rely on the meat companies' massive purchases for a bulk of their profits.

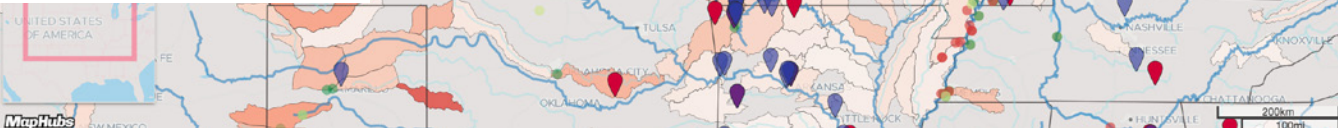
Nitrate Levels by Watershed

- Tyson Feed Facilities FDA Medicated Feed Facilities
- Tyson Meat Processing Facilities USDA
- ADM Grain Processing Facilities ADM
- ADM Grain Elevators ADM
- ADM Feed Facilities FDA Medicated Feed Facilities
- Bunge Grain Elevators Bunge
- Cargill Feed Facilities FDA
- Cargill Grain Silos Cargill
- Cargill Meat Processing Facilities USDA
- Major River Natural Earth
- Minor Rivers Natural Earth
- States Natural Earth

Nitrate Levels by Watershed 2016

- 0-1.6 mg/l
 - 1.6-4.4 mg/l
 - 4.4-8.6 mg/l
 - 8.6-17.8 mg/l
 - 17.8-32 mg/l
- EPA Storet; USGS NWIS

Base Map © OpenMapTiles © OpenStreetMap contributors



MAP OF NITRATE LEVELS BY WATERSHEDS, 2016 OVERLAID WITH TYSON AND TOP FEED SUPPLIER FACILITIES

Nitrate contamination is primarily caused by pollution from feed crops.

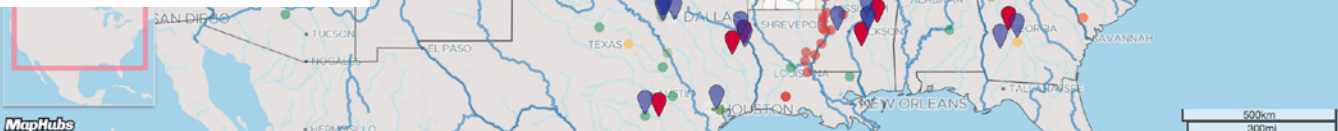
Grassland Conversion by County

- Tyson Feed Facilities FDA Medicated Feed Facilities
- Tyson Meat Processing Facilities USDA
- ADM Grain Processing Facilities ADM
- ADM Grain Elevators ADM
- ADM Feed Facilities FDA Medicated Feed Facilities
- Bunge Grain Elevators Bunge
- Cargill Feed Facilities FDA
- Cargill Grain Silos Cargill
- Cargill Meat Processing Facilities USDA
- Major River Natural Earth
- Minor Rivers Natural Earth
- States Natural Earth

Grassland Conversion 2007-2016 by County

- 0-5%
 - 5-10%
 - 10-15%
 - 15-20%
 - 20-25%
- USDA NASS CDL

Base Map © OpenMapTiles © OpenStreetMap contributors



MAP OF GRASSLAND CONVERSION BY COUNTY, 2016 OVERLAID WITH TYSON AND TOP FEED SUPPLIER FACILITIES

Conversion of grassland, which includes native prairie, is primarily caused by expanding feed crops.



Industry Overview: Factory Farms, Monoculture Landscapes of Feed, and Consolidation in the Heartland

The United States is the world's largest producer of beef and poultry² and the third largest producer of pork.³ In 2015, the U.S. produced 24 billion pounds of beef, in addition to 40 and 25 billion pounds of chicken and pork, respectively.⁴ In order to understand the environmental impacts of producing all of this meat, and to identify the companies responsible, it is important to understand how the industry and its supply chains are structured.

Consolidated Control of Industrial Meat

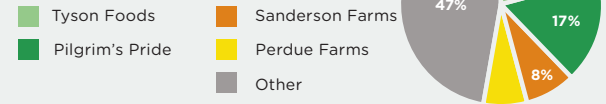
Despite common media depictions of small picturesque farms, the reality is that just five companies produce most meat in the United States, under a highly industrialized and centralized factory-farm system. While most animals were produced on small farms decades ago, large, industrial factory farms now control the market: anywhere from 50 to 75 percent of meat markets are now controlled by just four companies each, with Tyson controlling over 20 percent of the chicken, beef and pork markets.⁵ Industrialized farming confines thousands of hogs, chickens, and cattle in tight factory-like spaces,ⁱⁱ and concentrates corporate control over production standards, especially for hogs and chickens.

Monocrop Landscapes of Industrial Feed

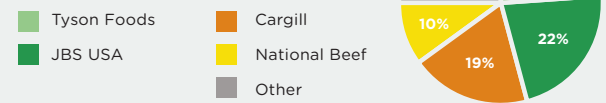
Raising all of America's meat animals requires vast amounts of corn and soy, which are the most widely grown crops in the United States. Around 40 percent of the corn and 70 percent of the soy grown in the United States go to raise meat, making the industry the single largest market for both of these crops.⁶ Just four companies control more than 85 percent of both the corn and soy processing market in the U.S.⁷ The agricultural traders ADM, Bunge, and Cargill—nicknamed the ABCs of global agriculture—consistently rank as the top grain processors in the U.S.⁸ These companies are the primary suppliers of feed grain to the meat industry, and their dominant market influence shapes the feed supply chain. These companies have adopted policies to improve the sustainability of raw materials they source overseas—for example, by forbidding deforestation for palm oil grown in Southeast Asia—but have adopted few policies to ensure that feed sourced in the United States is responsibly grown.

Leading U.S. Meat Producers

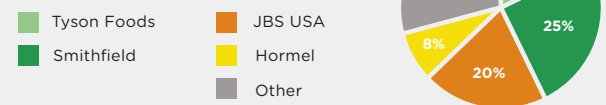
U.S. CHICKEN PRODUCERS



U.S. FED BEEF PACKERS

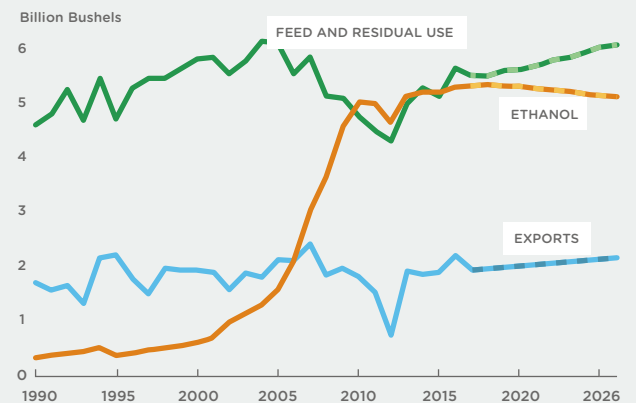


U.S. PORK PACKERS



Source: Tyson Foods, Inc. Investor Presentation May 2017

U.S. Projected Corn Use by Type through 2026

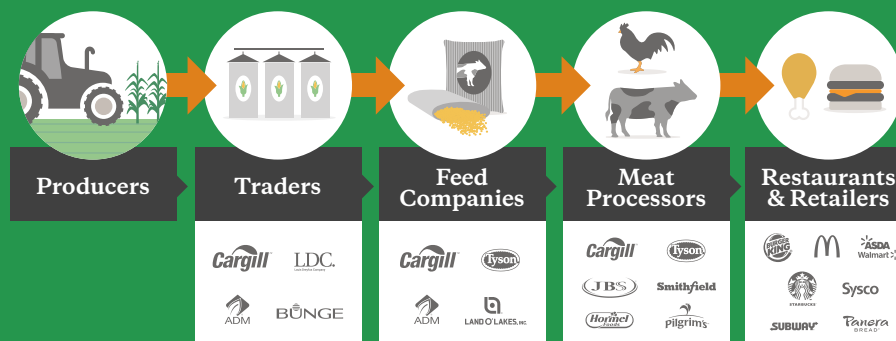


Source: USDA, Economic Research Service Agricultural Baseline Database.

ii Termed by the industry as Confined Animal Feeding Operations, or popularly called 'CAFOs'

iii While the boom in corn ethanol production has also become a major demand driver in recent years, about a third of the corn processed in ethanol facilities is sold as animal feed, and the domestic meat industry remains the single top market for this crop.

How Animal Feed Moves through the Meat Supply Chain



Geographic Concentration – The Midwest

Given the interdependence between the meat and feed crop industry, it is not surprising that our analysis found both industries to be primarily concentrated in the same regions of the American Heartland. Corn and soy are primarily grown in the aptly-named “Corn Belt” of the American Heartland, and minimizing transportation costs associated with meat and feed production is a key strategy

for both industries. As the meat industry has grown, demand for corn and soy has followed. Our analysis found that the supply chain—from producing the feed to raising the animals—and its environmental impacts are most concentrated in the American Heartland. The impacts are felt beyond the Midwest however, as pollution flows down along major rivers until it reaches the Gulf.

The Company Behind the Rise of Industrial Meat

Tyson is America’s largest meat company, controlling over 20 percent of the chicken, beef, and pork markets in the U.S. The company is recognized as the pioneer of the highly concentrated, industrialized meat system that dominates the industry today—expanding its market share by buying smaller competitors, and taking control of nearly all aspects of production, particularly in the poultry and pork supply chains. Tyson played a key role in the rise of America’s fast food industry, working directly with major fast food brands to introduce cheap chicken products, like McDonald’s “McNuggets” and Burger King’s “Chicken Tenders,” into Americans’ diets.⁹

Golden Island snacks, Sara Lee bread, Gallo Salame, and Chef Pierre breakfast pies.¹⁰ Tyson’s website claims it sells more pepperoni in the U.S. than any other company¹¹ and is the #2 producer of frozen food.¹² Tyson also sells beef, pork, and prepared foods to fast food chains, hotels, healthcare facilities, the military, foodservice distributors, and grocers.¹³ Fifty-three percent of its 2016 sales were of branded products sold directly to consumers, with Walmart as its largest single customer, accounting for 18 percent of sales.¹⁴ Nearly 30 percent of sales were to the food service industry,¹⁵ which includes companies such as McDonald’s and Burger King.

Tyson has come under investigation by state and federal governments for abusing its dominance in the market to fix prices, inadequately compensating farmers for raising the animals it processes, and other anticompetitive behavior aimed at boosting corporate profits that have come at the expense of both farmers and consumers.



To keep up with orders from companies like McDonald’s and Walmart, Tyson slaughters 125,000 head of cattle, 35 million chickens, and 415,000 hogs¹⁶ every week—nearly equal to the human population of California¹⁷ To raise all of this meat, Tyson requires an estimated *five million acres of corn*—greater than the size of New Jersey—each year, not to mention other feed like soybeans, which it buys from the major feed suppliers.¹⁸ While Tyson isn’t the only company driving the large-scale environmental problems associated with meat production, the company’s size, market control, and ability to shape the industry make its influence over the meat and feed markets very powerful.

While most consumers know Tyson by its red and yellow logo on the packaging of its chicken products, its other brands include Jimmy Dean and Aidells sausages, Hillshire Farm lunchmeat and sausages, Ball Park hot dogs, Wright bacon, State Fair corn dogs, Van’s and



The Impact: Contaminating Landscapes from the Heartland to the Gulf

Fertilizer Pollution from Fields of Feed

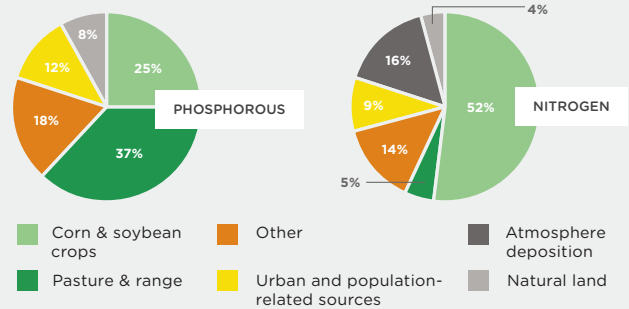
The manure and fertilizer pollution washing off corn and soy fields, which are largely used to grow feed, is the leading cause of water contamination in the country. Nitrogen (N) and phosphorus (P) are the main nutrients that crops need to grow, and typically come from manure and chemical fertilizers applied to fields. However, these nutrients become a major source of pollution when too much is applied or fields are improperly managed—washing off into nearby waterways and emitting potent greenhouse gases.^{iv} Pollution washing off crop fields is largely unregulated, and spraying excess manure onto nearby fields is a common method of cheap manure disposal for the meat industry, increasing the industry’s pollution footprint. *We use the common term “fertilizer pollution” to refer to both the manure and chemical forms of fertilizer pollution washing off feed crop fields in this report.* Although fertilizer pollution is preventable, the USDA estimates that at least two out of every three cropland acres fail to meet its best management practice criteria to prevent fertilizer runoff into nearby waterways. Furthermore, estimates suggest that around 40 percent of fertilizer applied to crops is never absorbed by plants.¹⁹ Heavy rainfall, soil erosion, and the destruction of wetlands and grasslands that normally absorb runoff are all factors that encourage manure and chemical fertilizers applied to fields to end up polluting surrounding waterways.

Nitrate pollution from fertilizer is a leading source of drinking water contamination across the country, but disproportionately affects Midwestern states where most feed crops are grown. Drinking water contaminated by nitrate pollution is linked to cancer, birth defects, thyroid problems, as well as a serious condition called Blue Baby Syndrome, which lowers the amount of oxygen in infants’ blood.²⁰ The U.S. Geological Survey (USGS) estimates that high levels of nitrates are found in more than 50 percent of rural water sources, particularly in Midwestern states, with 20 percent of water unsafe to drink.²¹ A recent analysis from the Environmental Working Group of 2015 public water

Livestock generate thirteen times more manure than humans in the United State. However, unlike human waste, livestock manure is generally not treated before it is released into the surrounding environment. Whereas smaller, diversified farms are able to spread their manure onto nearby crop fields at volumes where it can be absorbed, industrialized farms generate manure in such vast quantities that simply dumping it on nearby crop fields is not a viable option for responsible disposal.

Sources of Nutrients Delivered to the Gulf of Mexico

According to the USGS, “Illinois, Iowa, Indiana, Missouri, Arkansas, Kentucky, Tennessee, Ohio and Mississippi make up only one-third of the 31-state Mississippi River drainage area, but contribute more than 75 percent of nitrogen and phosphorus to the Gulf.



utility data found that 7 million Americans are exposed to unhealthy levels of nitrate contamination in their drinking water. The chart in Appendix 1 lists those counties where EPA and USGS data show nitrate concentrations exceed the federal safe drinking water standard, leaving the cost of removing excess nitrates to public municipalities.

Meat’s Fertilizer Spill

Fertilizer pollution is also the leading cause of annual toxic algae blooms that cause waterways across America to collapse into Dead Zones, which are toxic to marine life and unhealthy for recreationalists. While fertilizer pollution starts in the Midwest, it flows down the Mississippi River until it finally dumps out into the Gulf of Mexico, which collapses into one of the world’s largest Dead Zones each year as a direct result. **Approximately 1.15 million metric tons of nitrogen pollution flowed into the Gulf of Mexico in 2016 alone,²² which is around 170 percent more pollution than was dumped into the Gulf by the BP oil spill.** While the BP spill was recognized as a major industry disaster on a national scale, fertilizer spills into the Gulf every year with little scrutiny or accountability. This year’s Dead Zone is projected to be one of the largest ever, due to record levels of nitrate pollution flowing down the Mississippi River.²³

The EPA calls water pollution from excess nitrogen and phosphorus “one of America’s most widespread, costly, and challenging environmental problems.”²⁴ Current estimates indicate that two thirds of the coastal rivers and bays in the United States are moderately to severely degraded from excess nitrogen pollution.²⁵

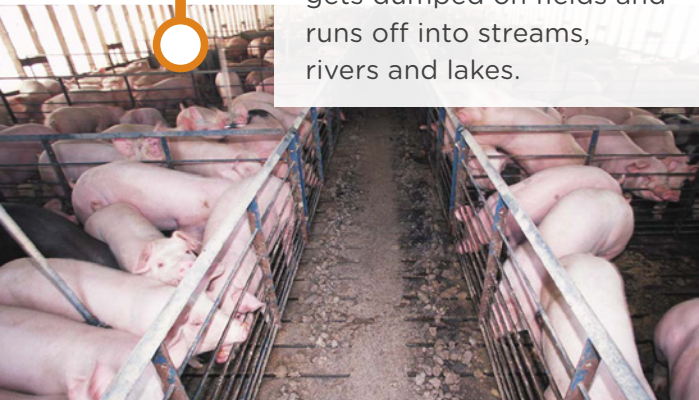
^{iv} Excess nitrogen from fertilizer volatilizes into the atmosphere to become nitrous oxide, a gas 300 times more potent than carbon dioxide.

Water Pollution in the American Heartland



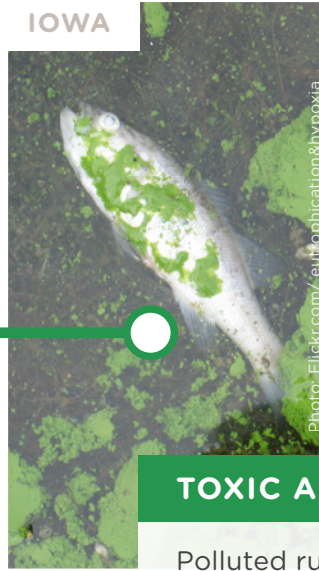
HOG PRODUCTION

Confined Animal Feeding Operations (CAFOs) produce huge amounts of animal manure that often gets dumped on fields and runs off into streams, rivers and lakes.



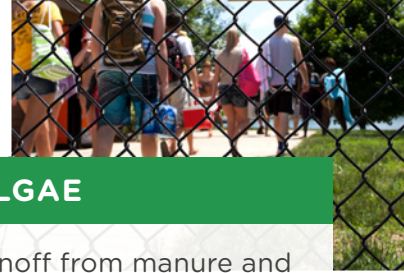
IOWA, NEBRASKA, KANSAS, MISSOURI

IOWA



TOXIC ALGAE

Polluted runoff from manure and chemical fertilizer causes toxic algae outbreaks in lakes and rivers across the country, contaminating drinking water and endangering public health.



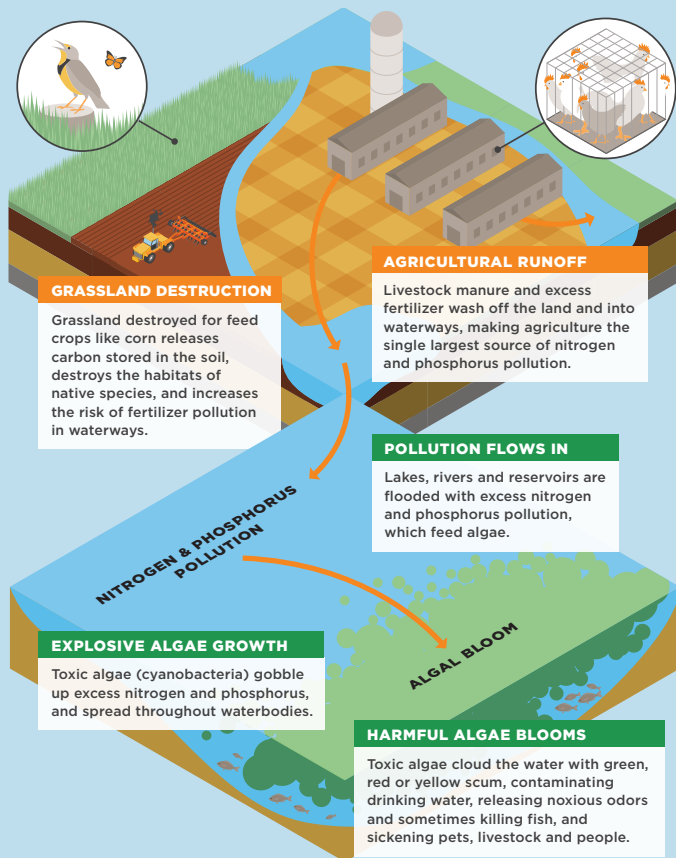
DEAD ZONE

Pollution accumulates as it flows downstream to the Gulf of Mexico, causing an oceanic Dead Zone that decimates Gulf communities, fisheries and livelihoods every summer. This year's Dead Zone is expected to be among the largest on record.





Fertilizer Pollution Starts Upstream



Toxic Algae Impacts

WARNING! DO NOT:



DRINK
Contaminated water can make people and animals ill



FISH
Handling exposed fish is dangerous



SWIM
People and pets risk illness by entering contaminated water



SMELL
Emits noxious, unpleasant fumes



EAT
Eating exposed fish can cause illness



HAVE FUN
People and pets should avoid all recreation in affected waters

Solutions

ECOSYSTEM CONSERVATION

Protecting natural grassland and wetlands from development can reduce fertilizer pollution, help to maintain a healthy environment for fish, wildlife, and plants, and make it harder for toxic algae to take hold.

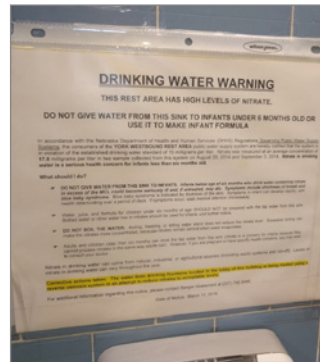
AQUATIC BUFFERS

Creating and maintaining natural buffers—using trees, shrubs and other plants—between farmland, development and waterways can help filter out excess nitrogen and phosphorus before they reach the water.

COVER CROPS

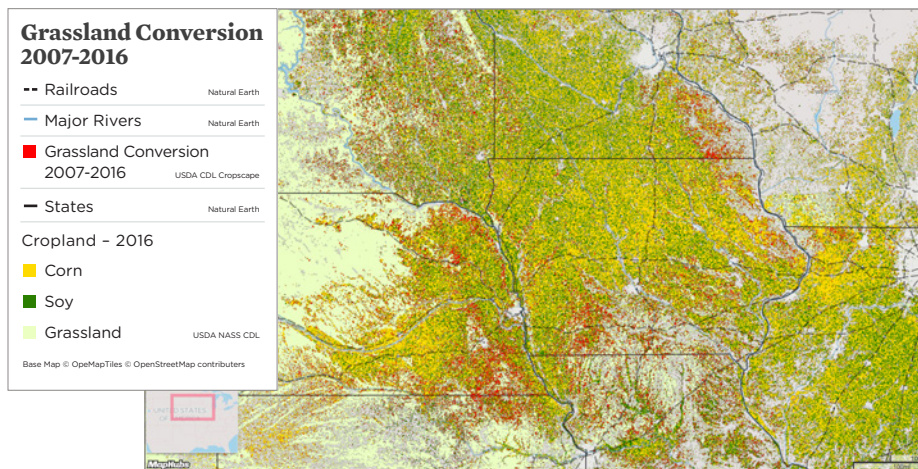
By planting farmland with cover crops instead of leaving the land bare between cash crops, farmers can protect soil from erosion and absorb excess fertilizer, helping to keep nutrients out of nearby waterways.

The Costs to Taxpayers



Fertilizer pollution affects millions of Americans that use and rely on waterways. Families, children, farmers, fishermen, recreationalists and even pets are affected. Because most of the pollution from crop fields is classified as unregulated “non-point source” pollution, the cost of fertilizer pollution is borne by communities and industries downstream. Each year, Americans are forced to spend nearly \$1 billion on bottled water due to agricultural nitrate pollution.³¹ And the U.S. Department of Agriculture (USDA) estimates public water treatment costs to remove nitrates originating from cropland are even higher: \$2 billion annually.³² Earlier this year, the city of Mankato, MN announced that unprecedented spikes in nitrate contamination will force the city to tap into the region’s underground aquifer, which is already overdrawn, or pay \$4 - 5 million to treat the water.³³ Residents of Des Moines, IA spent \$1.5 million in 2015 to remove nitrates from drinking water in an attempt to make it safe to drink.³⁴ The city sued upstream counties over this nitrate contamination, particularly from the Raccoon Watershed where Tyson dominates agricultural production. The lawsuit ultimately failed, and a local journalist who received a Pulitzer Prize for his investigative work into agribusiness interests attributes the result to the money and political influence from the Farm Bureau,³⁵ which represents Tyson and other agribusiness interests. More than 60 Iowa cities and towns have battled high nitrate levels in their drinking water over the past five years.³⁶ Cases like these have plagued Midwestern cities and towns for years, but record acres of corn production in recent years have worsened water pollution problems.

The American fishing industry is heavily impacted by fertilizer pollution washing downstream. The National Oceanic and Atmospheric Administration (NOAA) estimates that harmful algal blooms, caused mostly by fertilizer run off, cost \$82 million each year in lost fishing revenues and additional public health expenditures.³⁷



Prairie Destruction: Expanding the Pollution Frontier

Growing demand for feed crops is behind the destruction of millions of acres of natural grasslands, including native prairie, in recent years, which have been turned into industrial corn and soy fields.³⁸ This conversion is driving fertilizer pollution into areas normally buffered by natural landscapes and has released large amounts of carbon stored in plants and soil.

A recent University of Wisconsin study estimated that the recent loss of natural grassland “could have emitted as much carbon dioxide into the atmosphere as 34 coal-fired power plants operating for one year — the equivalent of 28 million more cars on the road.” This does not even account for the lost carbon capture capacity for absorbing emissions moving forward.

The iconic American prairie is one of our nation’s few remaining native ecosystems. Expansion of crop fields is driving its destruction at one of the highest native ecosystem loss rates in the world—nearly equal to deforestation in Brazil and Southeast Asia. Rates this high have not been seen since the Great Dust Bowl here in the U.S.³⁹ A 2013 Wright and Wimberly study **called recent loss of natural grasslands “one of the most important land cover/land use change events in recent U.S. history,”⁴⁰ leading U.S. grasslands to be classified as one of the most threatened biomes in the world.⁴¹**

Stripping grassland landscapes bare and covering them in industrial crop fields exacerbates fertilizer pollution by removing natural buffers and increasing soil erosion, as depicted in the photos below. For example, a 2016 study that analyzed the consequences of native ecosystem losses in the Midwest points to a 1200 percent increase in nitrate concentrations in regions of Iowa where Conservation Reserve Program (CRP) grasslands were plowed under to plant crops.⁴² Our analysis of grassland conversion to corn and soy found that many of the counties experiencing the highest conversion rates border the Missouri and Mississippi rivers, which flow into the Gulf of Mexico, and that USGS water quality data shows nitrate levels have recently increased in the watersheds just downstream from these regions.⁴³ The USGS analysis of national water quality trends released earlier this year shows high or increasing nitrate concentrations in several of the regions experiencing the highest rates of natural grassland conversion to corn and soybean production, such as eastern Nebraska⁴⁴, where nitrate problems have become so bad that doctors recommend pregnant women only drink bottled water in some regions.

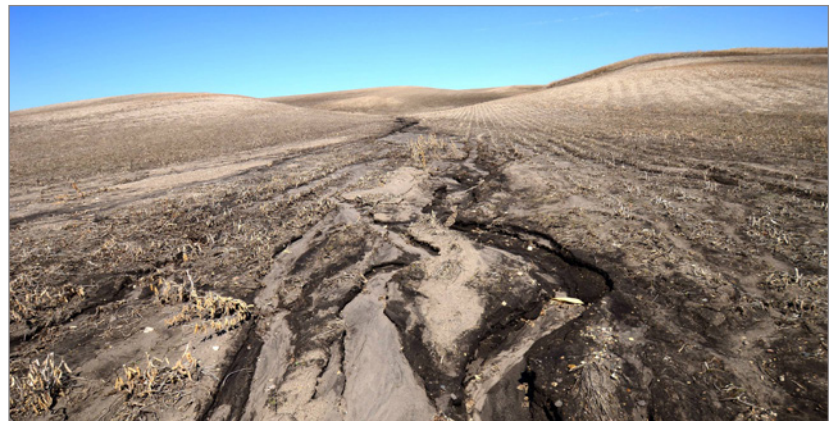
TYSON AND ITS INDUSTRY PEERS ARE CONSISTENTLY RANKED AMONG THE BIGGEST POLLUTERS IN AMERICA.

A report from Environment America calculated that Tyson generated more than 55 million tons of manure in 2016. According to the EPA’s Toxic Release Inventory (TRI), it dumped 104 million pounds of pollutants directly into waterways between 2010-2014, making it the country’s second largest polluter, second only to AK Steel. Tyson has been the subject of multiple lawsuits for illegally discharging untreated manure as well as slaughterhouse waste from its facilities directly into waterways, where it is flushed downstream. In one example, the State of Oklahoma filed a lawsuit alleging that Tyson polluted drinking water in the Illinois River Watershed (in Arkansas and Oklahoma) with excess poultry manure.²⁶ However, when Oklahoma Attorney General Scott Pruitt (now the EPA Administrator) took over the case, the judge did not issue a ruling, and Pruitt did not file an appeal. EWG found that Pruitt received \$21,700 in campaign contributions from Tyson executives and lawyers during this time,²⁷ and that nearly a tenth of Pruitt’s 2010 campaign contributions came from agricultural interests. These pollution violations have caught the attention of investors, and a coalition of investors has been pushing Tyson since 2015 to adopt a water stewardship policy to prevent further pollution incidents, with supporting votes from other investors increasing each year.²⁸ Much of the pollution from agriculture is unregulated, however, and the meat industry is actively involved in lobbying against water pollution limits. Trade groups, like the Farm Bureau, that represent industrial meat production Tyson is associated with²⁹ have lobbied in Washington, D.C., to eliminate EPA’s clean water rule, among other environmental safeguards.³⁰



The destruction of iconic American prairies destroys the remaining habitat of native species like monarch butterflies, bees, pheasants, and prairie dogs, whose habitat has already been shrunk by 150 years of prairie clearance to serve agriculture. Many of the world's largest food and agricultural companies - including ADM, Cargill, and Bunge - have pledged to protect native ecosystems in the tropics from expanding crop production.

However the destruction of prairies here at home remain largely unprotected. The ethanol industry is also responsible for driving expansion of corn into native ecosystems. However around a third of the grain entering ethanol facilities is processed into Dry Distillers Grains (DDGs) that is sold as animal feed,⁴⁵ and the meat industry remains the biggest buyer of corn and soy.



The Companies Responsible

To find out which companies were driving and expanding the fertilizer pollution crisis, we mapped the grain silos, feed facilities, and slaughterhouse facilities of the top meat and feed companies. We combined that with nitrate concentration data collected by EPA and USGS sensors in 2016, as well as with land-cover data from the National Agricultural Statistics Service Data Layer showing

conversion of grassland to corn and soy between 2007-2016. While tracing the feed from the slaughterhouse back to the field is challenging, meat companies tend to source grains as close to production as possible to minimize transportation costs. It's reasonable to assume that the companies with major facilities located in the Corn Belt are dominant buyers from the surrounding region.

What We Found

- ▶ **We found that Tyson and Smithfield have the heaviest concentration of meat facilities in those regions of the country with the highest levels of nitrate contamination,** although Cargill, Hormel, and JBS also have several facilities in the region. ADM, Bunge, and Cargill each have a sprawling network of operations in these same regions, and are the primary feed suppliers for the surrounding meat companies. We found that Tyson is the only meat company with major processing facilities in each of the states listed by the USGS as contributing the highest levels of pollution to the Gulf.
- ▶ **Iowa, where 65 percent of the state is covered in corn and soy, is suffering the highest concentrations of nitrate pollution in the country, at levels far exceeding the federal standard for safe drinking water.**⁴⁶ The meat industry is heavily concentrated in this state. Tyson and Smithfield each have six major pork processing facilities in Iowa. Tyson appears to be the dominant meat company in the highly contaminated Raccoon Watershed. Both Tyson and Smithfield likely source most of their feed crops locally to grow pigs in their tightly controlled network of contract farmers. Spraying excess manure on fields is a common disposal practice among the livestock industry in Iowa, and local community groups have been trying for years to restrict the practice due to its polluting impacts on waterways.⁴⁷ Neither company has a policy against this practice.
- ▶ **Tyson is also the dominant meat producer in the Ozark Plateau region of northwest Arkansas and Southwest Missouri.** These regions are experiencing elevated nitrate concentrations and have some of the highest concentrations of phosphorus contamination rates in the country. In these areas meat and feed facilities are concentrated near major rivers that flow into the Mississippi and then directly into the Gulf of Mexico, where the excess nitrogen and phosphorus pollution from upstream causes one of the largest Dead Zones in the world each year.
- ▶ **Our analysis found that Tyson’s top feed suppliers are behind the bulk of recent natural grassland clearance,** with the network of Cargill and ADM facilities dominating the market for corn and soy through their network of grain elevators and feed silos in all the states with the highest rates of conversion. Cargill and ADM have at least 20 grain elevators buying corn from regions where grassland loss rates are highest, and Tyson has four major beef and pork facilities, including the recent construction of the world’s largest beef plant, in Nebraska,⁴⁸ the state with the highest rate of grassland loss. JBS, Smithfield, and Cargill have fewer facilities in these regions.
- ▶ **We found that many of the counties experiencing the highest rates of grassland clearance border the Missouri and Mississippi Rivers that flow directly to the Gulf.** The expansion of new fields in these areas is likely contributing to what is projected to be the biggest Dead Zone ever this year.

Watershed Name	States	Nitrate (mg/l)	Area SQKM
North Raccoon	IA	17.8	6453
Little Sioux	IA,MN	17.2	7286
Logan	NE	13.6	2744
Upper Iowa	IA	16.2	3763
Boone	IA	16.7	2361
Middle Iowa	IA	11.8	4348
Sulphur Springs Draw	NM,TX	10.0	4490
Turkey	IA	14.9	4400
Little Nemaha	NE	10.5	2312



The Path To Cleaner Meat

From feed to slaughter, our analysis found the meat industry to be the driving force behind some of the most urgent environmental crises facing our country. With water pollution worsening, native ecosystems disappearing, regulations weakening, and consumers demanding a more sustainable food system, the meat industry needs to take responsibility for cleaning up the pollution in its supply chain and leading U.S. agriculture toward a more sustainable future.

As America's largest meat company, Tyson's commercial power shapes nearly every aspect of our country's agriculture- from the crops raised for feed, to the confined feedlots where animals are fattened before slaughter, to the policies that regulate the industry. Tyson has used its prominent role in the supply chain to drive the industrialization of American meat production, with little attention paid to the environmental impacts of the system. Its market dominance and regional influence means that commitments from Tyson can transform the entire industry. Public concerns about how industrial meat is produced has not escaped the company's notice, and Tyson's new CEO has stated in multiple public outlets that capitalizing on consumer interest in more sustainable protein will be a core strategy for the company's future growth. If this sentiment is sincere, Tyson could play a

pivotal role in transforming our meat and agricultural systems to reduce pollution and regenerate the landscape of our country.

While manure and methane emissions from direct livestock and poultry production are important sources of pollution, assessments consistently highlight feed as comprising the dominant bulk of the industry's environmental impact- from greenhouse gas emissions to native ecosystem clearance and water pollution. A pledge to raise meat on feed grown using sustainable and regenerative practices that prevent fertilizer runoff, improve soil health, and protect natural landscapes needs to be a central strategy of the meat industry's sustainability efforts.

Recent commitments from a growing number of food companies like Kellogg's, General Mills, Walmart, PepsiCo, and even Tyson's competitor, Smithfield, are showing the way forward. These companies have committed to improve fertilizer and soil-health practices in their U.S. crop supply chains and have launched programs and practices that Tyson and other meat producers can adopt to drive improvements in their supply chains. The meat industry needs to ensure that suppliers have the tools, information, and financial support necessary to implement better practices.



Tyson and other meat producers in the industry should immediately adopt the following measures:

1 Raise all Meat Using Pollution-Free Feed: Ensure all animal feed comes from suppliers with clear, verifiable policies to prevent fertilizer pollution from croplands.^v Animal feed suppliers should verify all fields they source from are enrolled in and reporting on nutrient management systems that prevent nitrogen and phosphorus runoff into surrounding waterways. Best practices to achieve pollution-free feed include:

- ▶ **Prevent erosion:** Keeping soil covered, minimizing its disturbance, and maintaining natural buffers on the landscape will prevent soil erosion that drives nitrogen and phosphorus loss and will naturally enhancing soil nutrients between plantings. Planting cover crops is widely considered the single most important strategy for reducing fertilizer loss.⁴⁹ Conservation tillage techniques are also a widely recognized best practice for improving soil health and fertilizer losses.⁵⁰
- ▶ **Protect, maintain, and restore natural buffers to absorb runoff:** Planting buffers between fields and waterways, restoring and protecting grasslands and wetlands around key watersheds^{vi}, and implementing nutrient reduction and treatment techniques for tile drainage systems are critical strategies for absorbing fertilizer pollution before it contaminates surrounding waterways.^{vii}
- ▶ **Use proper fertilizer application practices:** Enroll all fields in precision application programs that track and optimize fertilizer application using the 4R method (the right type is applied in the right places at the right time using the right rate).⁵¹ However the soil health practices above for keeping soil covered are the most important strategies for reducing fertilizer pollution.

2 Diversify Beyond Corn and Soy to Include Rotationally Raised Small Grains:

The inclusion of small grains (oats, wheat, barley, rye, triticale) in the feed ration provides multiple benefits. It supports sustainable farming practices on corn and soy acres and can improve animal health and welfare. Diversifying crop rotations beyond corn and soy to include these grains naturally enhances soil nutrients, and has been shown to reduce the use of fertilizers and herbicides, improve soil health, and increase crop productivity.⁵²

3 Implement more responsible manure management:

While the sheer volumes of manure generated in confined animal feeding operations make “sustainable manure management” a bit of a misnomer, best practices should be adopted immediately to reduce the worst pollution impacts. Storing manure in open lagoons prone to flooding and leakage is one of the worst industry practices, as is dumping the manure onto already saturated fields where it simply flushes away downstream. The major meat processors are known to strictly control almost all aspects of farmer livestock operations, but the responsibility for waste management is often left to the contract farmers, who often lack the logistical support, infrastructure, financial means, and economies of scale to prevent water pollution from manure runoff. Since farmers and contract growers operate on small profit margins while the meat industry reaps billions in profits, companies like Tyson should provide incentives and support to farmers and contract growers to manage manure more sustainably.

4 Enact a moratorium on native ecosystem losses:

In response to public concern about the rapid destruction of tropical ecosystems for soy and palm oil, many of the world’s largest food and agricultural companies have adopted policies not to source feed crops from suppliers found destroying these ecosystems. In response, the major grain traders ADM, Cargill, and Bunge that dominate the U.S. and tropical commodity crop markets have pledged to close their markets to suppliers driving deforestation. The great American prairies deserve nothing less, and companies committed to a more sustainable food system need to adopt policies to protect our native prairies here in the U.S.

5 Provide transparent reporting on progress towards cleaner meat:

To demonstrate progress, Tyson and other major meat companies need to collect and report data that verifies best practices and shows reductions in nitrogen and phosphorus pollution runoff. Key metrics to track across sourcing acres include a nitrogen and phosphorus balance calculation for fertilizer, acres of cover crop uptake, adoption of conservation tillage practices, pounds of manure stored in open lagoons, restoration of landscape buffers like grasslands and wetlands. A growing number of tools and technologies are available to help companies track their agricultural practices, and many are already being utilized by companies and farmers around the country.

v While fertilizer is the focus of this report, water pollution also stems from pesticide runoff into waterways as well, which contaminate drinking water across the Midwest.

vi About 80 percent of the nitrogen pollution in the Gulf originates in the Ohio River and Mississippi River basin, making the junction of these two rivers an important region to target buffer restorations (McLellan et al. 2015. Reducing fertilizer-nitrogen losses from rowcrop landscapes.)

vii The effectiveness of vegetative buffers depends on their size, density, and hydrologic conditions within the buffer zone, however a review of a wide range of studies found that buffers can remove about 74% of the nitrogen passing through the buffer root zone (US EPA, National Risk Management Research Laboratory, Riparian Buffer Width, Vegetative Cover, and nitrogen Removal Effectiveness: A Review of Current Science and Regulations. 2005). The USDA NRCS supports U.S. farmers to implement such buffer areas through the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP)



Consumers have succeeded in holding the meat industry accountable for delivering more sustainable meat options, on issues ranging from animal welfare to antibiotics.

Many of these issues are ones that the industry fought hard to keep unregulated, until consumers pushed back. While the industry initially protested, citing everything from denial of responsibility, impossible costs, to complex supply chains, consumers ultimately won in holding their favorite brands responsible for overcoming these challenges to deliver more sustainable food options. Mighty Earth has sent letters to more than 35 of the top companies involved in the U.S. meat supply chain, including producers and buyers, outlining these concerns

and requesting their response. While this report is focused on those companies most directly responsible for producing meat and animal feed, trusted supermarket and restaurant brands that sell meat to consumers also play a key role in ensuring that suppliers are acting responsible. Future reports will assess how these brands are responding. Consumers have a right to know where their food comes from and how it was produced, and can improve the system by calling on companies like Tyson to lead the way towards cleaner meat.

Endnotes

- 1 "U.S. Beef and Pork Consumption Projected To Rebound," U.S. Department of Agriculture Economic Research Service, February 2016, accessed May 22, 2017, <https://www.ers.usda.gov/amber-waves/2016/september/us-beef-and-pork-consumption-projected-to-rebound/>.
- 2 "Animal Products," U.S. Department of Agriculture Economic Research Service, April 7, 2017, accessed May 22, 2017, <https://www.ers.usda.gov/topics/animal-products/>.
- 3 "Hogs & Pork: Overview," U.S. Department of Agriculture Economic Research Service, October 6, 2017, accessed May 22, 2017, <https://www.ers.usda.gov/topics/animal-products/hogs-pork/>.
- 4 "World Agricultural Supply and Demand Estimates," U.S. Department of Agriculture, May 2017, accessed May 22, 2017, <https://www.usda.gov/oce/commodity/wasde/latest.pdf>.
- 5 "Strong Today Leading for Tomorrow," Tyson investor presentation, March 2017, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_presentations/2017/03/TSN-Investor-Presentation-March-2017.pdf.
- 6 USDA Coexistence Fact Sheets: Soybeans," U.S. Department of Agriculture, February 2015, <https://www.usda.gov/sites/default/files/documents/coexistence-soybeans-factsheet.pdf>.
- 7 ECO731SR3: Manufacturing: Subject Series: Concentration Ratios: Share of Value Added Accounted for by the 4, 8, 20, and 50 Largest Companies for Industries: 2007," U.S. Census Bureau, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ECN_2007_US_31SR13&prodType=table.
- 8 Longworth, Richard C. "Mega Farmers." Caught in the Middle: America's Heartland in the Age of Globalism. New York: Bloomsbury, 2008. Web, <https://books.google.com/books?id=wqd5J53Oof4C&pg=PT40&lpg=PT40&dq=consolidation+grain+elevators+united+states+cargill+adm&source=bl&ots=izsf-2nVpdh&sig=Zlp1G14bcyFcRxIthEDKZuFjf38&hl=es-419&sa=X&ved=0ahUKE-wiRhZbTxx3UAhWceT4KHSMBrG4ChDoAQhXMAc#v=onepage&q=consolidation%20grain%20elevators%20united%20states%20cargill%20adm&f=false>; Hendrickson, Mary, PhD, "The Dynamic State of Agriculture and Food: Possibilities for Rural Development," at the Farm Credit Administration Symposium, February 19, 2014, <https://www.fca.gov/Download/Symposium14/hendrickson19feb2014.pdf>.
- 9 Leonard, Christopher, The Meat Racket: The Secret Takeover of America's Food Business, New York: Simon & Schuster Paperbacks, 2015, 94, Print.
- 10 United States Securities and Exchange Commission, "Form 10-K, Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934," for the fiscal year ending on October 1, 2016, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_financials/2016/Annual/TSN-FY16-Form-10-K.pdf; "Strong Today Leading for Tomorrow," Tyson investor presentation, March 2017, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_presentations/2017/03/TSN-Investor-Presentation-March-2017.pdf.
- 11 "Pizza Toppings," Tyson Foods, Inc., 2017, accessed May 23, 2017, <http://www.tysonfoods.com/loved-brands/pizza-toppings>.
- 12 "Strong Today Leading for Tomorrow," Tyson investor presentation, March 2017, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_presentations/2017/03/TSN-Investor-Presentation-March-2017.pdf.
- 13 Our Story," Tyson Foods, Inc., 2017, accessed May 22, 2017, <http://www.tysonfoods.com/our-story>.
- 14 United States Securities and Exchange Commission. "Form 10-K, Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934," for the fiscal year ending on October 1, 2016, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_financials/2016/Annual/TSN-FY16-Form-10-K.pdf.
- 15 "Webcasts and Presentations," Tyson Foods Inc., Slide 55 of Investor Presentation, <http://ir.tyson.com/investor-relations/events-and-presentations/default.aspx>.
- 16 "Tyson Foods, Inc.," Vault, 2017, accessed May 22, 2017, <http://www.vault.com/company-profiles/food-beverage/tyson-foods-inc/company-overview.aspx>.
- 17 "Table 1: Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2016," U.S. Census Bureau, December 2016, accessed May 22, 2017, <https://www2.census.gov/programs-surveys/popest/tables/2010-2016/state/totals/nst-est2016-01.xlsx>.
- 18 To derive estimate, took number of chickens, cattle, and hogs produced each week by Tyson, multiplied this total by 52 weeks for an annual estimate, and then multiplied the total number of animals by the amount of corn required for each livestock ration (except for chicken where Tyson documented its annual purchase of 220 million bushels of corn in FY15). "Strong Today Leading for Tomorrow," Tyson investor presentation, March 2017, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_presentations/2017/03/TSN-Investor-Presentation-March-2017.pdf; "On average, how many pounds of corn make one pound of beef? Assuming an all-grain diet from background-

- ing through to 1,250-pound slaughter weight, I have heard estimates ranging from 6 pounds corn/1 pound beef to 20 pounds corn/1 pound beef. Can you clarify?" Extension, October 7, 2008, <http://articles.extension.org/pages/35850/on-average-how-many-pounds-of-corn-make-one-pound-of-beef-assuming-an-all-grain-diet-from-background>; Lammers, Peter J., Stender, David R., Honeyman, Mark S., "Niche Pork Production: Feed Budgets," Iowa State University, <https://www.ipic.iastate.edu/publications/840.feedbudgets.pdf>; Goodwin Jr., H.L., McKenzie, Andrew, Hamm, Sandra J., "The Broiler-Corn Ratio: Is it an Indicator of Fattened Broiler Profits?" University of Arkansas, Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting Portland, OR, July 29-August 1, 2007, <http://ageconsearch.tind.io/bitstream/9746/1/sp-07go08.pdf>.
- 19 "Using the supply chain to slash fertilizer pollution," Environmental Defense Fund, <https://www.edf.org/ecosystems/using-supply-chain-slash-fertilizer-pollution>.
- 20 "POURING IT ON: HEALTH EFFECTS OF NITRATE EXPOSURE," Environmental Working Group, February 1, 1996, <http://www.ewg.org/research/pouring-it-health-effects-nitrate-exposure>; McCasland, Margaret, Trautmann, Nancy M., Porter, Keith S., "Nitrate: Health Effects in Drinking Water," Natural Resources Cornell Cooperative Extension, <http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.aspx>.
- 21 Barton, Brooke, Clark, Sarah Elizabeth, "Water & Climate Risks Facing U.S. Corn Production," Ceres, June 2014, accessed May 23, 2017, <http://docplayer.net/25362764-Water-climate-risks-facing-u-s-corn-production.html>.
- 22 "Annual Nutrient Flux and Concurrent Streamflow - Updated Through Water Year 2016," U.S. Geological Survey, 2016, https://toxics.usgs.gov/hypoxia/mississippi/flux_estimates/delivery/Gulf-Annual-2016.xlsx.
- 23 Turner, R. Eugene, Rabalais, Nancy N., "2017 Forecast: Summer Hypoxic Zone Size Northern Gulf of Mexico," Healthy Gulf, http://www.healthygulf.org/sites/healthygulf.org/files/final_lsu_lumcon_2017_hypoxia_forecast.pdf.
- 24 "Nutrient Pollution: The Problem," U.S. Environmental Protection Agency, <https://www.epa.gov/nutrientpollution/problem>.
- 25 Howarth, Ramakrishna, et al., "Nutrient Management," Ecosystems and Human Well-being: Policy Responses, Chapter 9, <http://www.millenniumassessment.org/documents/document.314.aspx.pdf>.
- 26 United States Securities and Exchange Commission. "Form 10-K, Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934," for the fiscal year ending on October 1, 2016, accessed May 22, 2017, http://s1.q4cdn.com/900108309/files/doc_financials/2016/Annual/TSN-FY16-Form-10-K.pdf.
- 27 Erbenraut, Joseph, "Trump's EPA Pick Went Easy On Industry That Backed Him: Report," Huffington Post, January 16, 2017, http://www.huffingtonpost.com/entry/scott-pruitt-poultry-contributions-lawsuit_us_587960bae4b0e58057fee7bd.
- 28 "Shareholder Resolutions," Ceres Tools, 2017, http://tools.ceres.org/resources/tools/resolutions/@@resolutions_s3_view#!/subject=&year=&company=Tyson%20Foods%20Inc.&filer=§or=&status=&memo=&all.
- 29 "Farm Families," Tyson Foods, Inc., 2017, accessed May 22, 2017, <http://www.tysonfoods.com/our-story/farmers>.
- 30 "National Chicken Council," Center for Responsive Politics, 2017, accessed May 23, 2017, https://www.opensecrets.org/lobby/clientissues_spec.php?id=D000000568&year=2017&spec=ENV; "National Pork Producers Council," Center for Responsive Politics, 2017, accessed May 23, 2017, <https://www.opensecrets.org/lobby/clientbills.php?id=D000000676&year=2016>.
- 31 Ribaud, Marc. "Nitrogen in Agricultural Systems: Implications for Conservation Policy," U.S. Department of Agriculture Economic Research Service, September 2011, accessed May 23, 2017, https://www.ers.usda.gov/webdocs/publications/44918/6767_err127.pdf?v=41056.
- 32 Ribaud, Marc. "Nitrogen in Agricultural Systems: Implications for Conservation Policy," U.S. Department of Agriculture Economic Research Service, September 2011, accessed May 23, 2017, https://www.ers.usda.gov/webdocs/publications/44918/6767_err127.pdf?v=41056.
- 33 Mark, "Nitrates rising in Mankato's drinking wells," Mankato Free Press, May 28, 2017, http://www.mankatofreepress.com/news/nitrates-rising-in-mankato-s-drinking-wells/article_b3baed98-4253-11e7-9e89-43e32f6b8ca8.html.
- 34 Brooke, Clark, Sarah Elizabeth. "Water & Climate Risks Facing U.S. Corn Production," Ceres, June 2014, accessed May 23, 2017, <http://docplayer.net/25362764-Water-climate-risks-facing-u-s-corn-production.html>.
- 35 "Art Cullen of The Storm Lake Times, Storm Lake, IA" The Pulitzer Prizes, Cullen wrote the articles "Farm Bureau County" and "BV is Losing the Public," <http://www.pulitzer.org/winners/art-cullen>.
- 36 Eller, Donnelle, "High nitrate levels plague 60 Iowa cities, data show, The Des Moines Register, July 4, 2015, <http://www.desmoinesregister.com/story/money/agriculture/2015/07/04/high-nitrates-iowa-cities/29720695/>; Bradley, Eric et al., "Nitrate in Drinking Water: A Public Health Concern for All Iowans." Iowa Environmental Council, September 2016, http://www.iaenvironment.org/webres/File/News%20%26%20Resources/Publications/Nitrate_in_Drinking_Water_Report_ES_Web.pdf.
- 37 "NOAA's Ecological Forecasting: Protecting Human Health and Coastal Economies with Early Warnings," National Oceanic and Atmospheric Administration, <http://oceanservice.noaa.gov/ecoforecasting/noaa-ecoforecasting.pdf>.
- 38 Tyrell, Kelly April, "Plowing prairies for grains: Biofuel crops replace grasslands nationwide," University of Wisconsin-Madison News, April 2, 2015, <http://news.wisc.edu/plowing-prairies-for-grains-biofuel-crops-replace-grasslands-nationwide/>; Wright, Christopher K., Wimberly, Michael C., "Recent land use change in the Western Corn Belt threatens grasslands and wetlands," Proceedings of the National Academy of Sciences of the United States of America, January 17, 2013, <http://www.pnas.org/content/110/10/4134.full>.
- 39 Wright, Christopher K., Wimberly, Michael C., "Recent land use change in the Western Corn Belt threatens grasslands and wetlands," Proceedings of the National Academy of Sciences of the United States of America, January 17, 2013, <http://www.pnas.org/content/110/10/4134.full>; Larsen, Ben, "USDA Data: Grasslands, Forests Being Converted to Cropland at Alarming Rates," National Wildlife Federation, September 18, 2013, <https://www.nwf.org/News-and-Magazines/Media-Center/News-by-Topic/Wildlife/2013/9-18-13-USDA-Data-Grasslands-Forests-Being-Converted-to-Cropland-at-Alarming-Rates.aspx>.
- 40 Wright, Christopher K., Wimberly, Michael C., "Recent land use change in the Western Corn Belt threatens grasslands and wetlands," Proceedings of the National Academy of Sciences of the United States of America, January 17, 2013, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3593829/>.
- 41 Glaser, A., ed. "America's Grasslands Conference: Status, Threats, and Opportunities," National Wildlife Federation and South Dakota State University, Proceedings of the 1st Biennial Conference on the Conservation of America's Grasslands, August 15- 17, 2011, Sioux Falls, SD, <https://www.nwf.org/pdf/Policy-Solutions/Americas%20Grasslands%20Conference%20Proceedings061312.pdf>.
- 42 Morefield, Philip E., LeDuc, Stephen D., Clark, Christopher M., Iovanna, Richard, "Grasslands, wetlands, and agriculture: the fate of land expiring from the Conservation Reserve Program in the Midwestern United States," IOP Science, August 31, 2016, <http://iopscience.iop.org/article/10.1088/1748-9326/11/9/094005>.
- 43 "Water-Quality Changes in the Nation's Streams and Rivers," U.S. Geological Survey, <https://nawqatrends.wim.usgs.gov/swtrends/>.
- 44 "Water-Quality Changes in the Nation's Streams and Rivers," U.S. Geological Survey, <https://nawqatrends.wim.usgs.gov/swtrends/>.
- 45 "Corn Usage by Segment," World of Corn, 2016, <http://www.worldofcorn.com/#corn-usage-by-segment>.
- 46 McCasland, Margaret, Trautmann, Nancy M., Porter, Keith S., "Nitrate: Health Effects in Drinking Water," Natural Resources Cornell Cooperative Extension, <http://psep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.aspx>.
- 47 "Water, air quality fears conflict with pig farms," CNBC, February 16, 2015, <http://www.cnbc.com/2015/02/16/water-air-quality-fears-conflict-with-pig-farms.html>; "Clean Water Fight," Iowa Citizens for Community Improvement, <http://iowacici.org/uncategorized/clean-water-fight/>.
- 48 Dreeszen, Dave, "Expansion of Tyson's Dakota City plant nearing completion," Sioux City Journal, March 31, 2013, http://siouxcityjournal.com/special-section/local/industry/expansion-of-tyson-s-dakota-city-plant-nearing-completion/article_aafea3b1-e24a-5c7e-8272-f3e84f7db2bf.html.
- 49 According to the Iowa Nutrient Reduction Strategy (INRS), using cover crops is the single best practice for reducing both nitrate and phosphorus loss from agricultural fields, Lillard, Elizabeth, "Cover Your Costs Sustainable Agriculture Solutions for Cost Effective Water Treatment," National Wildlife Federation, 2016, https://www.nwf.org/-/media/PDFs/Wildlife/A-G/WQ-Benefits_Cover-Your-Costs_092616.ashx.
- 50 The Sources and Solutions: Agriculture," U.S. Environmental Protection Agency, <https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture>.
- 51 What are the 4 Rs," Nutrient Stewardship, <http://www.nutrientstewardship.com/4rs/>; Grady, Barbara, "From Kellogg's to Unilever, a quiet revolution in sustainable farming," Green Biz, July 27, 2016, <https://www.greenbiz.com/article/kelloggs-unilever-quiet-revolution-sustainable-farming>.
- 52 Tomer and Lieberman, 2014. Nutrients in soil water under three rotational cropping systems, Iowa, USA. <http://www.sciencedirect.com/science/article/pii/S0167880914000474>; Bennett et al., 2012. Meeting the demand for crop production: the challenge of yield decline in crops grown in short rotations.



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