

EXCHANGING SUSTAINABILITY DATA BETWEEN FARMERS AND CONSUMER-  
PACKAGED GOODS COMPANIES IN THE UNITED STATES: BARRIERS AND  
OPPORTUNITIES

A Project Paper

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by

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## ABSTRACT

The purpose of this Project Paper was to understand the phenomenon of sustainability data sharing from farmers to consumer-packaged good companies (CPGs) in agri-food supply chains in the United States, and the mechanisms, motivations, barriers, and opportunities that exist for farmers and CPGs as a result of this process. I explored key questions such as farmer and CPG motivations for participating in data sharing (focusing especially on the role of consumer demand), how data regarding sustainability practices on farms flows from farmers to CPGs, the major barriers that farmers encounter in the collection and sharing of sustainability data, and the opportunities for improvement to the data collection and sharing process. To conduct this study, peer-reviewed journal articles, industry reports, government reports, websites, and whitepapers were analyzed. Through this study, I found that consumer demand for more sustainable products is a major driver of the increase in sustainability data sharing from farmers to CPGs; the methods by which data is shared from farmers to CPGs is inconsistent throughout the agri-food supply chain, causing complications for both stakeholders; and farmers encounter many barriers to collecting and sharing data, including logistical, operational, legal and financial barriers. Finally, I found that a number of strategies are already underway to overcome barriers, and opportunities exist for innovation in the exchange of sustainability-related data.

## BIOGRAPHICAL SKETCH

Candice Reeves is completing her Master of Professional Studies in Agriculture and Life Sciences degree from Cornell University. Reeves completed her Bachelor of Arts in English Literature with a minor in Environmental Studies degree from the State University of New York at Geneseo in December 2011. Before graduate school, Reeves worked in the tech industry in New York City for several years, focusing on operations at the startup level to help propel companies into a place where growth could be achieved.

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## **Introduction**

Over the past decade, key stakeholders in the agri-food industry such as farmers, food production companies, and agribusinesses in the United States have built enhanced reporting mechanisms focusing on the environmental sustainability of their operations (Jakku et al., 2019). These agri-food industry stakeholders have been able to collect and exchange more and better information regarding their organizations' sustainability due to, in large part, a tremendous increase in the data collection that occurs on farms across the United States. Rising demand for more efficient and productive agricultural operations over the past thirty years has led to the rapid development of new technologies for data management. It may also be true that stakeholder demand for on-farm sustainability metrics has further driven farmers to engage with new technologies on their farms. Regardless of the motivating factors, the increase in technological data collection mechanisms in agriculture has allowed farmers to collect data regarding their farm operations that were never before possible. With these advanced technologies, farmers are able to develop a rich understanding of the health of crops, soil, water, nutrients, and other key components of agricultural processes, which has, in turn, provided them with key insights regarding environmental sustainability.

Farther downstream from farmers in the agri-food supply chain, consumer packaged-goods companies (CPGs), or companies that provide packaged products that customers use almost daily and replenish frequently (and for purposes of this paper, specifically, food and beverage products) have begun to capitalize on this wealth of data and have increasingly encouraged, required, or incentivized farmers, in their role as suppliers of ingredients for these consumer products, to share data regarding sustainability practices on their farms (Bové and Swartz, 2016). CPGs request this information as they have been encouraged by other members of

the agri-food industry to put in place bold short- and long-term sustainability commitments regarding the lifecycle of their products. For example, consumers at the far end of the supply chain have gradually demanded more sustainable food products from CPGs. These consumer demands, as reflected through spending behavior, convey a desire for products that have less of a negative environmental or social impact, or contain ingredients that the consumer believes are healthier for themselves and their families.

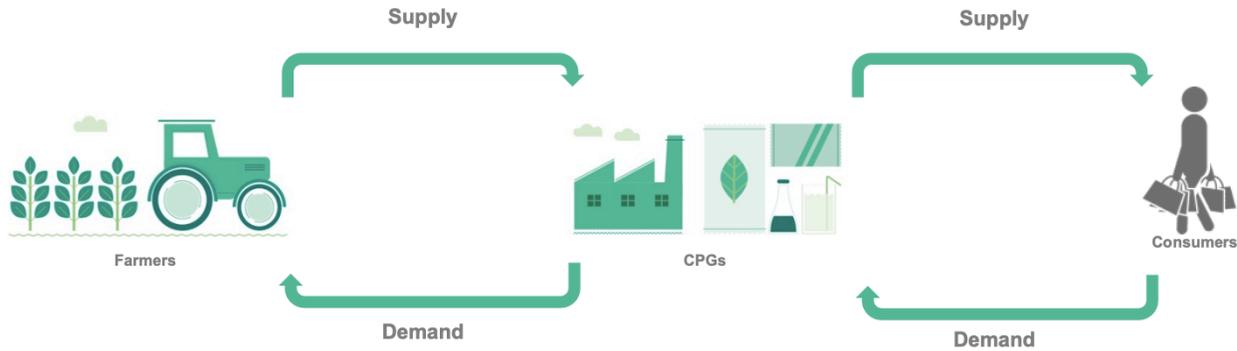


Figure 1: Sustainability Data Flow: Supply and Demand of Sustainability Data in the Agri-Food Industry

Alternatively, farmers are motivated to participate in the exchange of sustainability information either because they receive a financial incentive to do so, or risk losing market access if they do not share their data with the CPG that purchases their products. The information asked of farmers by these CPGs, the incentives that farmers receive to share information, and the barriers farmers encounter through these processes can vary significantly based on whether the farmer grows specialty or commodity crops and whether the farmer has a direct or indirect relationship with the CPG buyer. The lack of consistency regarding mechanisms by which data flows between entities and the rewards farmers receive (or do not receive) by participating in these processes create complications for farmers. Barriers that prohibit the seamless collection of data on farms also present difficulties for farmers, including costs associated with the labor,

training, and software/hardware of data collection technologies, as well as a lack of accessible broadband Internet for some farmers in rural areas of the United States (AFBF, 2020). Similarly, barriers exist that prohibit a seamless and equitable sharing of data, such as a lack of trust that farmers have with the company that is wanting to collect their data, as well as legal barriers, which complicate the ownership, and the farmer's understanding of that ownership, of on-farm data (Wiseman et al., 2019).

This system of supply and demand of sustainability-related information—the key players of which are farmers and CPGs in the agri-food industry—has created a mechanism whereby the process of both data collection and sharing is inconsistent and resource intensive for the stakeholders involved. As such, there are strategies that are already underway to overcome barriers to the successful collection of data such as campaigns to extend rural broadband for farmers, and strategies that can be engaged to aid in the successful sharing of data, such as farmer trade groups that provide research and education campaigns to help farmers better understand their data. Similarly, beyond overcoming barriers, innovative strategies such as aligning the entire industry on a consistent definition of sustainability and improving the consistency of data collection and exchange amongst all stakeholders may improve the process of sustainability data exchange for all. With these improvements, stakeholders may be better equipped to achieve the overall goal of improving sustainability in agri-food supply chains.

## **The use of data in agriculture—changes over time**

The sharing of on-farm data with CPGs was not always possible for farmers. Data collection through digital technologies in agriculture is relatively new, a rapidly developing field, and has evolved significantly over time. Beginning in the early 1990's, farmers in the United

States began collecting and using digital data after the introduction of precision agriculture through Global Positioning Systems technologies (Daberkow & McBride, 2001). By 2000, the use of yield monitoring technology had increased at a steady rate amongst US farmers, with 10% of wheat, 25% of soybean, and 30% of corn farmers using this technology (Fountas et al., 2005). With the introduction of precision agriculture, farmers were able to collect information on the exact planting location of crops in their fields, gathering data and enhancing the efficiency of their planting processes. Today, remote sensing, agronomic decision support systems, robotics, and farm management information systems create a broad digital transformation of modern-day agriculture, where farmers collect specific data points across all aspects of their operations with a very high level of granularity (Lezoche et al., 2020). With these technologies comes the collection of copious amounts of data, which have also led to a new sect of digital tools that have emerged to better help farmers understand massive data sets. These technologies include cloud computing, big data, internet of things (IoT), blockchain, and artificial intelligence technologies. Through these emerging tools, farmers have the ability to integrate previously isolated data sets into more usable connected systems of systems (Lezoche et al., 2020).

Farmers are now faced with choosing between a number of different technologies, all containing the promise of improving yields, decreasing input costs, or somehow improving their operations. What all of these technologies have in common is their ability to collect or analyze data in order for farmers to improve decision making. In many cases, the end goal of collecting data is so farmers may ultimately increase profitability or maintain/enhance market share, but these technologies often come with significant capital expenditures of financial resources, labor and training resources, and require other tools, such as reliable broadband Internet, in order to operate efficiently (Schimmelpfennig, 2016). Choosing to implement these technologies, then,

begs the question of return on investment for farmers, which also varies significantly based on variables such as farm size, crop, type of technology, and year of implementation. In a recent study looking at the effect of precision agriculture technologies on corn farming, for example, researchers found that overall the impact on US corn farmers' profits was small, yet positive (Schimmelpfennig, 2016).

The most significant impact on profitability of data collection technologies is on reducing input costs. Data helps farmers by providing information on the optimal health and needs of their plants and soil. In doing so, farmers are able to be as accurate as possible with added inputs as data informs farmers on the optimal use of fertilizers and pesticides thereby reducing environmental impact (Bongiovanni and Lowenberg-Deboer, 2004). Thus, through data-collection technologies, farmers are able to reduce chemical inputs, maintain healthy soil, optimize water use, increase yields, and in general, improve the accuracy of farming practices. Farmers maintain better natural resource management on farms than was feasible before through a decrease in inputs and an increase in data collected (Bongiovanni and Lowenberg-Deboer, 2004). Precision agriculture and other digital technologies have helped make certain improvements over the past several decades that have, overall, positively impacted the profitability of production farming.

Over the past decade, CPGs have capitalized on the wealth of data that their farmer-suppliers collect. CPGs did not have a lot of information about their suppliers historically, and so the mechanisms for the exchange of this information from farmers to CPGs have not been well developed. In a study by The Sustainability Consortium, researchers found that less than one-fifth of respondents to a survey of leading CPGs said they had a comprehensive view of sustainability performance within their supply chains (TSC, 2016b). In the same survey, more

than 50% of respondents reported being unable to determine sustainability issues in their supply chains (TSC, 2016b). But CPGs are increasingly being pressured by both consumers and NGOs operating in the agri-food industry to deliver more sustainable products (Friedberg, 2017). As such, CPGs are placing greater pressure on farmers to collect and share data to satisfy stakeholders who demand increased sustainability of consumer products.

This data that is requested of CPGs is, as stated, for purposes of sustainability marketing and reporting. But the data that farmers have been collecting on their farms for decades has been used to help improve efficiency and profitability of their operations. As such, in some cases, the data that CPGs request may already be collected by farmers as it satisfies both efficiency/profitability efforts as well as sustainability reporting—such as metrics related to water use or chemical fertilizer use—but in some cases, farmers may need to collect new types of data to satisfy requests made by their CPG-buyers—such as the estimated carbon sequestration on their farms. Data that reports on social sustainability efforts by farmers to CPGs may also introduce new methods of data collection by farmers than they previously experienced, as well, such as reporting information on workers’ wages or demographic data of their family or employees.

## **Motivations for data exchange, and key players’ responses to these motivations, within the agri-food industry**

### *CPGs’ motivations for collecting data from farmers*

The sustainable production of food is becoming more common, and more emphasized, due to an increase in the knowledge and saliency of social, environmental, and economic issues that are prevalent within food supply chains globally (Zhu et al., 2018). Consumers and NGOs

operating in the agri-food industry, who are more knowledgeable about sustainability issues than ever before, pressure CPGs to be more transparent about their products. CPGs are motivated by this stakeholder pressure but also by the actual risk posed by climate change on their supply chains (Friedberg, 2017). As a reaction, CPGs are publicly stating short- and long-term sustainability goals and are making significant changes to their product sourcing, ingredients, and packaging to reflect practices that they, and key stakeholders, consider to be more sustainable.

Consumers in the agri-food industry in the US are not only demanding sustainability in things like meats and vegetables, but in consumer-packaged goods. From 2013-2018, researchers found that 72% of the total growth in the CPG market came from sustainably marketed food products as opposed to conventional products (Kronthal-Sacco et al., 2019). These researchers looked at product marketing and packaging to assess environmental and social sustainability factors such as third-party certifications (i.e., USDA Organic, Fair Trade), undesirable traits (i.e., genetically modified, BPA, antibiotics), and positive characteristics (i.e., local, compostable, grass-fed, animal cruelty-free). Consumer-packaged goods that were marketed as environmentally or socially sustainable grew 5.6 times faster than products that were not in the same time period, proving that consumers are using purchasing power to influence brands and products that they view to be unsustainable (Whelan and Kronthal-Sacco, 2019).

In terms of sustainability, consumers are looking for products that have a positive impact on the world around them and are not simply asking for products that are made with fewer chemical inputs. Purchasing decisions in the agri-food industry are increasingly reflecting a consumer who views product sustainability as items that are “healthy” for themselves, their families, and for the world (Nielsen, 2018). Customers are willing to pay a premium for products

that they believe to have high quality and safety standards including, for example, products that are organic, antibiotic-free, hormone-free, or non-GMO. In a survey conducted on American consumers, researchers found that consumers showed the highest level of concern about water pollution and pesticide use in the development of products they purchase (Nielsen, 2018). In a separate survey, researchers found that consumers also place higher expectations on the sustainability of their food over other products, caring specifically about the energy, emissions, food quality and safety, and social responsibility involved in the production of these food products (Zhu et al., 2018). Farmers are able to report on certain metrics to satisfy CPG requests for data that reflect this overwhelming demand from consumers, but it should be noted that in other cases, these demands are well outside of farmers' control. Instead, CPGs rely on other stakeholders in their supply chains, or gather data from their own factories and operations, in order to paint a broader picture of overall supply chain sustainability.

When mapping these qualities and initiatives to the desire for consumer-packaged goods that are both healthy for consumers and for the world, these expectations translate into a strong desire for organic and natural products, support of plastic-reduction initiatives in product packaging, and ingredient transparency from CPGs (Nielsen, 2018). These trends in consumer behavior have motivated CPGs to alter their behavior, changing the configuration and mode of current food supply systems in order to optimize for operational efficiencies that make sustainability more achievable for these companies and their supply chains (Zhu et al., 2018).

Changes in the behavior of CPGs is also motivated by pressure enacted by large-impact civil society organizations such as the United Nations Global Impact and the Global Reporting Initiative, which have publicly called on large multinational companies—including CPG multinationals—to report their sustainability performance annually. This pressure has created a

standard within the industry that CPGs must conform to in order to stay ahead of their competitors, or remain in business (Friedberg, 2017). Similarly, Oxfam's *Behind the Brands* campaign that launched in 2013 aimed to influence the sourcing of the world's ten biggest food and beverage CPGs (the "Big Ten"): Unilever, Nestle, Coca-Cola, Kellogg's, Mars, Pepsico, Mondelez, General Mills, Associated British Foods, and Danone (Oxfam, n.d.). Oxfam evaluated these multinational organizations' policies on key sustainability issues including water use, women's issues, climate change, and land use impact. In order to place pressure on these organizations, Oxfam created a public "Company Scorecard" evaluation system in which the NGO measured each CPG's policies on sustainability issues, including the ways in which each expected their suppliers to behave regarding sustainability concerns, what each company did to measure impact of these key issues, and what each company did to try and improve the impact that every worker and farmer had on these sustainability issues (Oxfam, n.d.). After three years of creating evidence-based advocacy through advertising, media, online and offline stunts, shareholder activism, and collaborations with influencers, Oxfam was able to gain several hundred thousand public supporters who took over 700,000 actions, demanding more from the Big Ten. Through these actions, Oxfam and its supporters achieved a series of significant successes within the key focal areas in which the Scorecards were determined (Tamir, 2017).

CPGs are also motivated to set sustainability goals and encourage farmers to change practices because the effects of climate change, such as increases in droughts and floods on farms, can threaten a company's ability to operate in the future (Xie et al., 2018). For example, a recent study that analyzed the vulnerability of the global beer supply due to increases in droughts and floods in the coming decades found that average yield losses are expected to range from 3% to 17%. The researchers concluded that weather extremes on farms "may threaten the availability

and economic accessibility of beer” in the future (Xie et al., 2018). As another example of the risk posed to CPGs due to climate change, CPG giant Unilever estimates that the company already loses some €300 million per year across its many brands to higher food costs due to worsening water scarcity and declining agricultural productivity globally (Bové and Swartz, 2016). As such, Unilever, like many other CPGs, has set significant commitments to improving the sustainability of its supply chains and operations (see Figure 2). A report by CDP (previously known as Carbon Disclosure Project), a leading NGO on climate-related initiatives, analyzed 16 of the largest publicly traded consumer goods companies and found that these companies face the risk of both resource availability and water stress due to climate change, which threatens to disrupt their business models both up and downstream in their supply chains. The authors of this report mention that although the leaders in the industry are seeking ways to innovate in order to mitigate these risks, the business models of these companies remain linear, meaning they simply focus on sourcing and delivering a product to market, and not circular, meaning they are not taking responsibility and action on all parts of their supply chain, therefore exposing these companies to future resource constraints (Clarke et al., 2019).

Due to the demand felt from changing consumer preferences, pressures from civil organizations, and the risk posed by climate change to their supply chains, CPGs have made significant commitments to improving the sustainability of their businesses: supply chains remain the area with the highest sustainability vulnerability for an individual company. In the food and beverage industry, over 90% of the environmental impact that the production of consumer goods has is embedded in supply chains, and not created by the internal operations of the company itself (Bové and Swartz, 2016).

Based on recognition of the sustainability impact of their supply chains, leading CPGs in the agri-food industry have committed to improving sustainable production of their goods. These commitments include such goals as cutting energy emissions, reducing the impact on soil and water resources, and improving working conditions for suppliers along extensive and complicated value chains. And with these commitments, CPGs are directly, or indirectly, placing pressure on their suppliers—namely, farmers—to adhere to these commitments.

# Case Study: Unilever

## Sustainability Strategy and Goals

**2.5 billion people worldwide** use Unilever products everyday across its many brands. Amongst only its food-related brands, Unilever is considered **one of the "Big Ten,"** or one of the world's biggest food companies. Its impact is **tremendous** worldwide. The company implemented **"The Unilever Sustainable Living Plan"** to act as a blueprint for the company's sustainable growth.

Unilever's aim through the "Sustainable Living Plan" is to **decouple its company growth**, and profitability, from its **environmental footprint**, while increasing its **positive social impact**.

### Improving health and well-being for more than 1 billion

By 2020, Unilever set a goal to help more than a billion people take action to improve their health and well-being.

### Reducing environmental impact by half

By 2030, Unilever intends to halve the environmental footprint of the making and use of its products.

### Enhancing livelihoods for millions

By the end of 2020, Unilever intends to enhance the livelihoods of millions of people as their business grows.



Source:  
<https://www.unilever.com/sustainable-living/>

Figure 2: CPG Unilever's Sustainability Commitments

## *Farmers' motivations for sharing data with CPGs*

Farmers who ultimately sell their crop to CPGs are motivated to collect and share data with CPGs in order to either gain a price premium or to maintain/enhance market share with their buyers. Although it is difficult to ascertain the number of farmers in the US who receive a premium for sharing data versus those that share their data because they risk losing market share if they do not, logically this delineation—to the degree that it exists and is important—may be based on whether a farmer is a commodity or specialty crop farmer, and the relationship that the farmer has with the CPG-buyer.

In cases where farmers have direct relationships with the CPG who buys their crop (and does not interact or interacts less with intermediaries such as grain elevators or agribusinesses), the farmer may receive more care from the CPG and therefore may be better positioned to receive a premium for supplying sustainability data to the CPG. This type of relationship is more common for a specialty crop farmer, such as blueberry or barley, rather than a commodity crop farmer, such as corn or soy (TSC, 2016b).

CPGs who purchase from specialty crop farmers may have more limited options from whom to purchase their supply and may choose to build relationships with their farmers. One element of this relationship may include discussions about sustainability—or product quality—in the growing or harvesting process. In a simple case of supply and demand, because the CPG may have fewer options to choose from among specialty crop farmers, the company may be more inclined to pay premiums for sustainability data in order to stay competitive. For example, the beer brewer Molson Coors created a “Better Barley Better Beer Program” for its barley growers, which both provides them with agronomic assistance and pays a premium to those who adopt sustainable practices such as no-till, cover cropping, or improved irrigation systems (Wilcox,

2019). Over the past ten years, the company has invested \$20 million into this program, installing technology such as weather stations and soil moisture probes across barley farms in Montana, Idaho, Wyoming, and Colorado, helping farmers to harness climate data to make better growing decisions. This program contributes to Molson Coors' pledge of improving water efficiency in its agricultural supply chain and malting operations by 10% by 2025 (Sustainable Brands, 2019). In this case, the brewing company is both supporting its barley growers by providing them with scientific and technological assistance first-hand, paying a premium for a more sustainable product, and taking actions to achieve its climate-related goals.

CPGs such as Molson Coors may build closer relationships with specialty crop farmers from whom they purchase their product in order to maintain quality control that is needed for a less-processed ingredient. The CPG may need to be in closer and more frequent contact with the specialty crop grower to maintain this quality control and make requests on how the crop is produced. By building a relationship that is more reliant on trust and having a repertoire with their farmer-suppliers, CPGs that are buying specialty crop may be more incentivized to offer premiums for farmers who are growing sustainably.



Figure 3: Specialty Crop Supply Chain

In the case of commodity agriculture, however, farmers are more likely to sell their crop directly to a grain elevator that aggregates mass amount of the commodity in a given geographical location, to then sell the crop to a CPG. In this case, CPGs are less likely to build

relationships with their suppliers and are more likely to set requirements regarding what they expect from the crop. The top priority for CPGs buying within commodity supply chains is to buy the needed quantity and quality at the lowest price possible, and to ensure that it arrives on time for manufacturing into consumer goods (Friedberg, 2017). As CPGs have more options to choose from in terms of where they source the crop, they may be more likely to set demands without offering premiums in return. For example, many leading food and beverage companies that source large quantities of corn in the US, including Kellogg’s, General Mills, PepsiCo, and Coca-Cola, have set significant goals to source corn more sustainably, including from farmers that have reduced GHG emissions, and improved nutrient efficiency and biodiversity (Friedberg, 2017). These companies’ corn-based ingredients are not purchased directly from farmers, however, but through agribusinesses that operate grain elevators and mills across the Midwest, including ADM, Bunge, and Cargill (Friedberg, 2017). Food and beverage manufacturers must then rely on commodity traders and processors to collect the on-farm data needed to meet their sustainability goals, thus complicating the relationship between CPGs and farmers. CPGs have the upper hand due to both an abundance of relatively undifferentiated supply and the fact that they deal with large agribusiness intermediaries, which are often huge, conglomerate corporations, in order to make requests of farmers. In terms of supply and demand, CPGs may therefore be less incentivized to pay premiums and can instead demand sustainability data—and requirements—from their prospective suppliers.

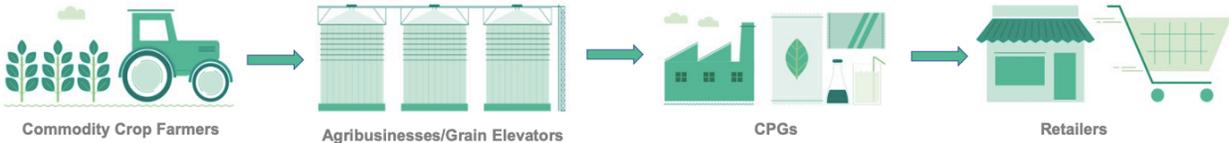


Figure 4: Commodity Crop Supply Chain

The exchange of sustainability data within the agri-food industry between farmers and CPGs extends well beyond simply these two stakeholders, as evidenced by the motivating role that both consumers and NGOs play and the intermediary role that agribusinesses play in the process. As a result of these many motivations for data exchange, CPGs are requesting data of farmers, who then supply this data either because they are paid to do so, or because they risk losing their buyer if they do not. Ultimately, the intentions of all stakeholders involved are geared toward improving environmental and social sustainability concerns that exist in the agri-food industry, but through these processes, a number of barriers arise that limit some farmers' ability to easily partake in, and benefit, from the process.

## **Farmer barriers in managing sustainability data**

### *Barriers to collecting data*

Many farmers face a number of barriers to collecting digital on-farm data. From a logistical and operational standpoint, farmers are now expected to be technologists and data analysts, as well as farmers. Another barrier to successfully collecting data is that broadband Internet access is still not available across many rural areas in the United States. Data collection and sharing technologies often require access to the Internet in order to function. Lastly, farmers also face significant financial barriers when it comes to purchasing equipment, partaking in trainings, and staying up to date with the latest software needed to adequately respond to CPG requests for sustainability data.

Data collection technologies, which are constantly evolving and improving, require management and analysis skills of farmers. Because there is such a diversity of technologies now used on farms, farmers are required to be analysts and technologists, as well as farmers and business owners, to successfully run their operations. Similarly, CPGs, at times, request that farmers provide data regarding labor practices and demographic information of their families and employees. Reporting these types of social metrics may be even farther outside of the “norm” for farmers, and the lack of expertise regarding these core concepts—rather than the technological limitations—may also represent barriers for farmers to report information.

Data collected on farms can also come from numerous technological sources that are not necessarily “speaking” to one another, and therefore farmers must find ways to make sense of their data, often analyzing several complex interoperating datasets in order to make the data they are collecting useful (TSC, 2016a). There are a number of companies that are attempting to solve this issue, including both startups and large agribusinesses, but adding another technology to the farmer’s portfolio only adds additional costs, time, and complications for the farmer.

The majority of on-farm data collection technologies also require access to broadband Internet in order to operate to their full potential, which, in the US, is not readily available across all rural areas. According to the USDA, 29% of US farms do not have access to the Internet (AFBF, 2020). Enhancing digital agriculture technologies that already exist to increase producers’ usage to full-scale across the United States could create \$47 billion or more each year in additional gross benefit for the economy. More than one-third of that potential value is driven directly by rural broadband connectivity, totaling an estimated \$18 billion of annual economic improvements (USDA, 2019). The lack of reliable Internet across a large portion of rural farms in the United States also adds to the income disparity between farmers who have access and

farmers who do not (USDA, 2019). Participating in the act of digital data collection is thus impossible for a large portion of farmers in the US, creating a significant barrier that many farmers face—and have little or no control over rectifying—in the process of data exchange between farmers and CPGs.

Implementing on-farm data collection technologies is also costly and requires a sizeable upfront investment, causing yet another barrier for farmers wishing to implement more robust data collection technologies. In order to use these technologies, farmers must invest in the hardware and software equipment, cost of installation where applicable, and the time and effort spent on training in order to use the technologies effectively. As these are upfront costs, if the farmer chooses to stop using this equipment the costs are usually non-recoverable (Schimmelpfennig, 2016). Data collection technologies are also known to have a limited resale value as they are often highly specialized to the farmer’s particular needs on that farm and also lose their value quickly, and the farmer may even face costs associated with uninstallation or discontinuing use (Schimmelpfennig, 2016). Similarly, the prospect of adding to an already potentially overwhelming debt load is something that farmers must consider before adding new technologies to their portfolio. Farmers who have a lower debt-to-asset ratio than others, for example, may be in a better position, and may be more likely, to adopt new technologies due to their lower credit constraints (Tey and Brindal, 2012).

Farmers implement on-farm data collection technologies with the promise of seeking a return on investment. It has been found, however, that those who are most likely to benefit financially from big data being used in agriculture are not actually the farmers themselves, but businesses upstream and downstream from the farm gate (i.e., input suppliers and manufacturers, or traders and marketers) (Jakku et al., 2019). That being said, precision agriculture technologies,

for example, have been shown to have a positive—albeit small—impact on profits for US corn producers (Schimmelpfennig, 2016). These positive results are not guaranteed for farmers and the net impact on profit varies by farm. Regardless, farmers are taking on risk, and are subject to high upfront costs, when they invest in technologies that are meant to enhance and enable more robust digitized data collection on farms.

### *Barriers to sharing data with CPGs*

Farmers also face a number of barriers to sharing their data. First, farmers face legal barriers as it is not always clear who owns the data they are collecting, and therefore what the legal implications are of sharing that data (Wiseman et al., 2019). Farmers may also be skeptical of sharing their data with companies if they lack information about why the data are needed, or for what it will be used (Jakku et al., 2019). This lack of knowledge can reduce trust in relationships. Farmers must also interact with third parties and spend time answering surveys and questionnaires regarding sustainability practices, and therefore the process of sharing data also requires additional time. That being said, farmers are not always compensated for the time spent, nor the data shared, increasing financial barriers for them to participate (Friedberg, 2017). Lastly, farmers have little agency or power in their relationships with CPGs in the data exchange process.

Farmers collect data automatically through hardware and software that they use in their field operations, which can present legal challenges for farmers who want to then share this data with other entities. Agricultural technology companies that supply on-farm equipment provide lengthy and complex software license agreements that not only govern the way that farmers' data can be collected, managed, and shared with their smart-farming providers, but are complicated

and difficult to understand without specialized training (Wiseman et al., 2019). This on-farm equipment does not necessarily directly report information to CPG companies, but the lack of understanding of who owns or has access to data from on-farm equipment has a “significant consequence for the agricultural industry as a whole,” as it contributes to the basis for the lack of trust that farmers have toward other entities in their supply chains who want access to their data (Wiseman et al., 2019, p. 7). Merely the act of turning on machinery or downloading technology often indicates that a farmer has agreed to a software’s terms of service and has thus accepted a broad range of terms regarding who can access and use the data that is generated on their farms (Wiseman et al., 2019). Researchers that analyzed Australian farmers’ knowledge of the terms that were agreed upon through using on-farm machinery found that 74% of farmers reported not knowing much about the terms with service providers (Wiseman et al., 2019). Similarly, the American Farm Bureau Federation found that 77% of farmers polled in the US were concerned with which entities could access the data they were collecting on their farms (AFBF, 2016). The sharing of data that is collected on farms through hardware and software therefore poses complications for both farmers and downstream players as farmers may not actually “own” and/or control access to their data that they are sharing, nor fully understand the risks of distributing it to other entities.

When data is shared with CPGs, farmers may be skeptical about how the data is being used, and do not always trust the motives of the companies asking for data, which is only emphasized by the lack of information passed to farmers from the CPG. There have been a number of cases where farmers’ data has been used against them by those who have access to it, including for competition and in order to control industry pricing. For instance, a class action lawsuit was filed against Tyson Foods, Inc. and other chicken processors by chicken farmers in

Oklahoma, claiming that these companies were sharing farmers' data without their permission. This data included things like broiler weights, grower payments, type of medicine and feed used, and transportation costs. The data was ultimately shared in an attempt to keep payments below competitive levels, thereby hurting the farmers' profitability (Wiseman et al., 2019). Similarly, researchers studying the effects of big data on grain producers in Australia found that growers were concerned that the sharing of data with other supply chain actors exposed them to enhancing power imbalances that already existed upstream and downstream in their supply chains (Wiseman et al., 2019).

Information about how each CPG company obtains their supplier information is also not always publicly available. Unlike sustainability goals that are front and center on CPG company websites, the *progress* toward these goals or the methods and metrics of their current suppliers is not readily available to farmers who participate in the exchange of data, nor to consumers. This raises questions about the validity of this data as CPGs can manipulate metrics in order to hold the company in the best light, and also emphasizes the extent to which CPGs are simply "checking the box" of collecting data to prove their sustainability goals.

How the data is put to use once it is received by a CPG, therefore, is not necessarily clear. Unlike data that is collected to prove certifications, which is often verified by a third-party entity, the data used to prove sustainability claims by private companies is often managed and interpreted by the CPG itself. How it is used after it is exchanged, therefore, is left to the discretion of the company. There is no consistency in the market of a third party that verifies the validity of sustainability claims made by CPG companies, or the data that they are collecting to back up those claims. Without third party verification, and without the full public disclosure of sustainability data, there is a potential gap of how well this sustainability data is being put to use,

which leaves the farmer who is supplying this crucial information uninformed about its ultimate use.

The process of sharing data also represents challenges for farmers as it can be time consuming and costly for them to facilitate the data exchange. These barriers also exacerbate issues of scale-based inequality between larger farms that have greater monetary and labor-related capital, as well as those with a lower debt-to-asset ratio, versus those that consist of smaller operations, with fewer resources and greater debt. Currently, there is no commonly applied methodology to assess and communicate environmental information along the agri-food chain between farmers (of any size) with CPGs. If farmers have multiple buyers, they may be burdened with responding to a multitude of requests, all asking for different types of information or different measurement schemes. This requires farmers to engage different pieces of software to report on data asked for by CPGs. It often takes a great deal of time to document per each company's standards if these standards vary (Notarnicola et al., 2012).

In some cases, as described, CPGs have existing and direct relationships with farmers and therefore go directly to the farmer to gather sustainability data (TSC, 2016b). In other cases, when companies do not have direct relationships with farmers, they engage with agribusiness partners (who are the commodity's direct purchaser) to gather the sustainability data they need. The lack of consistency creates burdens on behalf of the farmer to respond to any request that comes their way. Furthermore, the added requirement of farmers to engage in these forms of data exchange magnifies issues of scale-based inequality between large, resource-rich farms versus those that run smaller operations.

Services such as Field to Market (<https://fieldtomarket.org/>), whose business is built around gathering and communicating data between CPGs and farmers, provide a platform for

CPGs to develop surveys to then administer to farmers. Commodity crop farmers input their data, analyzing and comparing their “sustainability performance” according to a series of metrics that the company provides through its Fieldprint Calculator (Friedberg, 2017). This data may then be transferred to the CPG who is sponsoring the survey. Participating in these surveys, however, often simply gives the farmer market access to continue selling to the CPG who is requesting the data and does not provide additional benefits to the farmer beyond dictating their sustainability performance according to these eco-efficiency metrics set by Field to Market. The Fieldprint Calculator can also often require farmers to sit down for “half a day” to complete a single survey, without being compensated for their time (Friedberg, 2017). The burden of time and effort associated with completing surveys, without being compensated, and responding to numerous requests from multiple buyers represent major barriers for farmers to participate in the exchange of data with CPGs that purchase their product.

As discussed, CPGs have significant power over their suppliers and farmers have little agency to negotiate improvements to the process of data sharing with their buyers. This, of course, is rapidly changing (Bové and Swartz, 2016). There is a tremendous power imbalance in the CPG-farmer relationship when it comes to data exchange, as large, multinational CPG companies can easily and without difficulty move to another supplier if one farmer does not adhere to the company’s requests. Farmers are therefore expected to provide sustainability data to their suppliers or else they risk losing their buyer. Even if this is costly for farmers, if they question whether or not they can legally share the data, or if they do not trust the motives of their buyers, farmers have little agency to negotiate the matter. Once again, this is also further exacerbated for those farmers who have less access to capital, labor resources, or technological

knowledge than larger, more wealthy farms, leading to a gap in accessibility of fulfilling these types of requests from CPGs.

Lastly, CPGs and farmers consider sustainability needs and outcomes differently, which adds costs and time to the data exchange process. Through data collection technologies, farmers have come to think of sustainability in terms of “stewardship,” and look for ways to improve the health of land on their farm. This perception of sustainability refers to efforts to improve environmental impact in terms of efficiency (Roy Wendte, soybean farmer, personal communication, April 1 2020). CPGs, on the other hand, set sustainability goals that are more complex and global in nature, emphasizing the impact of their entire supply chains on more overarching societal issues such as climate change (see Figure 2 as a Case Study). Thus, when CPGs ask for data from farmers, the language does not always align with how the farmer thinks about sustainability. Similarly, the farmer may not be able to answer questions on a survey if he or she does not have access to data that can satisfy the questions that are written by representatives from CPGs. This adds to the time, effort, and cost associated with data exchange as the two stakeholders are not at all aligned on information and data points that are key to the process of data exchange.

## **Looking ahead: improving data exchange in the agri-food industry**

### *Overcoming barriers*

As described above, the barriers facing farmers when they collect and share sustainability data make the process complicated, arduous, and inequitable. A number of strategies can be introduced, or are already underway, to overcoming key barriers. First, improving communication channels and fostering dialogue between farmers and CPGs will help reduce

barriers involving the lack of farmer agency, as well as whether they receive a premium for reporting their data (“more carrots, fewer sticks”). Second, trade groups that work directly with farmers can be better leveraged: they may fund research into finding ways to remove barriers, and/or negotiate pricing or contracts with CPGs, agribusinesses, or technology suppliers. Third, to remove logistical barriers, initiatives are already underway by governmental organizations to help develop rural broadband accessibility across US rural regions. This may dramatically improve the process of sustainability data exchange for farmers. These strategies are discussed in more detail below.

Farmers that have direct relationships with CPGs requesting sustainability data—thus avoiding middlemen—are often able to gain additional benefits from sharing their data with the CPG. By building direct relationships between farmers and CPGs and improving communication between these players, each entity better understands the needs and barriers that the other faces. Farmers are often frustrated when they do not understand why they are divulging their data to CPGs or for what it is being used. In cases where farmers work directly with CPGs, logically the company would be better able to communicate why they are gathering this information, and how it is being analyzed and integrated into the companies’ product development and marketing. Similarly, CPGs, in exchange, may be in the position to understand the difficulties that farmers face in gathering and sharing their data, and therefore may be able to access this data in a more frictionless way. By removing middlemen, both entities in the data exchange relationship can more thoroughly understand the motivations and complications involved and can resolve these issues to create a more efficient data exchange process for both parties. Improved communication between CPGs and commodity farmers can be achieved through initiatives set by

CPGs to access and speak to farmers directly, removing agribusinesses in the communication process.

Agricultural trade groups can also be leveraged to help farmers through research on how to remove barriers and through collective efforts such as negotiating contracts on behalf of their commodity farmers. Many commodity crops in the US have trade associations that are formulated with the intention to fund research and development to better the overall yield, profit, and wellbeing of farmers producing that commodity. These groups have a tremendous opportunity to help their members with operational and logistical barriers that they encounter while using data management technologies. From soy to corn to milk to oranges, checkoff funds are already leveraged to invest in research and development for farmers and can be better engaged to perform research that helps reduce or remove barriers. Research such as analyzing the best data management technologies to use on farms for a particular crop, or in a particular location, can remove time and effort on behalf of the farmer, where the farmer now does not need to invest in researching and testing various technologies on their own. Similarly, trade groups can work at scale to negotiate pricing for farmers that are part of their associations, reducing the cost per farmer for using certain technologies.

Lastly, access to high-speed Internet is an essential tool for farmers in the data exchange process, and therefore a lack of access is a major barrier to farmer success. This issue has the attention of governmental agencies that are working to address this problem. The Rural Utilities Service (RUS) and the USDA currently have three ongoing programs that are developing the accessibility and speed of Internet supplied to rural areas in the US: The Rural Broadband Access Loan and Loan Guarantee Program, the Community Connect Grant Program, and the ReConnect Program (Congressional Research Service, 2019). The federal 2018 farm bill (P.L.

115-334, Agriculture Improvement Act of 2018) increases the annual authorization of funds from \$25M to \$350M, paving the way for broadband to be more fully developed over the next several years. Through these programs, high-speed Internet access will be improved for rural farmers, which will, in turn, vastly improve the ability for farmers to collect and exchange data more easily with their buyers (Congressional Research Service, 2019).

### *Beyond barriers: Opportunities for innovation*

Although working to overcome barriers is an important piece to improving the process of data exchange between farmers and CPGs, simply working toward overcoming barriers may limit the ability to innovate—i.e., significantly expand what sustainability data can provide. The notion of working to overcome barriers can be reductionist and prevents explanations of decision-making that identify “causal processes that are responsible for producing a certain outcome or effect” (Wellstead et al., 2018, p. 11). Instead, stakeholders who are working to improve processes, such as those involved in finding process improvements for the exchange of data between farmers and CPGs, must also work to identify specific mechanisms that affect the decision-making processes. In doing so, decision-makers will be more adept at identifying precision and depth to better understand the generative processes, which may lead to enhanced decision-making (Wellstead et al., 2018). Identifying barriers to overcome is simply not enough to enact change that will ameliorate the process of data exchange in the agri-food supply chain, which is meant to enhance sustainability outcomes for all stakeholders and improve sustainability in the industry as a whole.

This perspective provides opportunities for innovation in earlier stages of decision-making that may be engaged in order to overhaul processes that cause barriers. These initiatives

may help to propel the agri-food industry to a state where sustainability data is more easily collected and exchanged and facilitate a more sustainable agri-food industry. At the most basic level, CPGs and farmers discuss sustainability in drastically different terms. Innovations that address the way that these two stakeholders interpret and engage with sustainability, and decision-making regarding sustainability data collection and exchange can be altered at the onset. The actual technical exchange of data within the supply chain, as discussed, is also far from effective. There are a number of improvements that can be made to create consistency with and improve the technological exchange of data between these actors.

As one example, fundamentally, the lack of alignment regarding the definition of sustainability throughout the agri-food industry creates hurdles for all actors in the supply chain that are aiming to achieve sustainability. The definition of “sustainability” across all sectors, industries, countries, and cultures has been widely debated for decades. The United Nations Brundtland Commission in 1987 first famously defined sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). Among many other definitions, the for-profit sector often uses the “People, Profit, Planet” model as the definition of sustainability, coined by Elkington in 1994 (Elkington, 1994). In this vein, the “sustainability” information that farmers gather from data collection technologies is defined by both the efficiency that leads to an improvement in natural resource use on farms, as well as the potential for increased financial stability. That being said, “efficiency as sustainability” does not necessarily address larger sustainability issues that agriculture affects regionally, nationally, or globally. The efficiency as sustainability line of thinking also does not align with the sustainability needs or demands of both end-consumers and CPG companies. If CPGs define

sustainability as creating a more environmentally and socially responsible product lifecycle, but farmers simply view it as being as efficient as possible in their farm operations, a dramatic disconnect is created.

Creating initiatives that bring stakeholders into better alignment on what sustainability means can generate opportunities to reform the exchange of data for the benefit of the supply chain. This may be difficult to achieve, as, fundamentally, all of these actors have differing priorities as to what aspects of sustainability matter to their operations and success. That does not mean, however, that they cannot learn to better integrate their definitions of and goals toward a more sustainable industry. Simply being aware of different perspectives may nudge actors to be more responsive to the sustainability needs and goals of other actors in the supply chain.

This can be achieved through a few strategies. If the verbiage used between all parties is more consistent, and it means the same thing to all parties (such as, for example, the basic definition of “sustainability”), then operational efficiency will be improved as the time and effort involved in collecting data can be reduced. Aligning supply chain actors also allows for the opportunity to strengthen the industry’s voice surrounding sustainability as perceived by its consumers.

When farmers, CPGs, and other agri-food stakeholders are all marketing sustainability in the same way, industry players can also create goals that reinforce one another. Since these stakeholders still have differing priorities in their business operations, their goals may still differ from one another. But there is still the opportunity for these industry players to gain further legitimacy in terms of sustainability with one another, and with consumers, if they are able to build goals that use similar language and that complement one another. Key stakeholders in the agri-food industry may also be better equipped to influence the consumer regarding what

sustainability is and thus drive a unified message across the industry's consumers. Alignment on the narrative regarding sustainability may also enable the agri-food sector to create different, bigger goals that may improve sustainability in ways that were not before feasible. It should be noted, however that building industry-wide goals may result in watered-down achievements, as all stakeholders will inherently still have differing priorities in terms of their business and sustainability and so over-arching industry goals may be too broad in nature in order to achieve meaningful results.

As discussed, the technical mechanisms through which data is collected and exchanged are not only inconsistent but can be haphazard and can require multiple third parties to help facilitate. Overall, the lack of consistency and best practices causes additional work for farmers, agribusinesses, and CPGs when trying to facilitate this exchange of data. By creating a consistent framework or technology to more easily gather, communicate, and exchange this data, overhead financial and labor costs will be reduced.

A number of companies are already attempting to develop innovative solutions for connecting technologies used within agri-food supply chain to simplify data exchange. The emerging technology of blockchain as applied to the agri-food industry may facilitate the frictionless, simple exchange of data between multiple parties. Blockchain is a versatile technology in which data is recorded in a linear progression across several computers that are linked in a peer-to-peer fashion. Many startups, such as Ripe.io (<https://www.ripe.io/about>), AgTrace (<https://www.agtrace.ag>), and WholeChain (<https://wholechain.com/>) as well as large organizations such as IBM (<https://www.ibm.com/blockchain/solutions/food-trust>) have tested the application of blockchain across the agri-food industry, building solutions where computer systems on farms and within CPGs directly “talk” to one another without the need for

intermediary reporting. In the coming years, some technologists suspect that blockchain will be more widely adopted throughout the industry, creating such efficiencies as a more seamless exchange of data, and enhancing traceability of data (Casey & Wong, 2017). Others are more skeptical about the widespread adoption of blockchain in the agri-food industry due to complications it imposes such as, again, a necessity of accessibility to high-speed Internet, concerns about data privacy and accessibility (Zhao et al., 2019), and the need for a high level of coordination amongst all actors who may be participating in the blockchain system (Behnke & Janssen, 2019).

Other organizations are working on technologies at the decision-making level to improve data exchange. For example, a number of companies and non-profit organizations have come together to develop an open-source technology ecosystem called OpenTEAM (<https://www.wolfesneck.org/openteam/>) meant to “provide farmers around the world with the best possible knowledge to improve soil health” (Wolfe’s Neck Center for Agriculture & the Environment, 2017). OpenTEAM works to solve the fundamental issue facing farmers of having too many digital technologies on farms, none of which “communicate” to each other, which makes it difficult for farmers to use or share this data with their supply chains. Because OpenTEAM is an open source software, farmers are able to openly access the tool without a fee, can use all of the technologies offered, and can much more easily aggregate large amounts of data in much less time. OpenTEAM is funded by more than a dozen organizations, many of which are CPGs including such names as General Mills and Stonyfield Organic (Wolfe’s Neck Center for Agriculture & the Environment, 2017). This software is innovative in that it has the potential to improve the data collection and sharing process for farmers, but also provides a solution for CPGs as it creates easier pathways for farmers and CPGs to share farm-level data.

Such innovations that not only remove barriers, but re-think and innovate the decision-making that informs current processes have the potential to rewrite the data exchange process that exists today. These innovations can propel the agri-food industry toward improvements in the overall desired outcome of having robust sustainability metrics and reporting. Current efforts are a step in the right direction toward making supply chains more sustainable, but through improvements in the methods of data exchange the industry stands to ameliorate many existing issues. Innovative solutions will ultimately move the industry toward a more sustainable agri-food supply chain that will provide a more equitable system for all involved.

## **Conclusion**

As threats of climate change become increasingly palpable, awareness of what can be done to combat climate change also become more prevalent. One key manifestation of this is consumers increasingly seeking to purchase sustainably marketed products. Overall, the desire for CPGs to collect data from farmers and provide sustainability marketing information to their consumers reflects demand from consumers and NGOs, but also, through these motivators, contributes to a larger societal outcome of addressing climate change.

These efforts, although rooted in the desire to work toward this critical social and environmental issue, may create significant complications for farmers. Because farmers are unquestionably a fundamental aspect of the agri-food supply chain, barriers to their participation in data exchange can only harm the overall objective of achieving sustainability. As CPGs attempt to address demand, farmers are left to grapple with a fragmented data collection process that is not formulated with their interests in mind. Similarly, a power imbalance exists in the data

exchange process where CPGs often hold more control over their suppliers and therefore tend to be able to demand the sustainability metrics they “need”, even if it makes things difficult for farmers.

Furthermore, the lack of agreement on what sustainability means, and therefore the misalignment on how to work toward it, creates issues for farmers and CPGs to collaborate on—and thus strengthen—the overall effort of achieving sustainability. Without finding solutions to these barriers and the misalignment within the industry, CPGs will continue to ask for information that farmers will continue to struggle to provide. Only by working toward solutions to these barriers will the greater societal goal of finding ways to mitigate and adapt to climate change-related issues in the agri-food industry have the opportunity to be solved.

But addressing these barriers and finding innovative solutions offers promise to the agri-food industry to become more environmentally and socially sustainable, improve communication to eager consumers who want to know more about sustainability, and overall, be a leader in sustainability efforts across all major consumer industries. More incentives for farmers to engage in sustainability data exchange, and more technological, and financial assistance toward sustainability data exchange efforts will provide the opportunity for consumer-packaged goods, that are used by billions of people worldwide every day, to take a leap toward making our source of food more socially and environmentally sustainable for the world.

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