

Shared Value

How Smithfield Foods creates environmental and business benefits through supply chain partnerships





Report author

Datu Research, with contributions from Environmental Defense Fund and Smithfield Foods



About Datu Research

Datu Research is an international consulting firm that provides custom research to leading institutions working to solve humanity's greatest challenges — including human health, climate change and how to feed 10 billion people in 2050. Our clients are foundations, nonprofit organizations, corporations and governments who need the right data to envision, design, implement and evaluate their programs to reach their goals.



About Environmental Defense Fund

Environmental Defense Fund, a leading international nonprofit organization, creates transformational solutions to the most serious environmental problems. EDF links science, economics, law and innovative private-sector partnerships.

Smithfield

Good food. Responsibly.®

About Smithfield Foods

Smithfield Foods is a \$15 billion global food company and the world's largest pork processor and hog producer. Smithfield Foods is committed to providing good food in a responsible way and maintains robust animal care, community involvement, employee safety, environment and food safety, and quality programs.

Foreword

Stewart Leeth, chief sustainability officer at Smithfield Foods

Acknowledgments

Datu Research is grateful to Jessica Wingert for valuable research and writing, and to Angel Cruz and Sofia Tenorio Fenton for help with interviews and project management.

Table of contents

List of figures	3
List of tables	3
Foreword	4
Executive summary	5
Introduction	6
Smithfield Foods company overview	8
Supply chain sustainability at Smithfield	9
Setting the stage: Smithfield's approach to sustainability	9
Catalyst for change: Consumer and customer interest in sustainability	9
Finding the ways that work: Partnership with Environmental Defense Fund	10
Building the business case: Grain grower relationships	11
Expanding impact: Smithfield's GHG footprint and reduction goal	12
Expansion to new business opportunities: Smithfield Renewables	14
Tracking progress: Data management and reporting	14
Summary of progress: Smithfield and EDF partnership supply chain sustainability initiatives	15
Grain sustainability initiatives in depth	17
Smithfield Agronomics	18
Winter wheat program	20
Volunteer corn	22
Optical sensor loan program	23
Agronomic support for non-GMO soy	24
Midwest manure nutrient management: Beyond compliance	25
Converting manure solids to fertilizer	26
Regional Conservation Partnership Program	27
Hog farm sustainability initiatives in depth	28
Manure biogas technology	29
Supply chain sustainability lessons learned	34
The future of supply chain sustainability at Smithfield	39
Conclusion	40
References cited	41

List of figures

Figure 1: Smithfield Foods value chain	8
Figure 2: Percentage of wheat and corn for Southeast hog farms purchased locally in North Carolina, South Carolina and Virginia	12
Figure 3: Percentage of grain that Smithfield purchased directly from farmers	12
Figure 4: Results of Smithfield's GHG assessment	13
Figure 5: Total Smithfield wheat purchased that is attributed to the wheat program	20
Figure 6: Expansion of Smithfield's wheat program	21
Figure 7: Soil test phosphorous levels on a sample Iowa farm	25
Figure 8: Approximate breakdown of costs to install a manure-to-renewable natural gas system	31
Figure 9: Biogas generated and reused onsite, in \$millions and gigajoules	32

List of tables

Table 1: Smithfield and EDF partnership supply chain sustainability initiatives	15
Table 2: Summary of benefits and lessons learned from Smithfield and EDF partnership initiatives	16
Table 3: Summary of acres engaged in Smithfield's grain sustainability initiatives	17

Foreword

For more than five years, Environmental Defense Fund and Smithfield Foods have collaborated to address pressing environmental issues. Solving environmental problems is difficult work, but together we're making meaningful change through a focus on our organizations' shared goals to reduce greenhouse gas emissions in a way that benefits the farmers who grow grain and hogs for Smithfield pork products.

Smithfield has been building comprehensive sustainability programs step-by-step for many years, focusing on several core areas: environmental performance, animal well-being, food safety and quality, our people, and helping the communities where our people live and work.

We first collaborated with EDF in 2013 to reduce fertilizer loss on the vast network of farms from which Smithfield purchases corn used for animal feed. Working with EDF, we set a goal to engage 75 percent of the acres from which we directly source grain to reduce fertilizer loss and build soils. This effort helped corn growers adopt new tools and practices to more efficiently utilize fertilizer in their fields. It also helped our business by strengthening relationships with farmers in our communities and increasing local grain supplies. In 2018, we achieved this goal by working with grain farmers to adopt more sustainable practices on over half a million acres.

The success of this work set the stage for EDF and Smithfield to partner in the development of a groundbreaking goal to cut greenhouse gas emissions. With EDF's help, Smithfield became the first major animal protein company to set a goal to reduce absolute GHG emissions from our complete operations and supply chain 25 percent by 2025. This ambitious goal moved our sustainability program a giant step forward and paved the way for even more progress. One of the ways we will meet that goal is through manure-to-energy projects, which will utilize innovative technologies to create renewable natural gas for consumers throughout the country, while generating a new source of income for farmers.

We're also collaborating with EDF to reestablish native grasslands, prairie and milkweed to create habitat for monarch butterflies, which have experienced a 95 percent population decline since the 1980s. These prairie lands will also support other pollinators, improve soil health and create biomass for methane generation in our renewable natural gas projects.

With these efforts underway, I'm excited for what the future holds. As we prepare to produce safe, affordable food for 10 billion people by 2050, our collaborations with EDF provide an inspiring, effective approach to producing "Good food. Responsibly.®" Through our pioneering partnership and industry leadership, we will uncover the greatest benefits for the greater good.

Stewart T. Leeth

Vice president of regulatory affairs and chief sustainability officer

Smithfield Foods, Inc.



Executive summary

This report explains how Smithfield Foods, the world's largest hog producer and pork processor, became an industry leader in tackling the environmental impacts of growing hogs and the grain that feeds them. The company's partner in these efforts is Environmental Defense Fund, a nonprofit environmental organization. Smithfield's collaboration with EDF began with Smithfield's goal to engage 75 percent of the grain it buys directly from farmers in sustainable practices by 2018. Smithfield recently announced that it exceeded that target, engaging over half a million acres in practices that reduce fertilizer loss and improve soils. In 2016, Smithfield committed to reduce supply chain greenhouse gas emissions 25 percent by 2025. It was the first major meat company to set an absolute goal for reducing supply chain emissions.

These efforts are part of Smithfield's expansive sustainability program, which is organized by "pillars" and includes many other commitments to environmental stewardship, as well as to animal care, food safety, worker safety and community engagement. Smithfield's work with EDF is one way the company is achieving some of its environmental goals, including its groundbreaking efforts to reduce GHG emissions. Smithfield and EDF's work to create a more sustainable grain supply chain, the first major joint project of these two organizations, is a key part of the company's GHG reduction goal.

The common theme in Smithfield and EDF's collaboration is a focus on solutions that generate shared value for the environment, farmers and food companies such as Smithfield. That shared value creates lasting commitment to sustainable agricultural practices and can serve as a model for other grain buyers, food companies and retailers seeking to improve the environmental impact of the foods on our plates.

Highlights of the shared value generated include:

Value to the environment

- Smithfield achieved its 2018 goal to engage directly 75 percent of the acres from which it sources grain in sustainable practices that reduce nitrogen losses to water and air, including fertilizer optimization, cover crops and crop rotation with small grains. Smithfield successfully improved practices on over 560,000 acres.
- As part of Smithfield's GHG reduction goal, the company announced manure-to-energy investments that will capture approximately 85,000 metric tons of methane, a potent GHG.

Value to farmers

- Smithfield's agronomists provide advice and production planning to grain farmers, free of charge.
- Smithfield's winter wheat program provides seed to grain farmers at 40 percent savings compared to normal costs.
- Smithfield assists grain farmers in accessing new market opportunities, such as soy that is not a genetically modified organism (GMO), which provides farmers with an economic benefit of \$45 per acre.
- Smithfield will provide long-term biogas contracts to hog farmers who invest in manure-to-energy technology.

Value to Smithfield

- By building relationships with local grain growers and providing them with services such as sustainability programs, Smithfield increased the proportion of grain it buys directly from farmers from less than 10 percent to more than 60 percent in just 10 years, saving \$8 million in grain purchasing costs in 2018 alone.
- Smithfield sees a 1.6 times return on its wheat seed program investment.
- On average, Smithfield's manure biogas projects realize a rate of return of 15 percent or more, and a payback period of 5 to 7 years.

This report was developed through interviews with employees from Smithfield Foods, EDF and other individuals knowledgeable about Smithfield's sustainability efforts. Additionally, the report cites publicly available data from government and private sources. The case focuses primarily on sustainability efforts in grain production and on hog farms, the two main contributors to Smithfield's environmental footprint. It details those initiatives and lessons learned from their implementation that can assist other companies to proactively engage in supply chain sustainability.



Introduction

How are we going to feed 10 billion people by 2050 while preserving the natural resources on which we all depend? The perennial question is now compounded by factors perhaps greater than population growth. As more people around the world enter the middle class, their diets include more meat, the production of which requires greater amounts of grain and water to produce. At the same time, increasing global food production brings with it concerns about depletion of groundwater resources, runoff into surface waters and declining biodiversity. All of these dynamics threaten future harvests and are exacerbated by the most significant threat of all: climate change. If not addressed, the warming climate will continue to alter weather patterns, increasing both droughts and floods, often with devastating impacts on yields. In short, as noted in a recent United Nations report on the future of food and agriculture, “Business as usual is not an option.” (FAO, 2017; Gramer, 2017).

The financial world has taken note. Investors are signaling to companies that it is no longer optional to take responsibility for their social and environmental impacts. Platforms such as the Dow Jones Sustainability Index track the stock performance of the world’s leading companies in terms of economic, environmental and social criteria (ROBECOSAM, 2018). In early 2018, BlackRock, Inc., the world’s largest investment firm with nearly \$6 trillion in investments, published a letter to global CEOs confirming that corporate sustainability is being integrated into BlackRock’s investment process because “a company’s ability to manage environmental, social and governance matters demonstrates the leadership and good governance that is so essential to sustainable growth.” (Fink, 2018).

Consumers themselves are demanding change in food business practices. The importance of transparency and food traceability is now at an all-time high. Many consumers are no longer satisfied to purchase a product that they like; they also want to know that it was responsibly produced. In fact, an estimated 91 percent of global consumers expect companies to operate responsibly and address social and environmental issues (Cone Communications, 2015). Consumers and retail customers, such as grocery stores, increasingly expect companies to understand and proactively manage their impact on the environment.

“Today’s consumers want to know where their food is coming from and that it’s being made in a responsible, sustainable way. At Smithfield, we’re committed to meeting that demand and have made significant changes across all of our sustainability pillars to ensure we deliver and keep our promise to produce good food the right way.”

- Stewart Leeth,

Vice president of regulatory affairs and chief sustainability officer at Smithfield Foods

According to The Sustainability Consortium (TSC), for most companies the largest share of this impact occurs upstream in the supply chain, where a company may have little information about the production practices or environmental footprint of its agricultural suppliers. A 2016 TSC survey showed that of 2,500 supplier survey respondents, 1,700 had “limited visibility” into their supply chain, and almost 80 percent of respondents were “unable to determine” metrics in farm production, one of the hotspots for environmental impact (TSC, 2016). Companies in the food sector are increasingly working to engage with farmer-suppliers upstream, but complex and geographically dispersed supply chains create barriers for companies trying to influence supplier behavior (Ceres, 2017).

This report details how Smithfield Foods, the world’s largest hog producer and pork processor, is working closely with its suppliers to meet the company’s ambitious environmental goals to create shared value for the environment, farmers and Smithfield itself. Smithfield’s initiatives focus on two key supply chain segments: hog farmers, and the grain farmers who grow hog feed. The company’s partner in these efforts is EDF, a leading environmental nonprofit organization.

Smithfield and EDF have previously found themselves at odds on environmental issues, and even now, after a successful multiyear partnership, they don’t always agree. Yet they found common ground in the goal to drive sustainable, market-based solutions to the environmental challenges faced by Smithfield and the wider agricultural sector and food industry. To this collaboration, EDF brings decades of experience in protecting air, climate, land and water, and in linking science, economics, law and innovative private-sector partnerships. For its part, Smithfield brings an unusual willingness to transform its own

culture, building on the leadership of its first chief sustainability officer, Dennis Treacy. As Stewart Leeth, Smithfield’s current vice president of regulatory affairs and chief sustainability officer is quick to emphasize, that transformation continues today and continues to accelerate as Smithfield creates business value through meeting the company’s environmental and other sustainability goals.

This report summarizes Smithfield’s approach to supply chain sustainability as developed through its collaboration with EDF. The company is a leader in the animal agriculture sector and food industry in tackling the environmental impacts of feed grain production. In 2016, it became the first major protein company to set an absolute supply chain GHG reduction goal. This goal, which encompasses the full reach of Smithfield’s upstream supply chain from grain to bacon, will require collaboration with farmers, other suppliers and business partners, customers, and other partners like EDF to ultimately be successful. When achieved, Smithfield’s goal could have far-reaching impacts on agricultural sustainability overall.

These pages will describe in detail several of Smithfield’s supply chain sustainability efforts, with a focus on grain and hog production. As with any groundbreaking initiative, some of these efforts were successful, some were set aside and many are still evolving. In addition, this case study highlights important lessons for any company pursuing agricultural supply chain sustainability. Companies cannot achieve ambitious supply chain sustainability goals on their own. Achieving them requires collaboration. In that spirit, the goal of this case study is to inform others’ efforts to advance sustainable agriculture.

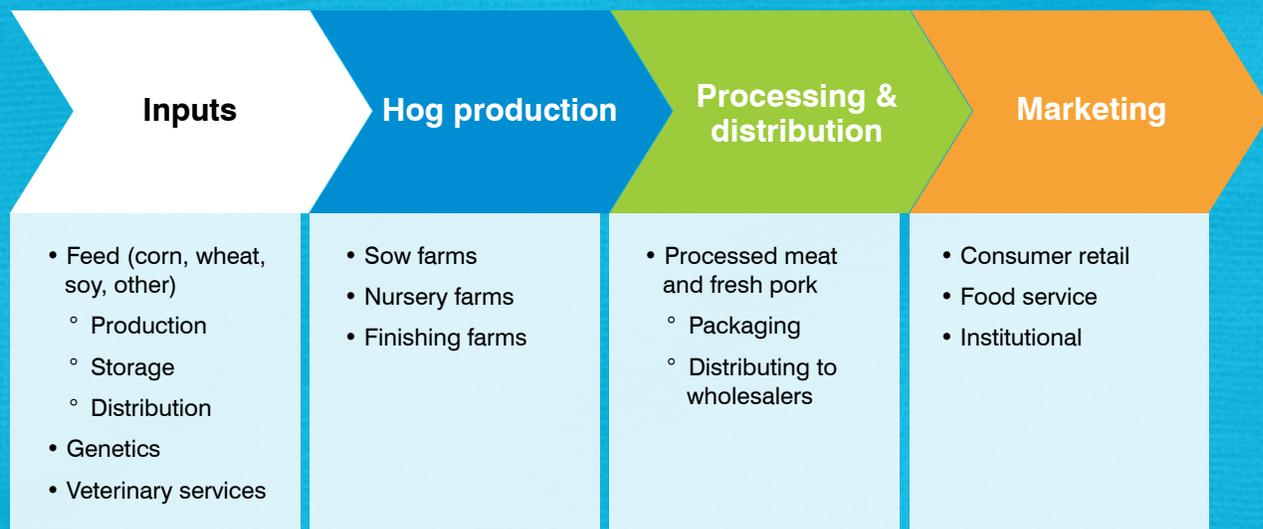


Smithfield Foods company overview

Smithfield Foods is the world’s largest hog producer and pork processor, and the fourth largest meat processor. Smithfield is a wholly owned subsidiary of WH Group Limited (The National Provisioner, 2017). Smithfield’s operations are in North America and Europe, but its products are distributed to over 40 countries around the globe. The leader in numerous packaged meats categories, the company saw its global sales exceed \$15 billion in 2017 (Smithfield Foods, 2018b). Smithfield Foods owns over 500 farms across the United States, including about 200 in North Carolina, and contracts with another 2,000 family farms where hogs owned by Smithfield are raised. In addition, Smithfield purchases approximately half of its supply of hogs from other farms across the United States. Internationally, the company owns farms in Romania and Poland and operates farms in Mexico through joint ventures (Diamond, 2018).

Smithfield is vertically integrated, with owned operations in growing grain and milling feed, hog production, processing, transportation and distribution, and marketing (see Figure 1). This vertical integration has allowed the company to observe, address and begin to track environmental improvements in supply chain segments from grain farms through product distribution.

Figure 1: Smithfield Foods value chain



(Lowe and Gereffi, 2008); (Westerbeek, 2018c)

While Smithfield owns a portion of many links in its supply chain, the majority of Smithfield’s GHG emissions are associated with the supply chain segments that are not owned by the company. Vertical integration creates an advantage in understanding how the full supply chain operates, but Smithfield’s sustainability goals extend beyond the owned portions of its supply chain to segments that it does not own, such as farms under contract and farms that only have purchasing relationships with Smithfield.



Supply chain sustainability at Smithfield

Smithfield's approach to sustainability has evolved substantially in the past 20 years, shifting from the need to achieve regulatory compliance, to adopting processes to encourage continuous improvement in the company's own operations, to addressing its broader supply chain. In the latest stage of this shift — addressing its grain supply chain — Smithfield's partnership with EDF has played a pivotal role. This case study section describes that shift and the business and environmental benefits that the company has discovered along the way.

Setting the stage: Smithfield's approach to sustainability

Consistent with the broader meat industry, Smithfield has often struggled with, and been criticized for, its environmental management practices. Tension between Smithfield and its critics was particularly pronounced in the late 1990s when its environmental violations and fines added up to dozens of printed pages. The company began a fundamental shift in its approach to sustainability in the early 2000s, when Dennis Treacy, former director of the Virginia Department of Environmental Quality, joined Smithfield as vice president of environmental and corporate affairs. Treacy and his team began gradually to shift the company's perspective, emphasizing structure and accountability. By 2014, the company had just one \$400 fine (Langert, 2015).

An important feature of Smithfield's sustainability culture is to recognize and reward its employees who are making an impact, either individually or on teams. Smithfield's environmental excellence award program highlights those efforts. In 2017, 144 projects were nominated, and 12 were selected as category winners. Each year, the president's award goes to one outstanding winner overall. All category winners receive a monetary award, part of which is given to the team, and part of which goes to a charity of the team's choice. As of 2017, Smithfield estimated that during the previous five years, its employees' award-winning projects had not only achieved environmental enhancements on Smithfield's farms and processing facilities but had also saved the company \$95 million in operating costs (Leeth, 2018).

Sustainability has also been incorporated and expanded into Smithfield's organizational structure. The sustainability program has been led for several years by Smithfield's current vice president of regulatory affairs and chief sustainability officer, Stewart Leeth, an executive-level leader. The program has corporate oversight committees and core teams to pilot development and manage implementation. In its own operations, Smithfield uses the ISO 14001 environmental management standard to guide continuous improvement in all of its facilities and farms across the United States. Smithfield was the first in the industry to become ISO certified across its entire company, worldwide. A continuous improvement mindset, along with an emphasis on the business value of sustainability, are priorities in Smithfield's approach.

As of 2017, Smithfield estimated that during the previous five years, its employees' award-winning projects had not only achieved environmental enhancements on Smithfield's farms and processing facilities, but had also saved the company \$95 million in operating costs.

(Leeth, 2018)

Over time, the company has emerged as an industry leader in several areas. Examples include implementing group housing systems for pregnant sows, improving transparency on antibiotics usage, and cutting water and energy use from its operations (Langert, 2015). Ceres also recently recognized Smithfield as the "highest performer" among its peers for water management (Ceres, 2017). The company's leadership in tackling the environmental impacts of its supply chain is the next frontier in that progress.

Catalyst for change: Consumer and customer interest in sustainability

Increasing consumer interest in food transparency and sustainability is now a widely documented phenomenon (Cone Communications, 2015). That interest is translated through retailers, the largest customers of food companies like Smithfield. Walmart, the world's largest food retailer, is a prime example of this dynamic. Walmart, which also has

a longstanding partnership with EDF, has set its own supply chain sustainability goals. These include two major GHG reduction goals: its 20-million metric ton reduction goal in 2010, and its Gigaton Challenge in 2017 (Walmart, 2010; Walmart, 2018).

As part of its GHG reduction goals, Walmart conducted an analysis of emissions throughout its supply chain and identified nitrous oxide emitted from excess fertilizer application to grains as an important emissions source. Walmart approached 15 major suppliers, including Smithfield, to develop plans to reduce fertilizer loss from grain production. Smithfield accepted the challenge, and in 2013 set its first grain sustainability commitment: to engage 75 percent of its directly sourced grain, or approximately 450,000 acres, in practices that reduce fertilizer loss and build soil health.

“EDF believes that a true sustainability leader commits to science-based goals, collaborates for scale, advocates for smart policy and accelerates environmental innovation. Smithfield has embraced this framework and ingrained sustainability into its culture.”

- Elizabeth Sturcken

Managing director and leader of EDF + Business' partnership with Walmart

Smithfield accepted the challenge, and in 2013 set its first grain sustainability commitment: to engage 75 percent of its directly sourced grain, or approximately 450,000 acres, in practices that reduce fertilizer loss and build soil health.

Finding the ways that work: Partnership with Environmental Defense Fund

As Smithfield considered how to respond to Walmart's request to address grain sustainability in its supply chain, Smithfield sustainability leaders approached EDF to explore a partnership to address the challenge. EDF, a leading environmental nonprofit organization, is known both for its collaborations with major corporations on sustainability issues core to business operations and for its extensive work and relationships with large-scale grain agriculture in the U.S.

When Smithfield made its commitment to grain sustainability, few major food companies were implementing sustainability initiatives that spanned their full supply chains. Animal agriculture consumed 39 percent of corn grown in the U.S. in 2017 (USDA, 2018a). Progress with major meat companies like Smithfield is critical to EDF's objective to engage the supply chain in improving grain sustainability at scale and ending fertilizer pollution from agriculture (EDF, 2018a).

From the start of their collaboration, Smithfield and EDF acknowledged that while they had a common interest in addressing grain sustainability, there were also issues on which they did not agree and would continue to pursue their separate interests. EDF does not accept any funding from corporations, so the organization came to the table with Smithfield as an equal partner.

EDF and Smithfield's collaboration on grain sustainability has grown into a close partnership in which EDF works with Smithfield on the design of its grain sustainability initiatives, makes connections with other organizations, businesses and scientists to support the implementation of those initiatives, and acts as a scientific adviser to ensure that Smithfield's efforts produce the targeted environmental improvements. In turn, EDF learns from its work with Smithfield, informing the organization's broader goal to achieve sustainable grain production at scale.

Through this collaboration, EDF and Smithfield staff have also built relationships that allow them to discuss challenging issues on which they do not agree. Agriculture and environmental groups have a contentious history, but partnerships like the one between EDF and Smithfield show the possibility of finding common ground and pursuing it jointly.

“You're driving through Iowa or Missouri, or wherever we might be at the time, and you talk. We're different people, but I can tell you when we set aside the things we might not agree on, and we focus on the things we can agree on, we're pretty effective. I think that's how you make progress. It certainly is a whole lot more productive.”

- Kraig Westerbeek,

Senior director of Smithfield Renewables, discussing the EDF partnership (Westerbeek, 2018a)

“Smithfield was willing to tackle feed grain sustainability at a time when few other companies considered that to be their responsibility. Today, many food companies and retailers are engaging on grain sustainability and understand its importance to the continued success of their business.”

- Maggie Monast,

Senior manager for economic incentives and agricultural sustainability at EDF (Monast, 2018b)

Building the business case: Grain grower relationships

Smithfield’s 2013 grain sustainability goal complements a critical business strategy for the company: to build strong relationships with grain farmers in sourcing regions local to its feed mills and farms. Because grains such as corn, soy and wheat are major ingredients in hog diets, grain is Smithfield’s largest purchasing expense, accounting for 50 to 60 percent of the cost of hog production (Westerbeek, 2018c).

Compounding this challenge is a mismatch between Smithfield’s largest hog production region — the Southeast — and the country’s largest grain production region — the Midwest. When grain must be shipped long distances by rail from the Midwest, or even brought by barge from Brazil, the cost disadvantage of growing hogs in the Southeast can rise to as much as \$10 per hog (Roberson, 2013).

Smithfield responded to this challenge with a new initiative, Smithfield Grain, which seeks to build direct relationships with local grain growers and procure a greater share of its grain directly and locally. Examples of these efforts include improving grain elevator service, encouraging early harvest to avoid late season losses, providing grain drying, and offering incentives and contracts to local farmers who plant desired feed grains such as winter wheat and sorghum.

Smithfield’s grain sustainability efforts aligned with the objectives of the company’s grain sourcing initiative: to build relationships with local grain growers by assisting them in becoming more productive, profitable and sustainable. This is reflected in the 2017 shift to move core responsibility for grain sustainability from Smithfield’s environmental management group to its grain procurement division. The company’s grain sustainability efforts, which are described in detail in the body of this case study, are widely recognized across the company as integral to the success of Smithfield’s grain procurement strategy.

“The message we deliver to farmers is that we’re here to help you keep more money in your pocket by leveraging new technology that’s available and by not spending it on items that you don’t need. By over applying fertilizer, you waste it — or by applying it at the wrong time, you’re not getting any value for it. So, let me help you do things the right way. And in doing that, it’s good for everybody.”

- Joe Szaloky,

Vice president of business development at Smithfield Foods
(Szaloky, 2018a)

Smithfield’s local grain strategy has worked. Since 2015, the share of corn and wheat purchased in the Southeast for the company’s North Carolina hog farms has grown from 61 to 82 percent (see Figure 2). Nationally, Smithfield purchases 63 percent of its grain by volume directly from farmers, up from 7 percent in 2008 (see Figure 3). Smithfield estimates that purchasing local grain saved the company at least \$8 million in purchasing costs in 2018 alone (Szaloky, 2018b).

Smithfield estimates that purchasing local grain saved the company at least \$8 million in purchasing costs in 2018 alone.

Figure 2: Percentage of wheat and corn for Southeast hog farms purchased locally in North Carolina, South Carolina and Virginia

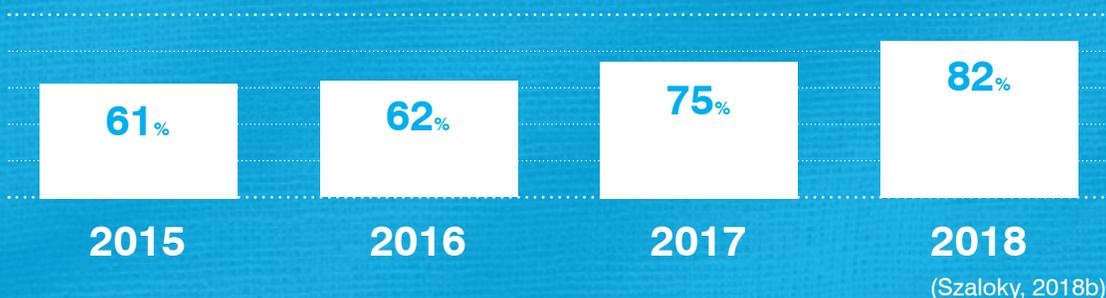
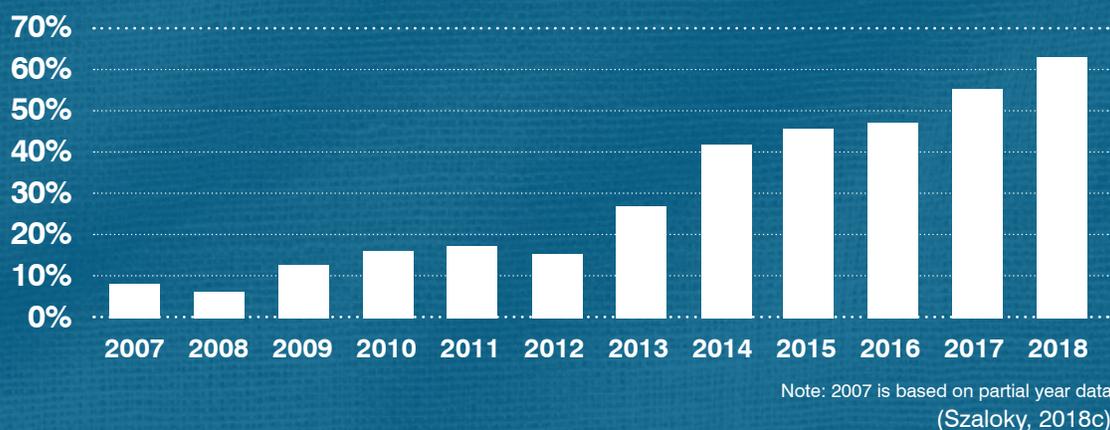


Figure 3: Percentage of grain that Smithfield purchased directly from farmers



Reducing grain transport saves costs for Smithfield, also benefiting farmers who participate. Smithfield’s approach to grain sustainability is to bring precision technology and agronomic expertise directly to local grain farmers, focusing on opportunities to reduce fertilizer loss and build soil health while maintaining or increasing yields.

Expanding impact: Smithfield’s GHG footprint and reduction goal

Based on the early success of the grain sustainability initiative and positive working relationship, EDF and Smithfield began to discuss the possibility of taking on additional projects and expanding Smithfield’s commitment beyond its grain supply chain. Smithfield’s environmental and sustainability team assessed the challenge of a broader GHG reduction goal, for which EDF advocated. The team ultimately recommended a 25 percent reduction by the year 2025, from a 2010 emissions baseline, to their President and CEO Ken Sullivan. He agreed and fully supports the effort.

During this process, Smithfield worked with the NorthStar Initiative at the University of Minnesota Institute on the Environment to profile the emissions footprint of Smithfield’s supply chain and identify hotspots. This emissions profile informed Smithfield’s GHG reduction goal and its action plan to achieve it.

NorthStar created a lifecycle analysis (LCA) of Smithfield’s supply chain, using an existing LCA developed for the National Pork Board in 2011 and

modified with NorthStar’s own corn and animal transportation model. To improve the accuracy of the LCA, Smithfield provided proprietary data on its owned and contract hog operations. Data was broken down by regions where grain is grown and hog operations are located. NorthStar’s model allowed a more accurate picture of Smithfield’s complete supply chain. Merged with Smithfield-specific data, this customized model made it possible to more accurately quantify Smithfield’s GHG emissions.

“Smithfield said, ‘Okay, we’re really trying to look at the full picture here. We’re really trying to use the best science that we can get a hold of.’”

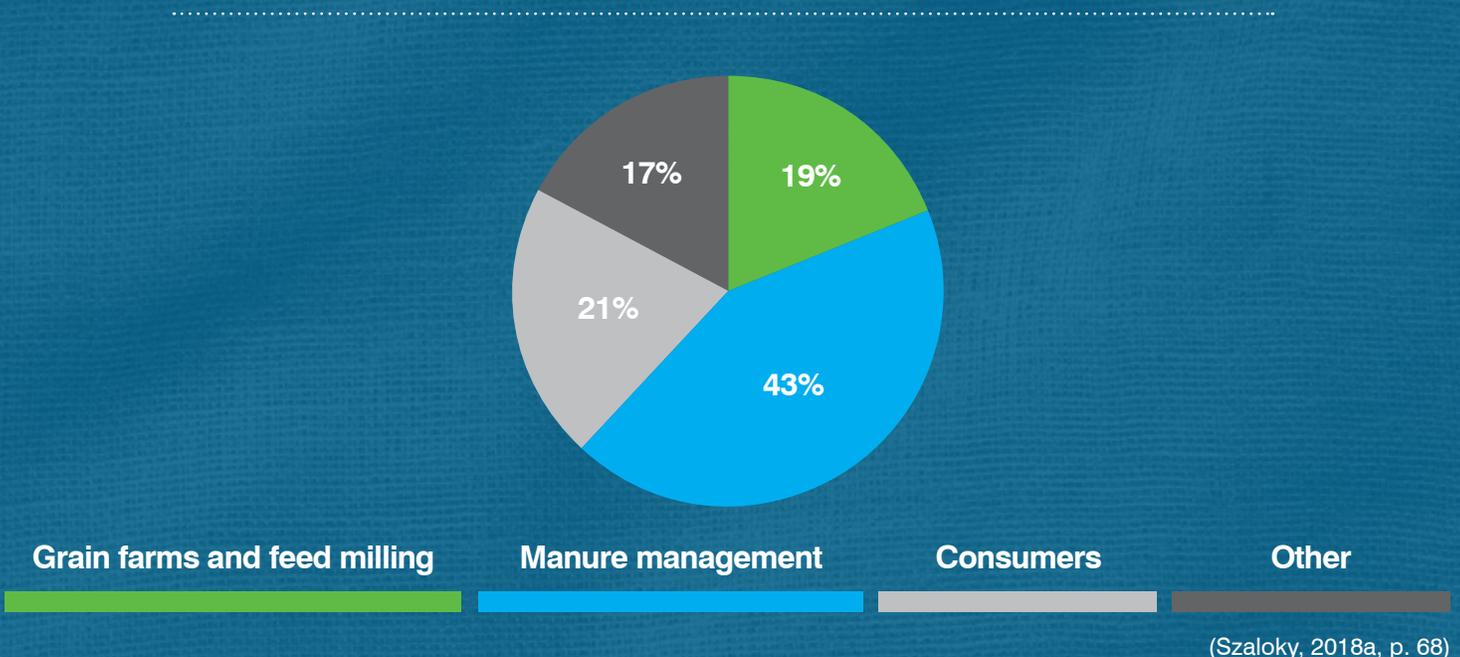
- Jennifer Schmitt,

Program director and lead scientist for the NorthStar Initiative at the University of Minnesota (Schmitt, 2018)

The LCA includes emissions estimates tailored to Smithfield’s unique supply chain, extending from grain production, through processing facilities, distribution, retailers and all the way to consumers (see Figure 4). The results of the emissions mapping were as follows:

- **Grain farms and feed milling** (19 percent).
- **Manure management** (43 percent).
- **Consumers** (21 percent).
- **Other**, which includes non-grain feed production, slaughtering, processing and transportation (17 percent).

Figure 4: Results of Smithfield Foods’ GHG assessment



The LCA process allowed Smithfield to refine its plan for how best to achieve its GHG goal. While other companies have set goals for their own operations, Smithfield’s goal, which the company calls its “25 by ’25 commitment,” was the first absolute supply chain GHG reduction goal set by a major protein company. Since then, other animal agriculture companies have set goals to influence the sustainability of their supply chains, including Tyson Foods (Tyson Foods, 2018), Cargill (Cargill, 2018), JBS (JBS, 2018) and Perdue Foods (Perdue Foods, 2018). It is important to note that some of these commitments do not include Scope 3 emissions, which are all indirect emissions that occur in the company’s value chain (World Resources Institute, 2019). Emissions from agricultural practices such as fertilizer and manure management are often categorized as Scope 3 emissions.



Expansion to new business opportunities: Smithfield renewables

With its GHG reduction goal in place and its emissions profile identified, Smithfield created a new business platform called Smithfield Renewables in 2017. Led by Kraig Westerbeek, senior director of Smithfield Renewables, and reporting through the company's sustainability team to the chief sustainability officer, the platform holds responsibility for administering all of the company's renewable energy and carbon reduction projects, setting a company-wide renewable energy strategy on farms and in facilities, and meeting the company's GHG reduction goal (Globe Newswire, 2017).

Smithfield announced its investment plans to achieve its GHG reduction goal in 2018. This includes a plan to implement manure-to-energy projects across 90 percent of Smithfield's company-owned and contracted hog finishing spaces in North Carolina and Utah, and nearly all of Smithfield's company-owned hog finishing spaces in Missouri over the next 10 years. This timeline will aid the company in achieving — and exceeding — its 25 by '25 commitment (Smithfield Foods, 2018d).

EDF estimates that when completed, these projects will capture more than 85,000 metric tons of methane per year, which in turn can be used to replace fossil fuels. The climate impact of these reductions over 20 years is equivalent to eliminating carbon dioxide emissions from more than 700,000 homes. The captured manure methane can be used as renewable natural gas to generate electricity, fuel transportation and attract new manufacturing to rural areas (EDF, 2018b).

Tracking progress: Data management and reporting

One of the greatest challenges of supply chain sustainability initiatives is collecting the data necessary to show the environmental outcomes of farm management changes. Data on fertilizer application, management practices and crop yields

are necessary to understand the environmental impacts of agricultural management changes. This data is generated on the farm, posing a challenge to access it in a way that protects farmer privacy while allowing others in the supply chain to understand the impacts of sustainability initiatives. The data challenge is one on which multiple food and agriculture supply chain associations and initiatives are focused, including Field to Market and TSC.

Smithfield's efforts on grain sustainability were tracked through Walmart's fertilizer reporting framework, developed with input from EDF. This reporting methodology asks companies to track acres of practices engaged and assigns the practices to different tiers, which represent assumptions of improvements in nutrient use efficiency and resulting changes. These are then multiplied by crop and geography-specific emissions factors and summed together to estimate the total emissions impact from the practices implemented. Smithfield's agronomists and other staff involved in their grain sustainability program kept track throughout the year of the acres engaged in the different sustainability initiatives detailed in this report. Those acres were then entered into the Walmart fertilizer reporting framework and used to generate emissions reduction estimates.

Looking to the future, EDF and many of its partners are engaged in the development of practical metrics for nutrient loss that are simple to track and provide value to farmers and food companies. EDF's goal to simplify metrics is meant to minimize assumptions, which are opportunities to introduce error into emissions estimates and reduce the certainty of actual environmental progress. In addition, there is a strong focus on ensuring that metrics offer value back to farmers for use in benchmarking and improving performance.

Summary of progress: Smithfield and EDF partnership supply chain sustainability initiatives

In the course of its partnership with EDF, Smithfield set two industry-leading sustainability goals and has made substantial progress toward achieving them.

The first was the company's 2013 grain sustainability target to engage 75 percent of its direct-sourced grain acres, or 450,000 acres, in practices that optimize fertilizer use and improve soil health. Smithfield achieved that goal in 2018, successfully engaging over 560,000 acres in sustainable practices.

The second goal, Smithfield's 2016 commitment to reduce its absolute supply chain GHG emissions 25 percent by 2025, is more recently underway. However, the company's recent pledge to invest in manure biogas technology at scale shows the company is on track to achieve its ambitious GHG reduction target.

The rest of this case study details the individual efforts that comprise Smithfield's progress in addressing the environmental impacts of its supply chain, while generating business value. Tables 1 and 2 provide summary information on those efforts, followed by detailed descriptions of each effort, and finally by lessons learned.

Table 1: Smithfield Foods and EDF partnership supply chain sustainability initiatives

Initiative	Start date	Description
Grain sustainability initiatives		
Smithfield Agronomics: agronomy services	2013	Providing free agronomic services to farmers, including nutrient management, cover crops education and reduced-cost seed
Wheat program	2016	Developing the southeastern supply of wheat with discounted seed and improved receiving capabilities
Volunteer corn	2015	Investing in equipment to encourage early harvest of grain has led to a volunteer corn crop in the fields that scavenges excess nutrients after harvest
Optical sensor loan program	2014	Purchasing and loaning GreenSeeker® optical sensors to farmers for precision nitrogen fertilizer application
Agronomic support for non-GMO soy	2018	Connecting farmers to non-GMO soy market opportunities and providing participating farmers with a price premium, reduced-cost seed and additional agronomic support
Midwest nutrient management: beyond compliance	2010	Employing Smithfield agronomists to support farmers with data and tools to go beyond state requirements in their manure nutrient management plans
Converting manure solids into fertilizer	2018	Partnering with Anuvia Plant Nutrients to convert Smithfield manure solids to a value-added fertilizer product
Regional Conservation Partnership Program	2015	Partnering to win a dedicated pool of U.S. Department of Agriculture cost-share funds for farmers who adopt conservation agriculture practices
Hog farm sustainability initiatives		
Manure biogas technology	1995 and 2016*	Deploying manure-to-energy projects at scale

*Note: Biogas projects were piloted in 1995, but an increased commitment at a larger scale and with a new focus on renewable natural gas occurred in 2016.

Table 2: Summary of benefits and lessons learned from Smithfield and EDF partnership initiatives

Initiative	Environmental benefits	Economic benefits	Key lesson learned
Grain sustainability initiatives			
Smithfield Agronomics: agronomy services	- Reduced fertilizer loss	- Increased local supply of grain - Grain transportation cost savings - Free agronomic assistance for farmers	- Providing free agronomic services to farmers helps them adopt new practices and maximize nutrient use efficiency.
Wheat program	- Reduced fertilizer loss - Improved soil health with winter cover	- Increased local supply of grain - Grain transportation cost savings - Free agronomic assistance for farmers - Reduced-cost seed for farmers	- Reducing seed costs helps to increase local grain supply, creating business value for Smithfield and its farmer partners.
Volunteer corn	- Takes up nitrogen left in fields post-harvest (nitrogen benefit still being quantified)	- Increased supply of local corn - Higher quality grain - Reduced risk of crop damage due to early harvest	- Developing the technical capability to facilitate early harvest increases farmer participation.
Optical sensor loan program	- Reduced fertilizer loss because of precision application	- Free trial period for farmers - Reduced fertilizer costs - Increased crop yields	- On-farm technology needs to be supported with technical assistance for successful adoption.
Agronomic support for non-GMO soy	- Reduced fertilizer loss due to added agronomic support	- Market access and premium pricing for farmers - Free agronomic assistance for farmers - Reduced-cost seed for farmers	- Providing farmers with new market opportunities also engages them in sustainability programs.
Midwest nutrient management: beyond compliance	- Reduced manure and fertilizer nutrient loss - Improved soil health	- Free agronomic assistance for farmers - Reduced fertilizer costs	- Agronomists who assist hog farmers with regulatory compliance are also a valuable resource for sustainability efforts.
Converting manure solids into fertilizer	- Transported manure solids out of areas with high concentrations of hog farms	- Turns manure solids into a value-added product	- Manure can be turned into a value-added product with the help of strategic partners.
Regional Conservation Partnership Program	- Expanded ongoing cover crop and nutrient management efforts - Reduced nutrient loss and improved soil health	- Farmers receive government cost-share payments to adopt new conservation practices	- Partnerships and government matching programs help to leverage increased support for conservation agriculture practices.
Hog farm sustainability initiatives			
Manure biogas technology	- Reduced manure methane emissions	- Long-term gas contracts for farmers - Biogas revenue	- Biogas implementation at scale requires a focus on the economics of the entire system.

Grain sustainability initiatives in depth

This section details nine grain sustainability initiatives that Smithfield implemented between 2013 and 2018. Table 3 presents the final tally of acres engaged in Smithfield's grain sustainability initiatives. Some variability in acres by initiative represent shifts in focus among initiatives. For example, 2016 and 2017 lack Smithfield Agronomics acres because agronomic guidance in those years was provided through other initiatives, such as the wheat program.

Table 3: Summary of acres engaged in Smithfield Foods' grain sustainability initiatives

Initiative	Region	2014	2015	2016	2017	2018
Smithfield Agronomics: agronomy services	Southeast	21,500	65,500	-	-	27,000
Wheat program	Southeast	-	-	35,835	49,740	70,200
Volunteer corn	Southeast	-	-	100,000	108,000	135,000
Optical sensor loan program	Southeast	-	-	20,000	20,000	20,000
Agronomic support for non-GMO soy	Southeast	-	-	-	-	25,000
Midwest nutrient management: beyond compliance	Midwest	-	-	166,641	228,809	173,310
Converting manure solids into fertilizer	Southeast	-	-	-	-	90,000
Regional Conservation Partnership Program	Southeast	-	-	-	752	13,163
Prairie, riparian buffers and cover crops	Southeast and Midwest	-	11,300	5,259	3,530	6,388
Total		21,500	76,800	327,735	410,831	560,061

Source: (Williamson, 2018a and 2018d); (Monast, 2018a)

Note: Prairie reclaimed cropland and the installation of field/riparian buffers are ongoing Smithfield initiatives that are not detailed in this report.





Smithfield Agronomics

Objective: Influence farmer grain production practices to reduce fertilizer loss, build soil health and improve farm profitability.

Description: Provide free agronomic services to farmers, including nutrient management, cover crop education and reduced-cost seed.

Quick fact: Smithfield improved grain farming practices on over 560,000 acres in 2018.

Smithfield and EDF began their collaboration in 2013 with a program to work with grain suppliers to establish sound fertilizer management practices. Now called Smithfield Agronomics, the program seeks to enhance farmer productivity and sustainability, develop partnerships with farmers and ensure a sustainable grain supply for Smithfield's operations.

At its inception, Smithfield Agronomics offered free agronomic assistance to farmers who grow grain in Smithfield's grain sourcing regions. The program focused on improved nutrient management practices, such as optimizing the amount of nitrogen fertilizer applied to reduce GHG emissions from nitrous oxide emissions (Shcherbak, Millar and Robertson, 2014). Through precise, targeted nutrient management, only the crops that need supplemental nutrients receive them. This often results in reduced operating costs and higher yields as crop nutrition is optimized. Together, reduced costs and increased profits from higher yields help the overall economic outcome for farmers, while the practices reduce the environmental impact of Smithfield's supply chain.

Catalyzed by discussions with Walmart, Smithfield made a commitment to improve fertilizer efficiency and soil health on 75 percent of the company's grain sourcing acres, the land required to grow the corn to feed Smithfield's hogs for one year, by 2018 (approximately 450,000 acres) (Williamson, 2018b). "We wanted the hallmark of our program to be the relationship with the farmer," said Dawn Williamson, director of environmental compliance and sustainability at Smithfield. "That we would support him or her in making decisions that would count toward our goal to advance sustainability throughout the grain supply."

Early in planning for the fertilizer goal, Smithfield and EDF staff discussed offering price premiums to incentivize farmers to change their practices. They questioned whether a premium would be sufficient to shift farmer practices, or if there were other

influences in the way that would prevent adoption. Smithfield decided instead to invest in resources, such as agronomists, to provide technical assistance to farmers and to begin to quantify environmental impacts.

Smithfield hired an agronomist to focus on North Carolina, South Carolina and Virginia, a core area of grain and hog production for the company. In addition to nutrient management, current agronomist Adam Lassiter supports farmers in accessing other facets of sustainable farming, including cover crops, education and reduced-cost seed. Lassiter works with farmers individually, surveying the farmers to understand their current nutrient management practices and then creating a custom program to address any needs. To create the custom plan, Lassiter collects soil nitrate and plant tissue samples, scouting the fields to focus on insect or disease concerns. He uses this information to create a field-specific nutrient management plan for the upcoming crop. Lassiter provides ongoing assistance during the season and continues to test soil and plant tissues specific to the region and commodity. Nutrient management plans are amended as needed.

In 2018, the Southeast agronomist worked with farmers to improve practices on 25,000 acres of corn, 43,000 acres of wheat and 25,000 acres of non-GMO soy (Lassiter, 2018). While Smithfield has conducted numerous town hall discussions to introduce farmers to the program, it has also grown through word of mouth, with many new-to-Smithfield farms engaging. "Every farm is different," says Lassiter. "Every management strategy is different, and so I evaluate each individual farm on ways to become more efficient. It just all depends on the region, the farmer, how aggressive they are and what practices they're looking to adopt. I find myself doing a lot of listening before really implementing anything."

The Smithfield agronomist also supports farmers in adopting other conservation practices, such as cover crops. Cover crops enhance soil health because they keep the soil anchored between growing seasons, which yields benefits in soil erosion, fertility, soil structure, moisture content, and weed and pest control. They have also been shown to reduce nitrogen loss to water, leading to water quality improvements. Working with grain farmers, the Smithfield agronomist proactively communicates the benefits of planting cover crops to increase adoption of the practice. He also provides agronomic advice on crop options and integration of cover crops into the planting rotation, as well as support in procuring the seed.

In addition to creating environmental benefits, the agronomics program supports several different business functions. Smithfield Agronomics sits within the procurement team responsible for grain buying, where it helps to partner with local farms and seeks to purchase more local grain. The agronomist also helps the procurement and research and development teams identify long-term trends in grain sustainability to support strategic planning for sourcing corn and grains in the region. For the Smithfield Renewables team, who is responsible for meeting the 25 by '25 goal, the agronomist's work clearly aligns with reducing emissions throughout the supply chain. In all, the benefit to Smithfield is two-fold: reduced GHG emissions in their supply chain and higher volumes of locally produced grain.

“By introducing these multispecies cover crops, you’re trying to mimic nature and you’re trying to do things in a different way that not only makes you more viable but you’re also reducing nitrogen, you’re reducing runoff, you’re reducing chemicals — and all that’s good as long as we remain profitable.”

- Carl Colman,

South Carolina farmer who worked with Smithfield’s agronomist



Winter wheat program

Objective: Increase the volume of locally grown winter wheat, which acts as a cover crop in winter months.

Description: Develop the Southeastern supply of wheat with discounted seed and improved receiving capabilities.

Quick Fact: Smithfield sees a 1.6 times return on their wheat seed program investment.

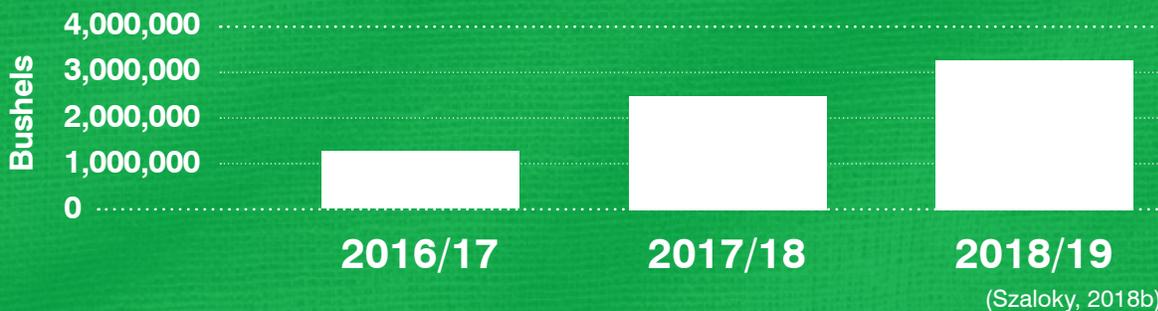
The winter wheat program, which provides discounted seed to farmers, directly benefits Smithfield’s procurement efforts with increased volumes of locally grown, more cost-effective wheat for hog feed. Buying the seed directly from the seed company removes layers of distribution and cost. As a result, Smithfield saves 40 percent over normal costs and passes these savings onto farmers (Smithfield Foods, 2018a, p. 73). Seed is sold to farmers on consignment, meaning that they don’t have to pay for seed until harvest, which helps farmers manage operating costs.

In return for participating, farmers are asked to sell at least 60 bushels per acre of their harvest back to Smithfield. Smithfield will also purchase anything above the 60 bushels per acre, but this gives farmers flexibility in case they have other buyers at harvest time. In the rare instances where farmers’ yields do not meet the 60-bushel threshold, a Smithfield agronomist works with the farmer to improve yields in future years.

Excess seed that remains after the optimal planting window closes is sold to farmers at cost as a cover crop. For the wheat cover crop, there are no purchase contracts with farmers, and the farmer has to pay for the seed upfront. Winter wheat creates ground cover during the winter, limiting wind erosion and preventing weeds from growing. The roots of the wheat increase microbial activity and soil tilth (Warncke, 2007). Winter wheat improves nutrient cycling of nitrogen, phosphorous and potassium. It is also easier to manage in the spring, with minimal tillage and trafficking requirements, leading to less soil compaction during wet conditions (SARE, 2012).

Smithfield buys as much of the local wheat harvest as it can (see Figure 5) (Szaloky, 2018b). If a farmer elects to sell to someone else, growing the wheat is still beneficial to Smithfield’s goal to develop the local grain economy in the long term.

Figure 5: Total Smithfield Foods wheat purchased that is attributed to the wheat program



Farmers have been receptive to the program. In 2018, Smithfield sold over 2.5 times the number of wheat seed bags to farmers in this program since its inception in 2016 (see Figure 6), and expects the program to continue to expand (Szaloky, 2018b).

Figure 6: Expansion of Smithfield Foods' wheat program

	Acres	Million bushels	Bags sold
2016	21,000	1.26	63,000
2017	42,000	2.52	126,000
2018	53,800	3.22	161,400

(Szaloky, 2018b)

The wheat program has also generated business value for the company and its farmer partners. Smithfield agronomist Adam Lassiter estimates that participant farmers realize an additional \$40 per acre profit over traditional planting (Lassiter, 2018). In addition to relationship building with farmers and improved nutrient management within its supply chain, the economics of the program are strong for Smithfield. Smithfield has seen a 165 percent internal rate of return on its seed investment (Szaloky, 2018a). Additionally, buying local wheat instead of more expensive corn or wheat from the Midwest also yields savings.





Volunteer corn

Objective: Increase the availability of early-harvest corn and allow fallen seeds to germinate, absorbing leftover fertilizer.

Description: Invest in infrastructure to encourage early harvest of grain and spur a volunteer corn crop in the fields.

Quick fact: Smithfield invested \$12 million in mechanical grain dryers to harvest corn earlier in the season.

Smithfield's demand for corn has outpaced the availability in the Southeast, so Smithfield made a push to partner with local farmers to harvest corn earlier in the season. Harvesting early gives Smithfield access to higher volumes of local corn, as well as a higher-quality product. To facilitate early harvest, Smithfield invested \$12 million in mechanical grain dryers at local grain elevators (Smithfield Foods, 2018a, p. 73). The farmer is charged the direct cost of the natural gas used to dry the corn, as well as for the volume shrink, which also would have occurred through field drying.

Access to grain dryers enables farmers to harvest their corn in August, reducing risk of crop damage from storms and animals. Farmers also receive roughly \$0.20/bushel more for grain harvested in August than in September. Corn harvested early has less mold and rot from field drying, leading to a higher-quality crop and improved feed quality for Smithfield hogs. Lastly, early harvest allows a wider window for farmers to plant winter wheat, which provides additional economic and environmental benefits.

During harvest, corn kernels are often left on the ground. When harvest is completed early, leftover kernels are able to germinate and grow in September and act as a volunteer cover crop. The young corn plants absorb leftover nitrogen remaining in the field. The early November frost then kills the corn and any weeds that may have begun to grow, and then the field is prepared to plant winter wheat.

To confirm the environmental value of volunteer corn, the Smithfield agronomist took several samples of the corn for nutrient concentration and biomass analysis by the N.C. Department of Agriculture and Consumer Services' lab. The volunteer corn crop samples analyzed took up 16 pounds of residual nitrogen, 9 pounds of residual phosphorus and 29 pounds of residual potassium in the 75 days between harvest and frost (Lassiter, 2018). Additional data is needed to more accurately assess the impact of volunteer corn in absorbing post-harvest soil nitrogen.

“If we have positively affected conservation practices anywhere, then we’ve done our job. If that corn or grain comes to us, that’s great. If it doesn’t, the work is still worthwhile.”

- Dawn Williamson,

Environmental and sustainability project manager at Smithfield Foods (Szaloky, 2018a)



Optical sensor loan program

Objective: Assist farmers in adopting optical sensor technology for precision nitrogen application.

Description: Purchase and loan the GreenSeeker® tool to farmers to increase technology adoption and target application of nitrogen.

Quick fact: Smithfield quickly saw a return on their investment in the tool via variable rate nitrogen application, which evened out crop yield.

The GreenSeeker® tool is an optical sensor technology that detects the greenness of crops and varies the application rate of fertilizer accordingly, with the goal of only applying what is needed by the crop. GreenSeeker® uses optical sensors that emit bursts of red and infrared light to measure and quantify crop health and variability. GreenSeeker® comes in two models with different capabilities and price points. The first is mounted onto sprayer booms and provides instant side-dress fertilizer application for fertilizers such as nitrogen. The second is a less costly, handheld model that provides readings and uses a smartphone or tablet application to make fertilizer recommendations based on the analysis (Trimble Ag Field Solutions, 2018). The benefit of the tool is that nitrogen is applied only as needed, and where needed, increasing yields while reducing fertilizer costs and the environmental impacts of excess fertilizer.

Smithfield owns a few crop farms in North Carolina and the company purchased a GreenSeeker® unit and tried it on its own crops to understand the technology and science behind the tool. The team quickly saw a return on their investment because the GreenSeeker® was able to add variable rates of nitrogen to land where manure had first been applied, evening out the crop yield. Smithfield saw the value in implementing this technology with its grain farmers as a best practice in nutrient management, but the purchase cost was too steep for many farmers, especially for a new, less-proven technology.

To facilitate adoption of the technology with minimal cost and risk to farmers, Smithfield purchased five units and lent them out to farmers to try out for one year. Smithfield paid for the equipment; the farmer only paid for installation. If a farmer liked the tool, they would purchase it from Smithfield, and Smithfield would buy another unit to lend out to another farm. If the farmer didn't like it, they returned it to Smithfield to lend out again. Smithfield also partnered with an agricultural data and technology company to analyze the data and offer technology troubleshooting to farmers.

While the technology was very attractive to Smithfield and farmers, it was also highly technical and complicated to administer. The science supporting the tool was based on a complex algorithm developed in Virginia, since the local land-grant institution, North Carolina State University, had not developed a North Carolina-specific algorithm. This made the tool less appealing to North Carolina farmers. It required expertise that many farmers did not have, and technical support by the developer was limited, so it was time-intensive to learn to use accurately to get actionable data for decision-making. Finally, shortly after the program was initiated, crop prices plummeted and the participating farmers did not want to make major technology investments. In short, the challenges of this program outweighed the benefits.

Ultimately, Smithfield and its grain farmers decided to move away from the optical sensor loan program but recognized that the model of buying technology to lease out to farmers has potential for different applications.



Agronomic support for non-GMO soy

Objective: Partner with grain elevators and farmers who are enrolled in sustainability initiatives by facilitating new markets.

Description: Create a market opportunity for farmers and grain elevators by offering reduced-cost seed for non-GMO soy, along with additional agronomic support.

Quick fact: Farmers were able to sell the non-GMO soy for a \$45-per-acre benefit over conventional soy, and the additional volume of identity-preserved grain helped grain elevators.

The non-GMO soybean program began in 2018 as an opportunity for Smithfield Agronomics to support local grain elevators, create a new market opportunity for grain farmers, and engage more farmers in the agronomy program. In the Southeast, grain elevators are a critical component of Smithfield's feed milling operations, but they are in jeopardy from decreasing volumes and profitability. Smithfield's procurement team partnered with a milling business to fulfill demand for non-GMO soybeans in the southeastern market. Based on this opportunity, the company facilitated a new market for farmers who are working with Smithfield Agronomics on sustainability initiatives.

Similar to the wheat program, Smithfield purchases non-GMO soybean seed from the seed company, selling it to the farmer at a discount. Payment for the seed is deferred until harvest, and the farmers commit to sell 40 bushels per acre to Smithfield. Farmers receive nutrient management assistance from Smithfield Agronomics. The crop goes to specific grain elevators that are able to manage the identity-preserved grain. In 2018, the program resulted in the planting of 25,000 acres of non-GMO soybeans.

The non-GMO soybean program is one way in which Smithfield is supporting its strategic partners by taking a long-term view of the health of the local grain economy. Farmers' profits increased, since the non-GMO soybeans sold for a \$20-per-acre premium over conventional soybeans, with an additional \$25-per-acre savings realized from the reduced-cost seed (Szaloky, 2018a). This adds up to a \$45-per-acre total benefit to the farmer for participating in the program. Additionally, farmers receive agronomic assistance and guidance on production planning as part of the larger Smithfield Agronomics program. While there is no direct environmental benefit to planting non-GMO soy, Smithfield benefitted by helping to keep essential local grain elevators profitable and running, while establishing new and stronger relationships with farmers who were adopting Smithfield's conservation agronomy practices.





Midwest manure nutrient management: Beyond compliance

Objective: Implement best management practices for manure nutrients on additional acres beyond regulatory requirements.

Description: Employ Smithfield agronomists to support farmers with data and tools to go beyond state requirements in their nutrient management plans.

Quick Fact: In Iowa, Smithfield has nearly 3.5 times more acres under a manure management plan than is required by the Iowa Department of Natural Resources.

In Iowa, a team of Smithfield agronomists is helping grain farmers and contract hog growers write and execute nutrient management plans, a regulatory requirement of the Iowa Department of Natural Resources (DNR). All farms are required by the Iowa DNR to have nutrient management plans, and nearly 78 percent of Smithfield growers rely on the Smithfield agronomists' expertise to write and execute their plans to ensure regulatory compliance (McLaughlin, 2018a). Growers who do not rely on Smithfield to write nutrient management plans often still work with the agronomy team on other aspects of environmental support. There is no fee for growers to participate. The program includes soil sampling, manure management plans and manure testing. It seeks to go beyond compliance by exceeding Iowa DNR requirements.

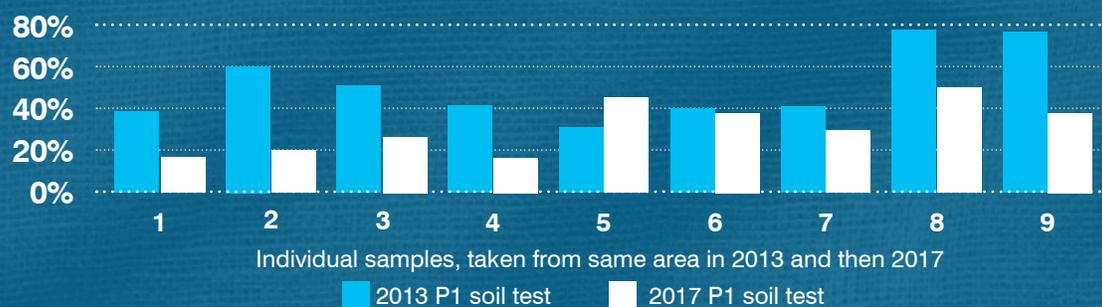
While soil sampling is a regulatory requirement — one sample for every 10 acres — Smithfield recommends more frequent sampling to its growers — one sample per 2.5 acres (McLaughlin, 2018b). Additionally, Smithfield uses geo-referencing to track the location of many of the samples, allowing farmers to be precise in the

application of any supplemental micronutrients (Moser, 2018a). State data for average application rates are typically used, which is less precise and can lead to over- or under-application.

Smithfield recognizes the importance of phosphorous management as a best practice for soil health, since phosphorous loss is an indicator of soil erosion. Smithfield farms have been required to sample soil for phosphorous levels since 2008, even though that only recently became a regulatory requirement. On some farms, Smithfield has seen phosphorus levels in fields decline because the crops are efficiently removing more phosphorous from the ground than is being applied in manure (McLaughlin, 2018a).

As an example, a private farm working with Smithfield's Midwest agronomy team plants a corn and soy rotation on a 38-acre field. Samples were taken in 2013 and again in the same general areas in 2017. During this time, phosphorus fertilizer was applied twice. All but one of the 2017 samples showed a decrease in phosphorous levels, a nearly 20 percent reduction on average (see Figure 7).

Figure 7: Soil test phosphorous levels from a sample Iowa farm



Source: (Moser, 2018b)

A farm's manure management plan has to be updated annually and submitted to the Iowa DNR every four years. Smithfield agronomists write the nutrient management plans for farmers and then work with them over the course of the season to administer and update the plan as needed. Manure application supplies nutrients, and the agronomists work with farmers to ensure that fertilizer is not over-applied. As of 2018, Smithfield had nearly 3.5 times more acres under the manure management plan than required by the Iowa DNR (Williamson, 2018c).



Converting manure solids to fertilizer

Objective: Repurpose manure to create a nutrient-dense commercial-grade fertilizer.

Description: Partner with Anuvia Plant Nutrients to use Smithfield manure to create a sustainable fertilizer.

Quick fact: The manure remnants create a sustained, controlled release of nutrients.

Smithfield views manure and the nutrients it contains as valuable resources. To that end, the company established a partnership in 2018 with Anuvia Plant Nutrients. The aim: to create a sustainable fertilizer from the biological remnants collected from manure treatment systems at company-owned and contract hog farms in North Carolina. Anuvia produces enhanced efficiency fertilizer for the turf and agricultural industries. By reclaiming organic waste in manure, processing it into fertilizer and applying to agricultural fields, Smithfield's manure is being used in a circular supply chain.

To create the fertilizer, Smithfield will collect and dry remnant solids that accumulate at the bottom of anaerobic lagoons. Once collected, the material is transported to Anuvia, where it will be converted into a nutrient-dense, commercial-grade fertilizer. The organic matter creates a sustained, controlled release. Notably, Anuvia's product is granular and can be easily dropped into existing farm equipment, unlike the other manure-to-fertilizer products on the market (Cosgrove, 2018).

Through this partnership, Smithfield has sought to reduce its environmental footprint from manure while creating business value for the company and its strategic partner.





Regional Conservation Partnership Program

Objective: Supplement existing conservation agriculture investments with federal cost-share funding for farmers.

Description: Partner to secure funding from a dedicated pool of federal cost-share funding for farmers to adopt conservation agriculture practices.

Quick fact: EDF, Smithfield and partners secured two Regional Conservation Partnership Program awards, one for \$500,000 in North Carolina and another for \$1 million in North Carolina and Iowa.

USDA's Regional Conservation Partnership Program is a public-private partnership program that provides a dedicated pool of Natural Resources Conservation Service (NRCS) cost-share funds to producers to adopt conservation agriculture practices such as nutrient management systems and cover crops.

Partner organizations, such as farmer cooperatives, local governments and nonprofit organizations such as EDF, collaborate with private farms to increase the conservation and restoration of soil, water, wildlife and related natural resources on regional or watershed scales. Funding pools are broken out by geography, and are awarded to projects that demonstrate solutions, contributions, innovation and participation (NRCS, 2018). Award recipients and partner organizations match contributions to the program, amplifying the overall impact.

EDF, Smithfield and partners secured two Regional Conservation Partnership Program awards, one for \$500,000 in North Carolina and another for \$1 million in North Carolina and Iowa. Funding goes directly to farmers who participate in Smithfield sustainability initiatives. Another benefit of the Regional Conservation Partnership Program is the opportunity to bring more partners into supply chain initiatives. While EDF was the lead partner for nominated projects, 16 other agricultural and conservation groups collaborated to win these awards (USDA, 2018b).

Regional Conservation Partnership Program 2017 Awarded Project — “SmithfieldGro: Sustainable grain supply chains”

Project Partners:

- Environmental Defense Fund
- Smithfield Hog Production
- North Carolina Pork Council
- North Carolina Farm Bureau
- North Carolina Soybean Producers Association
- North Carolina Division of Soil and Water Conservation
- North Carolina Foundation for Soil and Water Conservation
- The Nature Conservancy North Carolina Chapter
- North Carolina State University
- Iowa Corn Growers Association
- Iowa Pork Producers Association
- Iowa Soybean Association
- Practical Farmers of Iowa
- Conservation Districts of Iowa
- Iowa Agriculture Water Alliance
- Iowa Department of Agriculture and Land Stewardship

The Regional Conservation Partnership Program project in North Carolina has been active for two years, and the project in North Carolina and Iowa will begin enrollment in 2019. Smithfield and EDF's promotion of the Regional Conservation Partnership Program to North Carolina farmers gained large interest, with more than a hundred farmers signing up to participate. The vast majority of farmers who signed up to participate applied for funds to plant cover crops on their fields, a practice that improves water quality and reduces soil loss.

One of the challenges with the Regional Conservation Partnership Program is that the funds are limited, and awards were exhausted quickly. Fortunately, many of the farmers who did not receive awards were still able to obtain funding for sustainability practices through USDA NRCS's Environmental Quality Incentives Program. Despite being limited by available funds, the Regional Conservation Partnership Program is one example of how Smithfield is using partnerships to further expand ongoing conservation agriculture practices.



Hog farm sustainability initiatives in depth

Manure management is the single largest contributor to Smithfield's GHG emissions, accounting for as much as 45 percent of total supply chain emissions. Manure emits methane gas, a particularly potent GHG. With the setting of the GHG reduction goal and the establishment of Smithfield Renewables, the company has renewed urgency to advance the biogas and manure management projects it has pursued in its hog operations for years. These projects are critical components of Smithfield's 25 by '25 reduction strategy, providing an example of how Smithfield is integrating sustainability into its business functions to ensure program success.



Manure biogas technology

Objective: Use biogas to create renewable energy and reduce manure methane emissions.

Description: Deploy manure-to-energy projects at scale.

Quick fact: The Optima KV biogas project is expected to produce approximately 80,000 dekatherms of renewable natural gas annually, enough to power nearly 950 homes for one year.

In the mid-1990s in Milford, Utah, a Smithfield farm installed an anaerobic digester to produce and capture biogas. In anaerobic digestion, bacteria feed on hog waste in an environment free of oxygen. The bacteria emit a biogas of methane, or natural gas, as well as carbon dioxide. This biogas was turned into methanol, which was ultimately converted to biodiesel at a facility in Texas. The process proved to be costly and inefficient, but it constituted an important step in repurposing manure. Smithfield continued to manage the biogas capture and refining process for the environmental benefits and the incremental progress toward sustainable manure management.

In 2007, Smithfield publicly supported and lobbied the legislature in the state of North Carolina for the creation of the Renewable Energy Portfolio Standard, which required utilities in North Carolina to generate 12.5 percent of energy from renewable sources by 2020. The law included a requirement that swine manure must be used to generate a portion of that renewable energy, the only law like this in the country (USDOE, 2018). At that time, most biogas projects focused on creating renewable gas from manure and converting it into electricity through electron generators or microturbines. Smithfield participated in three of these systems, two of them on large contract grower operations (Westerbeek, 2018b). One project, a partnership between Smithfield and Blue Mountain Biogas Power Generation plant in Beaver County, Utah, is the largest swine manure-to-electricity project in the country.

While manure-to-electricity projects continue to operate and generate increasingly valuable renewable energy, they pose a number of challenges. Onsite electricity generators are not nearly as efficient as utility power plants. The process of using internal combustion engines or microturbines to convert biogas into electrons is inefficient, resulting in considerable heat loss. With farms in warmer climates, there isn't much use, and therefore little value, for recovered thermal energy.

From an infrastructure perspective, it is expensive to convert existing electrical grids, which were designed to send power from a generation source to end-users, into a system that allows for electrical production. These challenges mean that all but the largest of farms struggled to justify investment in these types of renewable energy projects.

Recognizing that other, more specialized companies were making strides in biogas technology, Smithfield decided to take a partnership approach to renewable energy projects going forward. The company invited proposals from several companies on the cutting edge of renewable energy technology. Projects were evaluated by proximity to energy transmission lines and by requisite population of swine in an area. Smithfield also knew that projects or systems needed to be simple enough for a farmer to operate and have an economic payback. The company decided to implement viable projects at different facilities around the country.

As technology has evolved, Smithfield Renewables has focused on new technology that generates renewable natural gas from manure, instead of electricity. In this approach, biogas generated on farm is converted into renewable natural gas and inserted into existing pipelines. This approach is more efficient and greatly simplifies the on-farm requirements and infrastructure needs. It also allows smaller farms to participate in the program because the gas is processed centrally at aggregation points and the infrastructure costs can be split among many farms, increasing the return on investment.

In order to generate natural gas, manure is captured in hog barns and transferred to covered lagoons or anaerobic digesters, where anaerobic digestion takes place. During anaerobic digestion, solids are broken down and methane gas is released, which is then captured and transported to a central processing facility for all digesters in the area.



Transforming manure into energy

Smithfield Foods leads the industry in developing pioneering technologies that transform manure into energy. These ventures are part of Smithfield Renewables, a platform dedicated to accelerating the company's carbon reduction and renewable energy efforts.

1 Capturing manure from barns

Hogs are raised in barns. The manure they generate falls through slatted barn floors then is temporarily stored in concrete pits below. Underground pipes transfer the manure—including nitrogen, phosphorous and other nutrients—to lagoons or digesters, structures for storage and treatment.

2 Anaerobic treatment at work

Anaerobic treatment systems break down the solids associated with nutrients in manure, leaving a low-solid effluent product that is used to fertilize nearby fields. Covers on the lagoons and digesters capture biogas emitted from the anaerobic digestion process.

3 Renewable natural gas

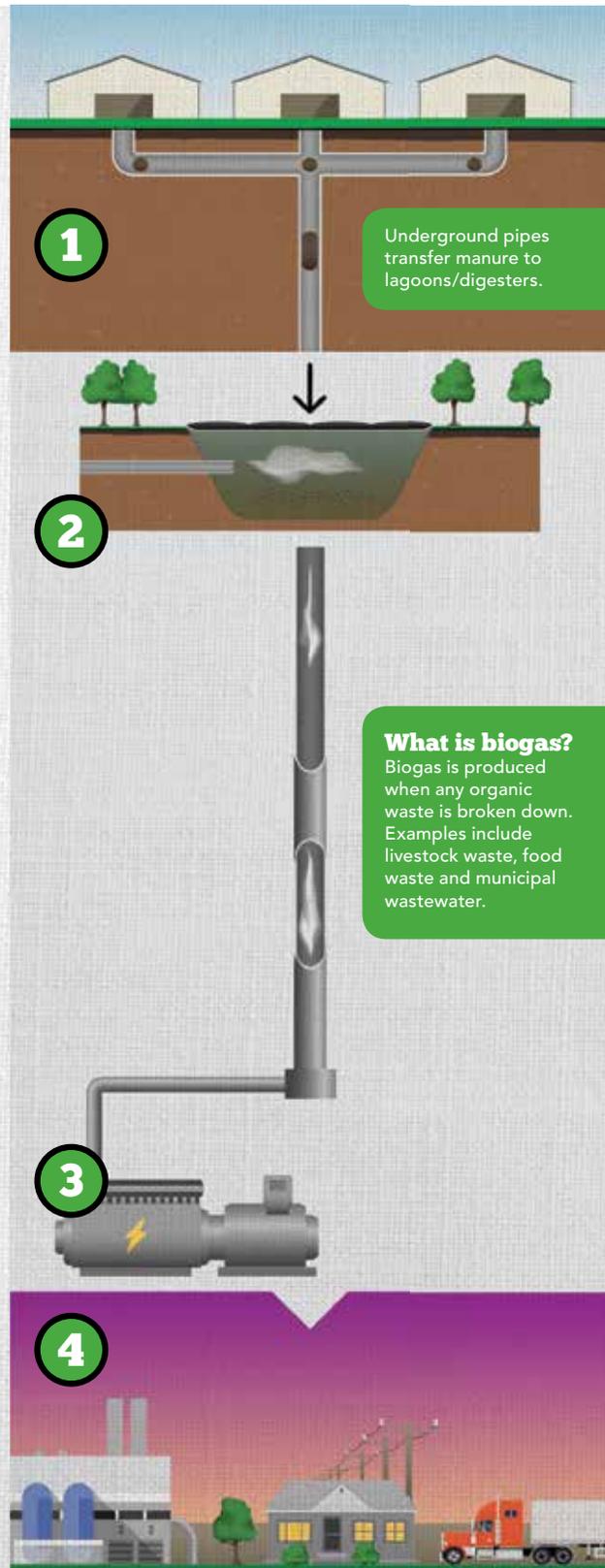
Biogas is transported to refineries for cleaning—going from 60-70 percent to over 96 percent methane. Cleaned, renewable natural gas is now ready to be injected into an existing natural gas pipeline.

4 From manure to energy

Once refined, renewable natural gas can be used for multiple purposes, including electricity for homes and businesses, fuel for compressed natural gas vehicles and boilers in facilities or plants.



smithfieldfoods.com



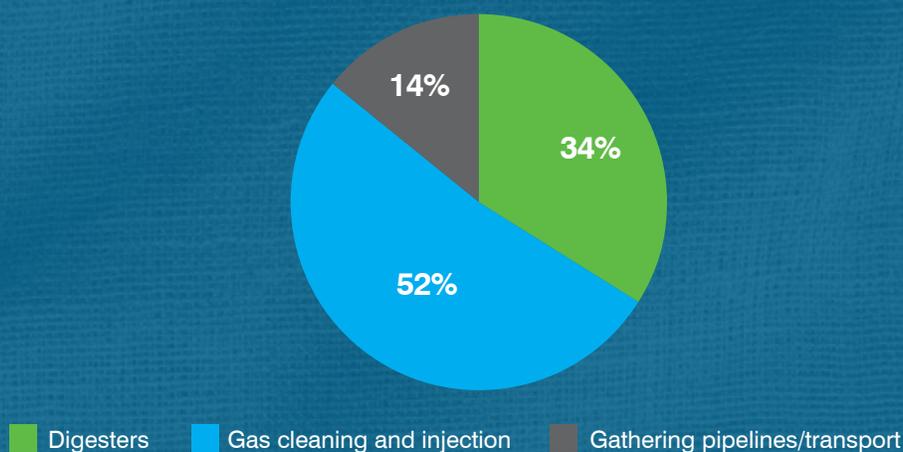
Renewable natural gas from manure projects has become increasingly financially attractive. The federal Renewable Fuel Standard provides significant incentives for transportation fuels derived from biomass sources such as manure. Markets for renewable natural gas have advanced enough to justify investments in biogas projects. The increase in biogas projects seen in recent years is an indication of a fundamental change in manure management using biogas capture and reuse as a management strategy.

A flagship example is the Optima KV project, which started in 2016 near Kenansville, North Carolina, in partnership with Optima BioEnergy. The project, which includes seven contract producer farms and five anaerobic digesters, uses gathering pipelines to capture biogas from hog farms. Optima built waste collection systems and digesters at the farms to transport hog manure and liquids to digesters. Biogas captured from the digesters is converted at a central location to pipeline-ready natural gas, which is then injected into a nearby Piedmont Natural Gas

pipeline. Having centralized gas conversion means that the most expensive infrastructure is shared among participating farms, creating shorter payback periods and an opportunity for smaller farms to participate (see Figure 8).

The Optima KV biogas project is expected to produce approximately 80,000 dekatherms of renewable natural gas annually, enough to power nearly 950 homes for a year (Smithfield Foods, 2018a, p. 76). The remaining effluent from the digesters is held in existing lagoons until it is used to fertilize crops (NC Pork Council, 2017). In addition to facilitating the process with its contract farmers, Smithfield leased the land that carries the natural gas transmission line to Optima for 20 years for \$1 (Smithfield Foods, 2018a, p. 76). In sum, the Optima KV project uses new technology, meets North Carolina's Renewable Energy Portfolio Standard regulations regarding renewable natural gas, and eliminates many of the costs and complications that come with generating electricity from manure.

Figure 8: Approximate breakdown of costs to install a manure-to-renewable natural gas system



Source: (Westerbeek, 2018b)

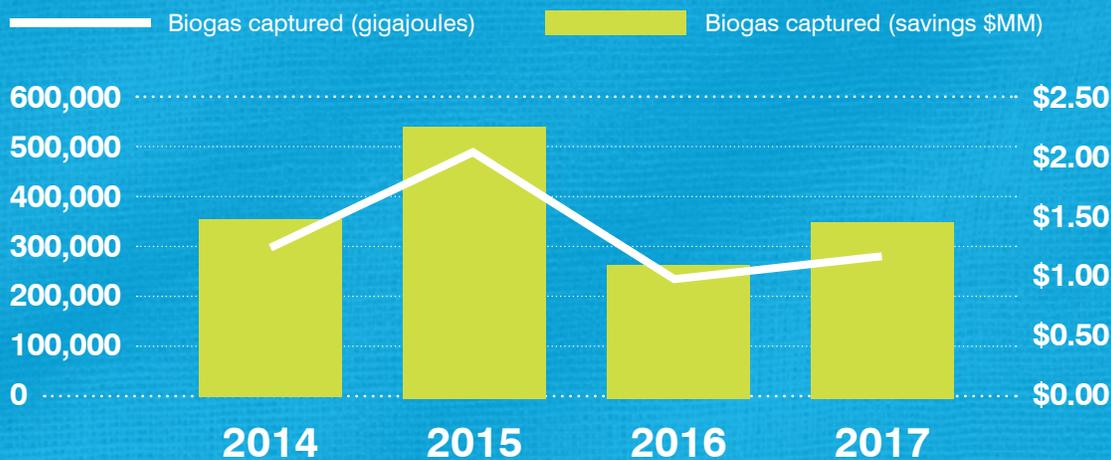
For John Kilpatrick, the owner of Circle K II Farms, participating in the Optima KV project was a clear choice from both an environmental and economic perspective. “The benefits are selling the methane, the gas, which would normally be a waste product. Why not capture it, use it and make a benefit from it? It’s just a matter of putting the pieces of the puzzle together,” Kilpatrick said (Smithfield Foods, 2018c).

The economic benefits of installing a renewable natural gas system have attracted interest from other Smithfield farmers. Elwood Garner, a contract hog grower for Smithfield, estimated that his 5,280-hog farm could yield between \$60,000 and \$70,000 in revenue each year with a biogas system, when implemented (Murawski, 2018).

At a similar project in northern Missouri, Roeslein Alternative Energy is converting manure into renewable natural gas. The project, which began in 2016, is expected to produce an estimated 1.3 million dekatherms of renewable natural gas annually, enough to provide electricity to about 15,400 homes for one year (Smithfield Foods, 2018a, p. 76).

Smithfield has several additional waste-to-energy projects at its processing facilities that collect biogas from covered, anaerobic digesters and use the biogas generated as a substitute for natural gas to fire the boilers at these facilities. In total, these facilities produced nearly 270,000 gigajoules of energy in 2017, saving the company over \$1.3 million dollars in natural gas costs (see Figure 9) (Smithfield Foods, 2018a, p. 58). For Smithfield, it's important that these biogas projects are economical to build and operate. On average, Smithfield's investments in its biogas projects realize an unleveraged rate of return of over 15 percent and a 5 to 7 year payback period, as long as renewable energy and carbon markets remain stable (Westerbeek, 2018b).

Figure 9: Biogas generated and reused onsite, in \$millions and gigajoules



Source: (Smithfield Foods, 2015); (Smithfield Foods, 2016); (Smithfield Foods, 2017)

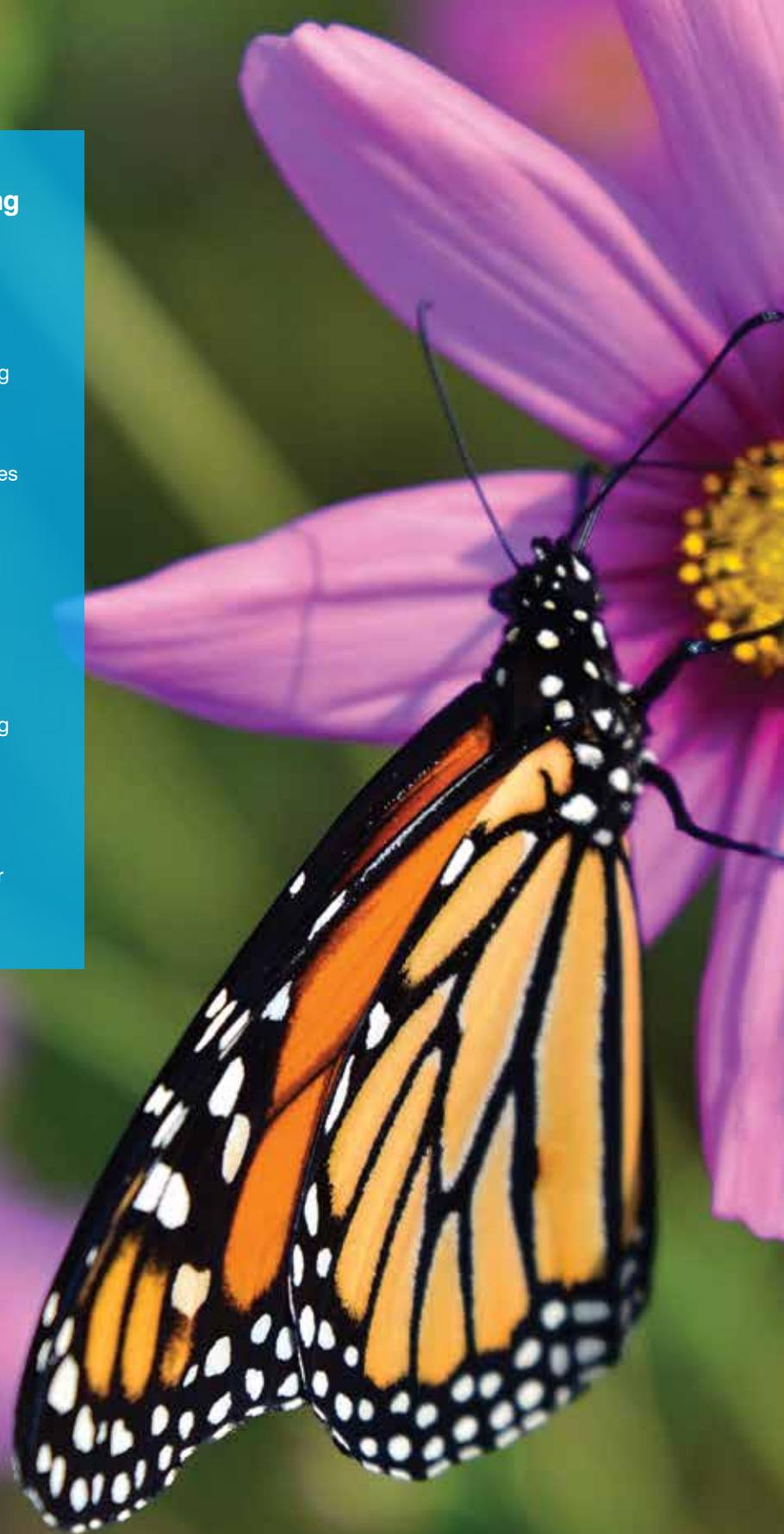
Building on this progress, in late 2018 Smithfield announced its plans to expand manure biogas at scale. The company announced new investment to implement “manure-to-energy” projects across 90 percent of Smithfield’s hog finishing spaces in North Carolina and Utah, and nearly all of Smithfield’s hog finishing spaces in Missouri over the next ten years. Smithfield has also formed a joint venture with Dominion Energy called Align RNG to help implement these projects and expand them into Virginia, with the potential for wider-scale implementation across the country. Smithfield and Dominion are jointly investing at least \$250 million over the next decade to achieve Smithfield’s 90 percent hog finishing space goal. These efforts require converting existing anaerobic treatment lagoons to covered digesters or constructing new covered digesters to capture biogas, which will be transported to central processing facilities to be converted into renewable natural gas. Smithfield’s plan will aid the company in achieving — and exceeding — its 25 by ’25 commitment (Smithfield Foods, 2018d).

EDF estimates that when achieved, these projects will capture more than 85,000 metric tons of methane per year, which in turn can be used to replace fossil fuels. The climate impact of these reductions over 20 years is equivalent to eliminating carbon dioxide emissions from more than 700,000 homes. In addition, the captured manure methane can be used as renewable natural gas to generate electricity, fuel transportation and attract new manufacturing to rural areas (EDF, 2018b).

This commitment marks a monumental shift in the adoption of manure biogas technology. As it unfolds, Smithfield will continue to collaborate with universities and other partners to better quantify the impact of waste-to-energy technology on environmental outcomes and endeavor to further develop improvements to manure management systems (Smithfield Foods, 2018d).

Restoring native prairie and protecting iconic species through the Monarch Butterfly Habitat Exchange

Smithfield and EDF realized that the location of the Missouri manure-to-energy project presented an opportunity to provide additional biodiversity benefits, since northern Missouri is a key stopping point for monarch butterflies during their annual migrations. EDF has been working with other partners in the Midwest to develop a Monarch Butterfly Habitat Exchange to provide opportunities for private landowners to conserve habitat for the iconic butterfly. Smithfield spent \$300,000 to plant native prairie grass, including milkweed and wildflowers, on 1,000 company-owned acres surrounding hog farms. This created a habitat that will provide nutrition for monarchs and other pollinators, while also improving soil health (Smithfield Foods, 2018a, p. 77). To further the environmental impact of this project, the prairie grasses will be harvested at selective times during the year, and the biomass from this harvest will supplement covered manure lagoons to create more natural gas. Lastly, EDF will establish a pollinator indexing tool as a result of this project, which aims to establish baselines and identify improvement opportunities to better aid pollinator populations.





Supply chain sustainability lessons learned

Smithfield has demonstrated its commitment to supply chain sustainability by setting ambitious goals and doing the work required to achieve them. Not all programs have been successful, demonstrating the recurring challenges faced by Smithfield and others in the animal agriculture industry. Others have produced positive results, far exceeding the company's expectations. All have provided important opportunities for learning and continuous improvement. Based on these lessons learned, the seven major lessons below are intended to assist other food companies that are similarly committed to improving the environmental sustainability of their supply chains.

1

Set big, audacious goals.

Smithfield was one of the first animal agriculture companies to tackle grain sustainability, and it was the first major meat company to set an absolute GHG reduction goal for its supply chain.

To develop effective supply chain sustainability strategies, Smithfield did not wait for pressure from stakeholders, competitors or other influencers who may have limited insight into the nuances of the company and its industry. Instead, Smithfield leaders proactively established a supply chain strategy that allowed the company to identify and set goals for the most significant environmental metrics that are material to its business. Setting aggressive goals based on science has allowed Smithfield to focus on progress where it makes business sense for the company and society.

Establishing big, audacious goals also helps to garner support from partners. Most notably, Smithfield's ambitious approach led to its partnership with EDF, a leading environmental nonprofit. EDF does not receive funding from corporate partners. Instead, EDF carefully selects corporate partners that are trying to create transformative change.

“When Smithfield was considering their greenhouse gas goal, we often talked about two things. First, that supply chain goals are not ‘go it alone’ goals. They require collaboration to be achieved. And second, that when you set ambitious goals, others rush to support you. EDF’s partnership with Smithfield is a prime example of that.”

- Maggie Monast,

Senior manager, economic incentives and agricultural sustainability at EDF (Monast, 2018b)

2

Recognize business value as more than just return on investment.

In addition to return on investment, Smithfield generated business value by building resilience within its supply chain, developing strategic partnerships, identifying new business opportunities and enabling the success of farmers.

The overarching lesson of Smithfield's supply chain sustainability initiatives is that sustainability can generate business value, not just for Smithfield, but for its suppliers and customers as well. The business value is not limited to practices that have a clear return on investment, but also those that build the resilience of its supply chain or lead to new, innovative business opportunities. Smithfield's iterative approach demonstrates that some of the more valuable and transformative programs yield benefits in other important ways, such as strengthening local markets, improving long-term soil health or preserving pollinator habitat. The company has learned from experience that a strong supply chain sustainability program takes patience and the right mix of varied initiatives. Economic returns can be difficult to measure and can require an adjustment period before turning positive.

Many of Smithfield's sustainability programs, such as the wheat program, have both an economic and environmental significance for Smithfield and its farmers. Other programs, like the non-GMO soy program, don't create explicit profit for the company, but improve the profitability of its critical partners, reinforce the local grain economy and fortify Smithfield's supply chain. Programs like renewable natural gas from manure show that with cutting-edge technology, daunting environmental challenges like manure management can be

addressed in a way that generates profits for farmers, investors and Smithfield. Overall, Smithfield's multi-pronged approach has allowed the company and its partners to create business value while making industry-leading change.

“We have proven that environmental sustainability and financial sustainability are not mutually exclusive and will trend upward in parallel planes. There are many ways to enhance environmental protection while increasing profit for every phase of the chain — from the grain grower to our procurement of ingredients and so on all the way through the process of landing high-quality pork on a grocery shelf.”

- Dawn Williamson,

Environmental and sustainability project manager at Smithfield Foods (Williamson, 2018b)

3

Integrate environmental impact into the decision-making of all business functions.

Smithfield has developed a culture of sustainability over time by integrating environmental priorities into business functions and enabling employees throughout the organization to identify and improve environmental practices.

Smithfield has found that infusing the culture of sustainability into a business is a continual process. The leadership team has set the expectation that environmental objectives must be not a discrete endeavor, but a permanent feature of core business operations — exemplified by Dennis Treacy, prior chief sustainability officer, and Stewart Leeth, current vice president of regulatory affairs and chief sustainability officer, creating Smithfield Renewables. Equally notable is the fact that Smithfield Agronomics reports directly to the grain procurement group, ensuring that the sustainability of the supply chain becomes an integral part of effective business management.

Employees in Smithfield facilities have been empowered to identify and address environmental opportunities, and the management team recognizes and rewards those employees through operational excellence awards. In all, Smithfield has taken a holistic approach to sustainability in the organization, recognizing that continuous improvement will come from all parts of the business.

“We’ve been working for many years to integrate sustainability and continuous improvement into our company culture across all parts of the business. Early on, we realigned our teams and adopted the ISO 14001 standard for our company-wide environmental management system, which was an industry first. We have held internal environmental training conferences each year for the past 17 years, which include recognition of employees who have identified and implemented important environmental improvements at our farms and processing facilities. These early efforts, and many others, have allowed us to take leadership positions on many important sustainability issues and have helped encourage our employees to embrace the challenge of meeting them.”

- Stewart Leeth,

Chief sustainability officer at Smithfield Foods (Leeth, 2018)

4

Provide farmers with the support they need to successfully adopt new practices.

Smithfield has partnered effectively with farmers to improve the sustainability of its supply chain by providing farmers with resources and support to help them make environmentally and financially sound decisions for their farms.

Many organizations are looking upstream in their supply chains to reduce their environmental footprint, but with limited visibility, companies are challenged to improve what they can't even see (TSC, 2016). Smithfield's organizational structure has allowed the company to directly provide farmers with technical expertise and guidance to ultimately improve the health and resilience of the company's supply chain.

Agriculture is a high-risk business, so farmers naturally require satisfactory evidence of the likely effects of any change in practice before they will risk adopting it. Smithfield has provided the support and technical assistance farmers needed to implement new practices successfully through investments such as hiring agronomists and providing corn dryers for early harvest. This results in win-win solutions. Farmers improve their own profitability while reducing negative environmental impacts, and Smithfield earns a positive return on its investment.

5

Establish key metrics early and devote resources to ongoing measurement.

Data collection methods are immature for many farm practices, and without the establishment of key metrics and resources dedicated to measurement, it is difficult to track progress.

Despite Smithfield's success in helping farmers adopt targeted practices, quantifying the impacts of those changes has been challenging. The current approach of tracking acres of improved practices leaves many questions unanswered about environmental and economic impacts.

Embracing cutting-edge technology often presents further challenges, when technology development outpaces its ability to quantify environmental outcomes. In several cases, Smithfield has decided not to offer specific fertilizer optimization tools or technologies due to lack of regionally specific data on the impacts on crop yields and nitrogen

use. In other cases, Smithfield or EDF have tested tools themselves at considerable effort and cost. This challenge is one reason why EDF developed NutrientStar (nutrientstar.org), a science-based review program for nutrient management tools.

Smithfield has made modest strides in record keeping and quantifying the impact of their sustainability initiatives, but this remains an ongoing endeavor. As the company looks to the future, improving data tracking systems to shift from tracking acres to tracking nitrogen and crop yield outcomes is a top priority to ensure Smithfield can validate its progress toward its 25 by '25 GHG reduction goal.

6

Look beyond traditional business partnerships.

Partnerships with EDF, suppliers and other companies have all had a role in advancing Smithfield's supply chain sustainability efforts.

Smithfield's supply chain sustainability initiatives have spurred the company to adopt a fresh perspective on the value of partnership. The company looks at traditional business partnerships in new ways, such as its efforts to build relationships with local grain growers and provide renewable energy opportunities for contract hog producers. Smithfield has realized the benefits of partners outside of its business relationships, such as its groundbreaking partnership with EDF and the benefits of the Regional Conservation Partnership Program. And it has embarked on new, innovative business relationships, such as its sustainable fertilizer efforts with Anuvia, and renewable natural gas generation with Roeslein Alternative Energy and Dominion Energy.

Smithfield's partnership with EDF, in particular, has pushed both organizations to learn new ways to be effective and seek common ground and solutions. The partnership began around a shared goal of improving fertilizer management, and it has expanded over time to include more complex issues such as GHG emission reductions. Each team brings expertise in its own field to make the partnership successful. Smithfield contributes information about the realities faced by large animal agriculture businesses, as well as a willingness to take risks. EDF provides scientific expertise and helps connect Smithfield's sustainability efforts to those of other agricultural organizations, companies and university partners. Both EDF and Smithfield are able to respectfully challenge one another and come to agreement on industry-changing initiatives. Despite their significantly different perspectives, the teams are able to build trust in each other through open and constructive collaboration.

“EDF keeps us on our toes. We remind each other internally, ‘How are we going to prove that to EDF?’ The partnership has been beneficial to us because they serve as a watchdog.”

- Dawn Williamson,

Environmental and sustainability project manager at Smithfield Foods (Williamson, 2018b)

7

Accept that continuous improvement requires continual learning.

Iteration and a sustained focus on specific environmental challenges has allowed Smithfield to drive change in their own organization and across their supply chain.

One of Smithfield's strengths as an organization is its willingness to try innovative approaches to sustainability challenges and to continuously evolve their approach based on the outcomes. Smithfield has demonstrated a sustained focus on several critical and complex environmental challenges. Annual employee awards for efforts that uphold the company's guiding principles of responsibility, operational excellence and innovation are an example of how the company encourages a culture of improvement.

The many sustainability initiatives profiled in this case show Smithfield's willingness to try a variety of approaches to find the one that works best for the environment and Smithfield and farmers' businesses. These examples show the importance of patience and trial and error in finding tools and approaches that fit the needs of Smithfield's supply chain.

“It goes with their philosophy of continuous improvement. ‘We’re going to try something, and then we’re going to refine it, and do better.’ Patience with that process is a necessary attribute of a corporation that’s taking on something that nobody has really done before.”

- Maggie Monast,

Senior manager, economic incentives and agricultural sustainability at EDF (Monast, 2018a)





The future of supply chain sustainability at Smithfield

Although Smithfield and EDF have worked together to make significant advances in agricultural sustainability, there is still much more work to be done. Looking to the future, the teams plan to further develop existing programs and find new ways to collaborate.

Smithfield's GHG reduction goal has unified Smithfield's employees around a common objective and provided context for evaluating future business decisions. In its supplier network, Smithfield will continue to identify opportunities for grain farmers and hog growers to access new markets and supply chain sustainability opportunities.

Thanks to its focus on shared value to the environment, grain farmers and Smithfield's own business, Smithfield Agronomics is a core component of the company's future supply chain sustainability efforts. The company intends to add farmers and acreage to the program in both its Southeast and Midwest grain sourcing regions. One of the most significant remaining areas for improvement is Smithfield's ability to access farm-level data that will allow for more accurate calculations of environmental impact.

Manure methane capture and biogas generation is an expanding focus of Smithfield's GHG reduction efforts and business ventures. Smithfield and EDF will also collaborate to understand the full environmental impacts of the transition to biogas technology and identify additional management changes or technologies required to reduce those impacts.

Conclusion

Smithfield's supply chain sustainability efforts, complete with its lessons and successes, offer a constructive learning opportunity for other animal agriculture companies, farmers, nonprofit organizations and governments. As consumer demand for corporate responsibility continues to grow, food companies that lean into developing constructive partnerships and sustainability solutions have the ability to create shared value for themselves, their partners and society.

Data will be one of the most challenging and persistent hurdles for Smithfield and other companies working to improve the sustainability of their supply chain. Tracking progress toward the 25 by '25 reduction goal is critical for the validation of the program, but without tools, detailed records and robust data management systems, it will be difficult to show the true impact. Many companies and organizations are working to solve these challenges. Unless industry alignment is achieved, companies risk relying on unscientific methodologies.

Even with data challenges, Smithfield's early success in partnership with EDF shows that such collaborations can have beneficial impacts both for businesses and the planet. As an influential business in consumer packaged goods and protein, Smithfield is well positioned to share its lessons learned with other companies. It is especially important to encourage others to set their own science-based sustainability goals and work with strategic partners to achieve them.

Smithfield's experience shows that animal agriculture companies have particularly significant opportunities to reduce GHG gas emissions. Meaningful progress in sustainability, including large-scale GHG reductions, will require authentic collaboration across organizations and industries.

References cited

- Cargill. (2018). Cargill sets new goal to address climate change. February 01, 2018. <https://www.cargill.com/story/cargill-sets-new-goal-to-address-climate-change>.
- Ceres. (2017). Feeding Ourselves Thirsty, Tracking Food Company Progress Toward a Water-Smart Future. September 7, 2017. Retrieved from www.feedingourselfsthirsty.ceres.org.
- Cone Communications. (2015). 2015. Cone Communications/Ebiquity Global CSR Study. Boston, MA. Retrieved from <http://www.conecomm.com/2015-cone-communications-ebiquity-global-csr-study-pdf>.
- Cosgrove, Emily. (2018). Smithfield Partners with Agtech Startup to Convert Controversial Hog Waste Lagoons into Sustainable Fertilizer. AgFunder News. April 5, 2018. Retrieved from <https://agfundernews.com/smithfield-taps-agtech-startup.html>.
- Diamond, Max. (2018). Animal activists are happy with Smithfield Foods' new housing for pregnant pigs. January 18, 2018. Retrieved from <https://www.newsobserver.com/news/business/article195357299.html>.
- EDF. (2017). Seeking Green. April 14, 2017. Retrieved from <https://youtu.be/PCxD74uSKwU>.
- EDF. (2018a). Mission and Values. Environmental Defense Fund. Retrieved October 3, 2018, from <https://www.edf.org/our-mission-and-values>.
- EDF. (2018b). Smithfield Addresses the Hog Industry's Vulnerability to Climate Change. October 25, 2018. Retrieved from <https://www.edf.org/media/smithfield-addresses-hog-industrys-vulnerability-climate-change>.
- FAO. (2017). The future of food and agriculture-Trends and challenges. The Food and Agriculture Organization of the United Nations. Rome. Retrieved from <http://www.fao.org/3/a-i6583e.pdf>.
- Fink, Lawrence. (2018). Larry Fink's Annual Letter to CEOs- A Sense of Purpose. Retrieved on October 20, 2018 from <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter>.
- Gramer, Robbie. (2017). World's Ability to Feed Itself 'In Jeopardy,' U.N. Warns in New Report. Foreign Policy. February 22, 2017. Retrieved from <https://foreignpolicy.com/2017/02/22/worlds-ability-to-feed-itself-in-jeopardy-u-n-warns-in-new-report-united-nations-global-trends-food-agriculture/>.
- Globe Newswire. (2017). Smithfield Foods Announces New, Industry-Leading Environmental Initiative, Smithfield Renewables. October 12, 2017. Retrieved from <https://globenewswire.com/news-release/2017/10/12/1145160/0/en/Smithfield-Foods-Announces-New-Industry-Leading-Environmental-Initiative-Smithfield-Renewables.html>.
- JBS. (2018). JBS USA Commits to Reducing Greenhouse Gas Emissions, Water, Electricity and Natural Gas as Part of Company's First Sustainability Report. April 11, 2018. <https://jbsa.com/about/news/2018/04-10/#.W7u3pGhKjIV>.
- Langert, Bob. (2015). The Inside View: Smithfield Foods: Anatomy of a sustainability turnaround. GreenBiz. June 8, 2015. Retrieved from <https://www.greenbiz.com/article/smithfield-foods-anatomy-sustainability-turnaround>.
- Lassiter, Adam. (2018). Agronomist, Smithfield Foods. Personal communication with Datu Researchers. September 5, 2018.
- Leeth, Stewart. (2018) Chief Sustainability Officer, Smithfield Foods. Personal communication with Datu Researchers. August 29, 2018.
- Lowe, Marcy, Gary Gereffi. (2008). A Value Chain Analysis of the U.S. Pork Industry. Center on Globalization, Governance & Competitiveness, Duke University. October 3, 2008. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.364.6315&rep=rep1&type=pdf>.
- McLaughlin, Scott. (2018a). Midwest Agronomist, Smithfield Foods. Personal communication with Datu Researchers. September 5, 2018.
- McLaughlin, Scott. (2018b). Midwest Agronomist, Smithfield Foods. Personal communication with Datu Researchers. October 8, 2018.
- Moser, Rick. (2018a). Midwest Agronomist, Smithfield Foods. Personal communication with Datu Researchers. August 21, 2018.
- Moser, Rick. (2018b). Midwest Agronomist, Smithfield Foods. Personal communication with Datu Researchers. October 11, 2018.
- Monast, Maggie. (2018a). Senior Manager, Economic Incentives, Agricultural Sustainability, Environmental Defense Fund. Personal communication with Datu Researchers. September 27, 2018.
- Monast, Maggie. (2018b). Senior Manager, Economic Incentives, Agricultural Sustainability, Environmental Defense Fund. Personal communication with Datu Researchers. November 21, 2018.
- Murawski, John. (2018). Is pig poop the next fracking? Smithfield Foods about to put energy goals to the test. The News & Observer. November 20, 2018. Retrieved from <https://www.newsobserver.com/news/business/article221773920.html>.
- The National Provisioner. (2017). 2017 Top 100 Meat & Poultry Processors. Retrieved October 10, 2018 from <https://www.provisioneronline.com/2017-top-100-meat-and-poultry-processors>.
- NC Pork Council. (2017). NC Pork Report. North Carolina Pork Council. Winter 2017. Retrieved from <http://www.nxtbook.com/naylor/NCPQ/NCPQ0417/index.php#/20>.
- NRCS. (2018). About RCPP. Natural Resources Conservation Service, United States Department of Agriculture. Retrieved on October 23, 2018 from <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/rcpp/>.
- Perdue Foods. (2018). Earth Day demands action and accountability, especially from companies. April 22, 2018. <https://www.perduefarms.com/news/blog/perdue-2022-environmental-sustainability-goals/>.
- ROBECOSAM. (2018). Dow Jones Sustainability Indices. Retrieved on October 20, 2018 from <http://www.sustainability-indices.com/about-us/dow-jones-sustainability-indices.jsp>.

- Roberson, Roy. (2013). Future of Southeast livestock industry depends on local grain. January 15, 2013. Retrieved from: <https://www.southeastfarmpress.com/livestock/future-southeast-livestock-industry-depends-local-grain>.
- SARE. (2012). Handbook 9, Managing Crops Profitably. Sustainable Agriculture Research & Education (SARE). Third Edition, June 2012. Retrieved from <https://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition>.
- Schmitt, Jennifer. (2018) Program Director and Lead Scientist for the NorthStar Initiative, University of Minnesota. Personal communication with Datu Researchers. September 5, 2018.
- Shcherbak, Iurii, Neville Millar, G. Philip Robertson. (2014). Global Metaanalysis of N2O fertilizer responses. Proceedings of the National Academy of Sciences. June 9, 2014. <https://doi.org/10.1073/pnas.1322434111>.
- Smithfield Foods. (2015). 2014 Sustainability & Financial Report. Retrieved from <https://www.smithfieldfoods.com/integrated-report/2014>.
- Smithfield Foods. (2016). 2015 Sustainability & Financial Report. Retrieved from <https://www.smithfieldfoods.com/integrated-report/2015>.
- Smithfield Foods. (2017). 2016 Sustainability Report. Retrieved from <https://www.smithfieldfoods.com/integrated-report/2016>.
- Smithfield Foods. (2018a). 2017 Sustainability Report. Retrieved from <https://www.smithfieldfoods.com/integrated-report/2017>.
- Smithfield Foods. (2018b). Company Profile and History. Retrieved from <https://www.smithfieldfoods.com/about-smithfield/company-profile>.
- Smithfield Foods. (2018c). Smithfield Renewables Video. July 3, 2018. (Unpublished).
- Smithfield Foods. (2018d). Smithfield Foods Announces Landmark Investment to Reduce Greenhouse Gas Emissions. October 25, 2018. Retrieved from <https://www.smithfieldfoods.com/newsroom/press-releases-and-news/smithfield-foods-announces-landmark-investment-to-reduce-greenhouse-gas-emissions>.
- Szaloky, Joseph. (2018a). Vice President Business Development, Smithfield Foods. Personal communication with Datu Researchers. September 4, 2018.
- Szaloky, Joseph. (2018b). Vice President Business Development, Smithfield Foods. Personal communication with Datu Researchers. November 28, 2018.
- Szaloky, Joseph. (2018c). Vice President Business Development, Smithfield Foods. Personal communication with Datu Researchers. December 6, 2018.
- Trimble Ag Field Solutions. (2018). GreenSeeker Crop Sensing System. Retrieved on October 23, 2018, from <https://agriculture.trimble.com/precision-ag/products/greenseeker/>.
- TSC. 2016. Greening global supply chains: From blind spots to hotspots to action. The Sustainability Consortium. Retrieved on October, 19, 2018 from <https://www.sustainabilityconsortium.org/wp-content/themes/enfold-child/assets/pdf/2016-impact-report.pdf>.
- Tyson Foods. (2018). Sustaining Our World- 2017 Sustainability Report. <https://www.tysonustainability.com/environment/energy-and-emissions.php>.
- USDA. (2018a). Agricultural Baseline Database. United States Department of Agriculture, Economic Research Service. Retrieved on November 26, 2018 from <https://www.ers.usda.gov/data-products/agricultural-baseline-database/>.
- USDA. (2018b). Regional Conservation Partnership Projects Fiscal Year 2018 Projects by State. Washington, DC: United States Department of Agriculture. <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/>.
- USDOE. (2018). Renewable Energy and Energy Efficiency Portfolio Standard. Washington, DC: United States Department of Energy. July 9, 2018. <http://programs.dsireusa.org/system/program/detail/2660>.
- Walmart. (2010). Walmart Announces Goal to Eliminate 20 Million Metric Tons of Greenhouse Gas Emissions from Global Supply Chain. February 25, 2010. Retrieved from https://corporate.walmart.com/_news/_news-archive/2010/02/25/walmart-announces-goal-to-eliminate-20-million-metric-tons-of-greenhouse-gas-emissions-from-global-supply-chain.
- Walmart. (2018). Project Gigaton. Retrieved from <https://www.walmartsustainabilityhub.com/project-gigaton>.
- Warncke, Darryl. (2007). Benefits of wheat in a rotation. Michigan State University Extension, Department of Crop & Soil Sciences. August 23, 2007. Retrieved from https://www.canr.msu.edu/news/benefits_of_wheat_in_a_rotation.
- Westerbeek, Kraig. (2018a). Director of Smithfield Renewables, Smithfield Foods. Personal communication with Datu Researchers. August 16, 2018.
- Westerbeek, Kraig. (2018b). Director of Smithfield Renewables, Smithfield Foods. Personal communication with Datu Researchers. October 24, 2018.
- Westerbeek, Kraig. (2018c). Director of Smithfield Renewables, Smithfield Foods. Personal communication with Datu Researchers. November 8, 2018.
- Williamson, Dawn. (2018a). Environmental and Sustainability Project Manager, Smithfield Foods. Personal communication with Datu Researchers. August 21, 2018.
- Williamson, Dawn. (2018b). Environmental and Sustainability Project Manager, Smithfield Foods. Personal communication with Datu Researchers. August 29, 2018.
- Williamson, Dawn. (2018c). Environmental and Sustainability Project Manager, Smithfield Foods. Personal communication with Datu Researchers. October 4, 2018.
- Williamson, Dawn. (2018d). Environmental and Sustainability Project Manager, Smithfield Foods. Personal communication with Datu Researchers. November 8, 2018.
- World Resources Institute. (2019). Greenhouse Gas Protocol FAQ. February 2, 2019. Retrieved from https://ghgprotocol.org/sites/default/files/standards_supporting/FAQ.pdf.