Data Landscape Mapping in Agricultural Supply Chains

THE SUSTAINABILITY CONSORTIUM™

Project Report

February 2019

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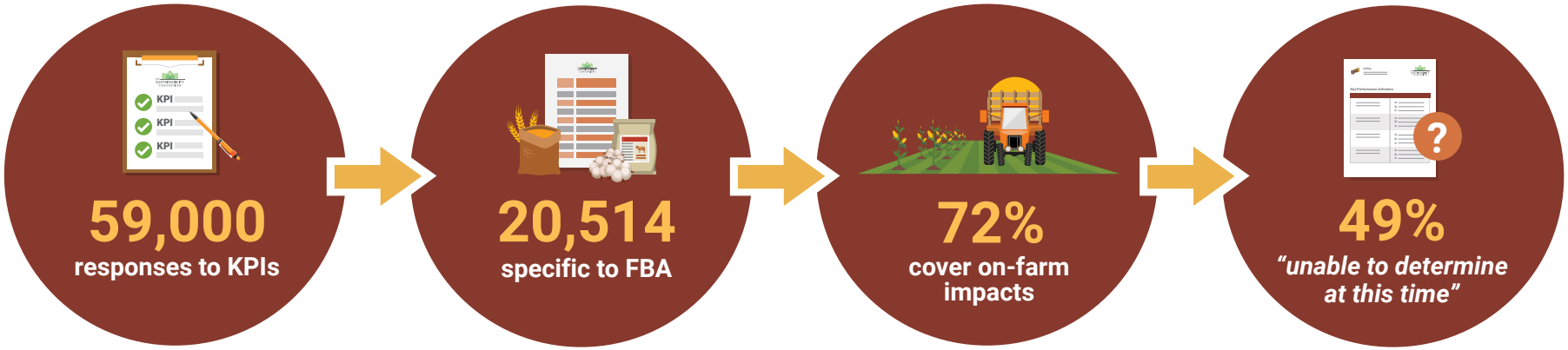
Project Introduction

Context

The Sustainability Consortium (TSC) has developed a sustainability measurement and reporting system for retailers and product manufacturers to increase the transparency of their supply chains and improve the sustainability performance of consumer products. In 2017, TSC's tools were used to collect nearly 59,000 product supplier responses to key performance indicators (KPIs), 20,514 of which were specific to TSC's Food, Beverage, and Agriculture (FBA) toolkits. Within the FBA toolkits, 72% of the KPIs cover on-farm impacts, yet the 49% response rate of "We are unable to determine at this time" to the farm-level KPIs suggests that food companies face a barrier when attempting to collect, analyze, and communicate farm-level information to retail.

In order to effectively communicate their supply chain impacts and, ultimately, score well when responding to TSC KPIs, food companies need consistent access to quality farm-level data. Food companies also use farm-level data to gauge progress against their corporate sustainability goals and to identify collaborative opportunities for improving on-farm sustainability performance. In addition, farm-level data can help to inform business decision-making across the entire agricultural sector. Although TSC's KPIs have spurred food companies to collaborate with suppliers, improve their data collection processes, and prioritize sustainability, overcoming the "I don't know" barrier remains a pressing issue in the agricultural sector.

In 2017



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Project Goals & Objectives

The goal of this project was to facilitate the flow of farm-level data to food companies, and ultimately retailers, that utilize TSC KPIs by improving data systems connectivity in the agricultural sector. To this end, TSC identified several objectives related to the project goal:

- **Improve visibility** into existing systems and technologies to better understand the data collected on-farm, how those systems and technologies are connected to sustainability reporting platforms, and the mechanisms for collecting and reporting data through ag supply chains;
- **Strengthen communication** to downstream suppliers about sustainability programs that require farm data, including communication about the value proposition related to data collection for farm and supply chain management; and
- **Economize data management time** by streamlining reporting systems and identifying opportunities for creating additional tools to support data collection and reporting.

To meet these objectives, TSC and project participants engaged in five key activities:

- Developed a **systems landscape map** that identifies the key systems and platforms currently in place to collect and manage on-farm data;

GOALS

IMPROVE **VISIBILITY**

STRENGTHEN **COMMUNICATION**

ECONOMIZE **TIME**

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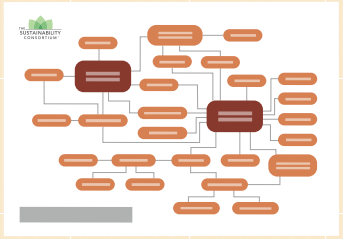
- Conducted **case study interviews** to better understand how farm management software and sustainability data collection and reporting platforms function, where system connectivity and compatibility already exist, and where and how it can be improved;
- Compiled **data elements documentation** that identifies the data input requirements across five farm sustainability metrics tools and how those tools can be used to respond to TSC KPIs;
- Built an **Application Programming Interface (API)** that automates the process of translating data from select farm sustainability metrics tools into five TSC KPIs;
- Developed a spreadsheet-based **respondent tool** to simplify the process of aggregating farm-level data when reporting into TSC KPI's Fertilizer Application KPI.

Project Stakeholders

Throughout the course of the project, TSC engaged over 100 industry leaders from companies and organizations with expertise in food production, farm data management, farm sustainability measurement, and consumer goods manufacturing (Appendix A). From August 2017 to November 2018, project participants attended three in-person workshops, six webinars, and numerous meetings of a smaller committee that provided technical expertise and guidance as needed (Appendix B). API development was led by Anthesis Group with input from TSC staff and project participants.

ACTIVITIES



Systems Landscape Map

Case Study Interviews

Data Elements Documentation

Application Programming Interface

Respondent Tool

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Historical Background

Sustainable agriculture has been one of The Sustainability Consortium's principal areas of focus since its inception in 2009, both at the product category level and across a range of projects. At the product category level, TSC's Food, Beverage, and Agriculture (FBA) sector houses 55 of TSC's 131 toolkits and represents 47% of all key performance indicators (KPIs) across TSC's eight consumer goods sectors. TSC also has on-farm KPIs for non-food categories including cotton used in textiles and palm oil used in home and personal care products. In addition, the FBA sector has been a convening space for members – and in some cases, non-members – to engage in projects that drive impact on various issues in food and agricultural supply chains.

In 2015, TSC convened a special meeting of key stakeholders to discuss TSC's role in sustainable agriculture (Figure 1). Meeting participants concluded that TSC is uniquely positioned to provide sustainability measurement and reporting mechanisms for food systems and to bring together relevant stakeholders on issues related to sustainability reporting across agricultural supply chains. Following this meeting, TSC launched the Agricultural Metrics Task Force and the Metrics Providers Project to work on collaborative solutions for improving data flow through agricultural supply chains, using sustainability metrics as the driver.

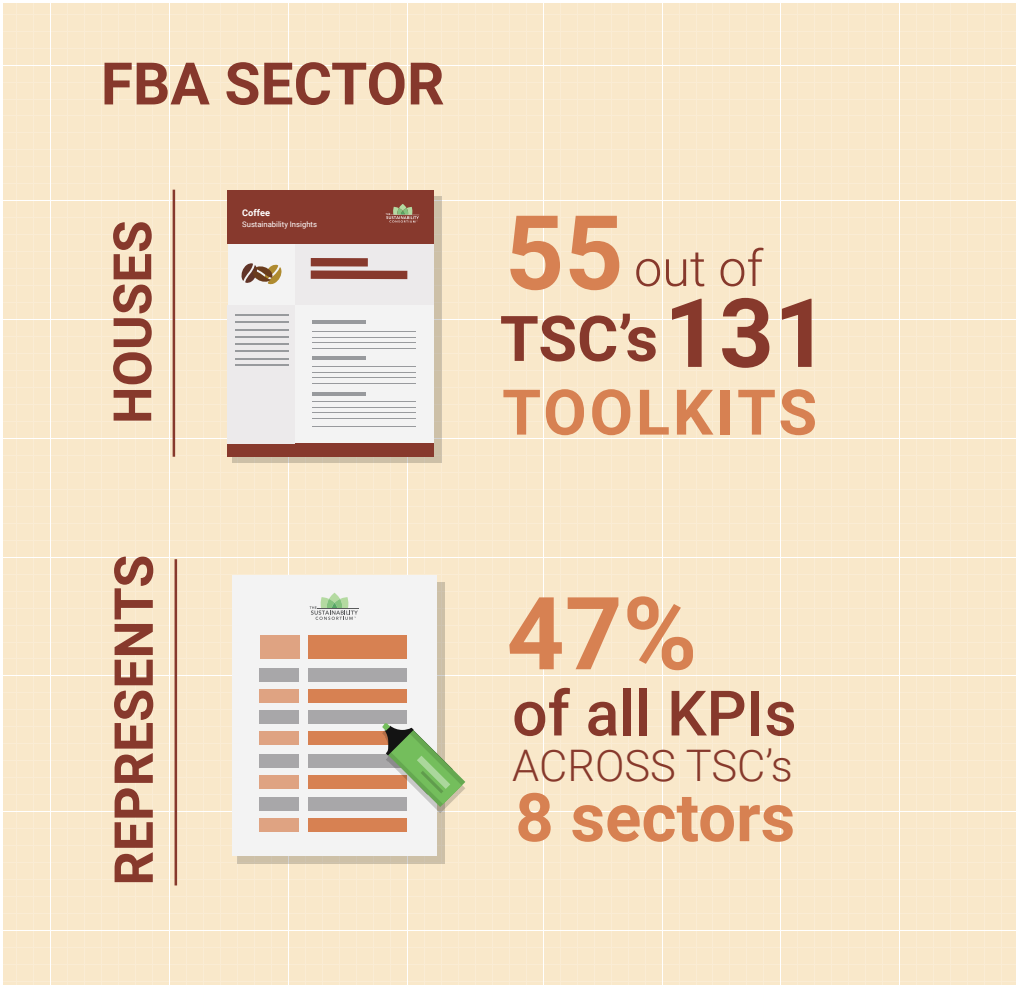

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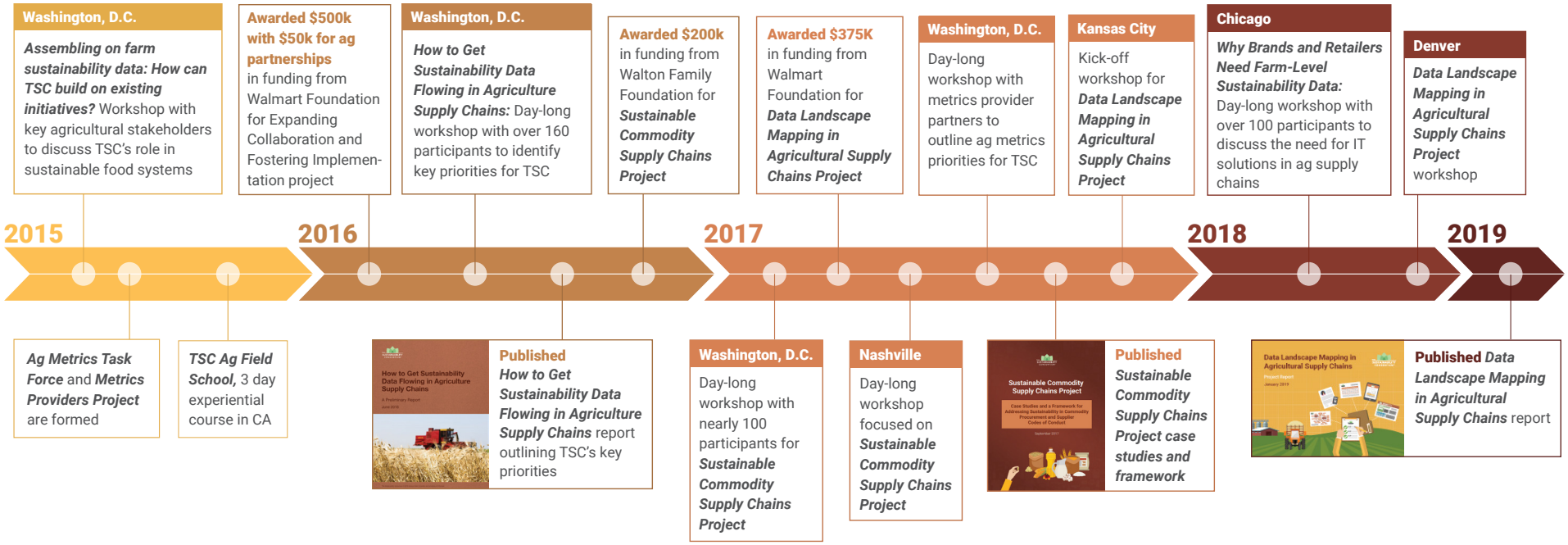
Figure 1: Timeline of milestones and projects completed by TSC's Agricultural Metrics and Metrics Providers Task Forces



Key stakeholders were convened again in 2016 for a day-long workshop focused on setting priorities for TSC's work in sustainable agriculture and food systems. Over 160 participants worked together to identify five priorities for TSC that are documented in the report *How to Get Sustainability Data Flowing in Agriculture Supply Chains*.

1. **Clear communication roadblocks in the value chain**
2. **Provide incentives for growers and companies**
3. **Improve IT interoperability and data alignment**
4. **Identify and implement the most effective improvement opportunities**
5. **Harmonize metrics and simplify data collection**

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Collectively, the five priorities reinforce TSC's effort to improve the transparency and reporting of sustainability impacts throughout food value chains. Since the 2016 workshop, TSC has completed a series of projects, several of which have been supported by $625,000 in total combined funding from the Walmart Foundation and the Walton Family Foundation (Table 1).

The "I Don't Know" Barrier

Several of TSC's priorities for sustainable agriculture are directly related to overcoming the "I don't know" barrier observed in supplier responses to TSC's Food, Beverage, and Agriculture KPIs. In 2017, 49% of supplier responses to the FBA KPIs were "We are unable to determine at this time," with 72% of these responses specific to the farm-level KPIs. Several factors help to explain this response barrier. First, food companies tend to have limited visibility into many of the farm-level activities addressed in the KPIs.[1] Second, even in situations where visibility exists, the retail buyer may not be asking the Tier 1 supplier about their sustainability performance on TSC KPIs. In these cases, there is little incentive for the supplier to gather the information needed to respond to the KPIs, rendering "We are unable to determine at this time" the most effortless option. Lastly, even if the sustainability conversation is occurring in the buying room, previous research conducted by TSC suggests that the lack of data systems connectivity in many agricultural supply chains poses a significant challenge to collecting and reporting sustainability information.[2]

Table 1: TSC's priorities for sustainable agriculture and food systems and associated projects.

Priority	Project
1. Clear communication roadblocks in the value chain	Sustainable Commodity Supply Chains Case Studies and Framework
2. Provide incentives for growers and companies	Sustainable Commodity Supply Chains Case Studies and Framework
3. Improve IT interoperability and data alignment	Data Landscape Mapping in Agricultural Supply Chains
4. Identify and implement the most effective improvement opportunities	TSC Action Recommendations
5. Harmonize metrics and simplify data collection	TSC Metrics Providers Project

[1] Food safety traceability requirements help to increase visibility to the farm level in most specialty crop supply chains, as does the somewhat shorter supply chain.

[2] https://www.sustainabilityconsortium.org/downloads/sustainable-commodity-supply-chains-project-case-studies-framework-addressing-sustainability-commodity-procurement-supplier-codes-conduct/?wpdmdl=20737&ind=1504892583977

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Despite this visibility and communication barrier, supplier scores have been improving slightly each year since 2015 (Figure 2). This may be due, in part, to food companies' efforts to collaborate with their suppliers, improve data collection processes, and track progress on environmental and social issues to meet their corporate sustainability goals. TSC's work with the Metrics Providers Project may also be a contributing factor. For the past several years, TSC has worked with numerous agricultural metrics development organizations, including the Cool Farm Alliance, Field to Market, Potato Sustainability Initiative, SAI Platform, and the Stewardship Index for Specialty Crops to identify opportunities where TSC can leverage existing farm-level sustainability metrics in the Food, Beverage, and Agriculture KPIs. As a result of these collaborations, TSC has improved its alignment with the farm-level metrics developed by these organizations (Figure 3), as well as communication related to the use of farm sustainability metrics tools in TSC's KPI guidance (Figure 4). Together, these efforts have likely contributed to an uptick in supplier responses, though additional research is needed to verify the correlation.

Figure 2: TSC's Food, Beverage, and Agriculture Toolkit Scores, 2015-2017.

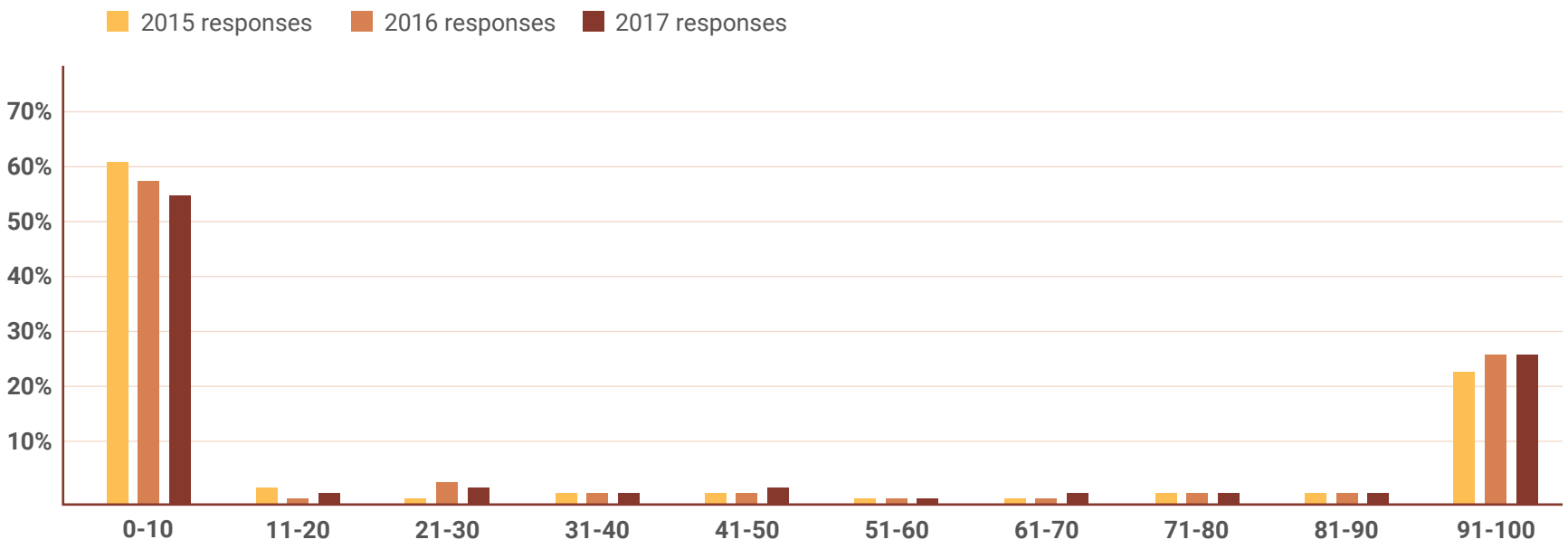

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Figure 3: TSC's alignment with farm-level metrics development organizations.

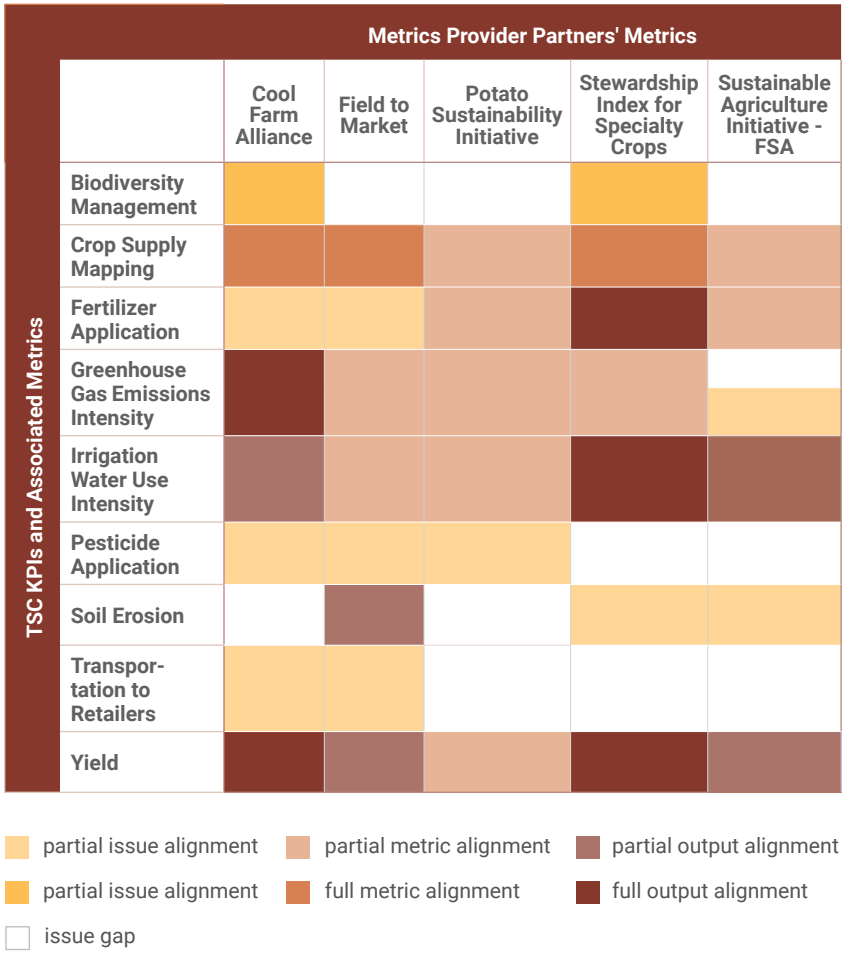
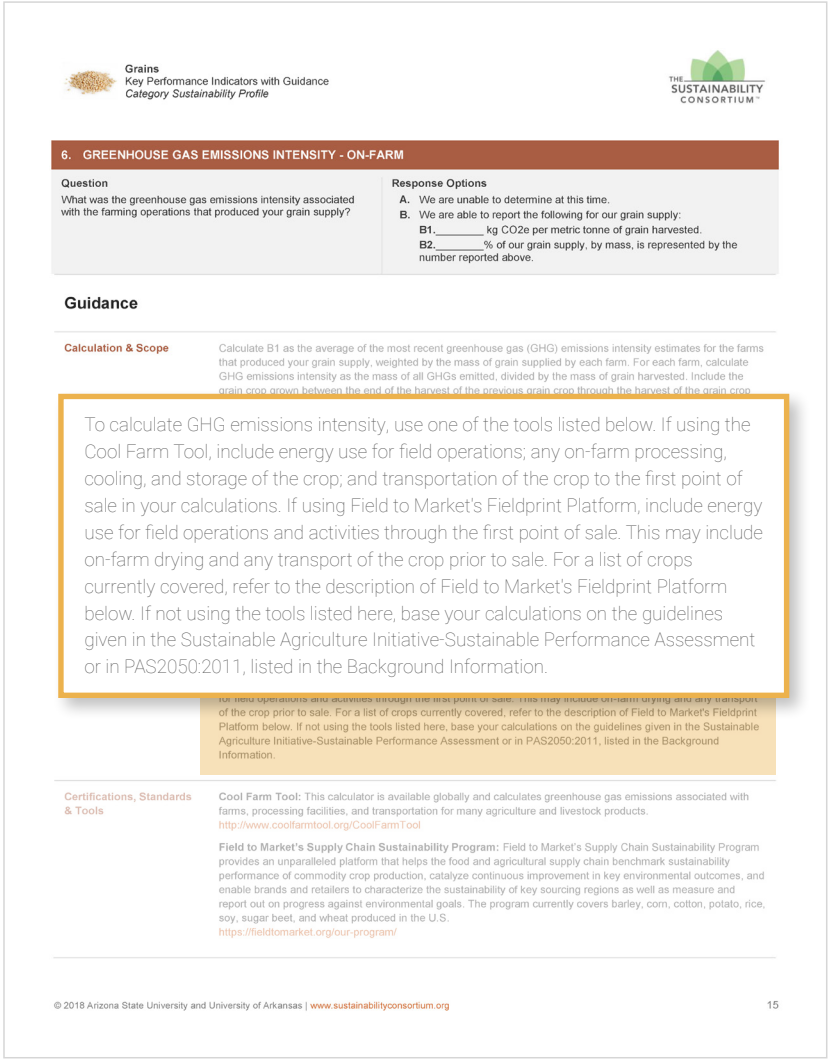


Figure 4: Example of guidance for using farm-level sustainability metrics tools to calculate responses to TSC's farm-level KPIs.



Grains
Key Performance Indicators with Guidance
Category Sustainability Profile

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6. GREENHOUSE GAS EMISSIONS INTENSITY - ON-FARM

Question
What was the greenhouse gas emissions intensity associated with the farming operations that produced your grain supply?

Response Options
A. We are unable to determine at this time.
B. We are able to report the following for our grain supply:
B1._____ kg CO2e per metric tonne of grain harvested.
B2._____% of our grain supply, by mass, is represented by the number reported above.

Guidance

Calculation & Scope

Calculate B1 as the average of the most recent greenhouse gas (GHG) emissions intensity estimates for the farms that produced your grain supply, weighted by the mass of grain supplied by each farm. For each farm, calculate GHG emissions intensity as the mass of all GHGs emitted, divided by the mass of grain harvested. Include the grain crop grown between the end of the harvest of the previous grain crop through the harvest of the grain crop

To calculate GHG emissions intensity, use one of the tools listed below. If using the Cool Farm Tool, include energy use for field operations; any on-farm processing, cooling, and storage of the crop; and transportation of the crop to the first point of sale in your calculations. If using Field to Market's Fieldprint Platform, include energy use for field operations and activities through the first point of sale. This may include on-farm drying and any transport of the crop prior to sale. For a list of crops currently covered, refer to the description of Field to Market's Fieldprint Platform below. If not using the tools listed here, base your calculations on the guidelines given in the Sustainable Agriculture Initiative-Sustainable Performance Assessment or in PAS2050:2011, listed in the Background Information.

Certifications, Standards & Tools

Cool Farm Tool: This calculator is available globally and calculates greenhouse gas emissions associated with farms, processing facilities, and transportation for many agriculture and livestock products.
http://www.coolfarmtool.org/CoolFarmTool

Field to Market's Supply Chain Sustainability Program: Field to Market's Supply Chain Sustainability Program provides an unparalleled platform that helps the food and agricultural supply chain benchmark sustainability performance of commodity crop production, catalyze continuous improvement in key environmental outcomes, and enable brands and retailers to characterize the sustainability of key sourcing regions as well as measure and report out on progress against environmental goals. The program currently covers barley, corn, cotton, potato, rice, soy, sugar beet, and wheat produced in the U.S.
https://fieldtomarket.org/our-program/

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Although supplier scores to most of TSC's farm-level KPIs have been improving year over year, there is still room for improvement, as evidenced by the low farm-level KPI scores relative to KPIs at the processing, manufacturing, and transportation stages in both commodity and specialty crop supply chains (Figures 5 and 6, respectively). TSC's Agricultural Metrics Task Force members have suggested that the "I don't know" and low KPI score barrier do not result from the absence of farm data; rather, the lack of systems connectivity across agricultural supply chains is likely the most influential barrier to data flow. Consequently, food companies are often not able to access the data they need to respond to TSC's farm-level KPIs.

Figure 5: Average KPI scores for KPIs in TSC's commodity crop product categories.

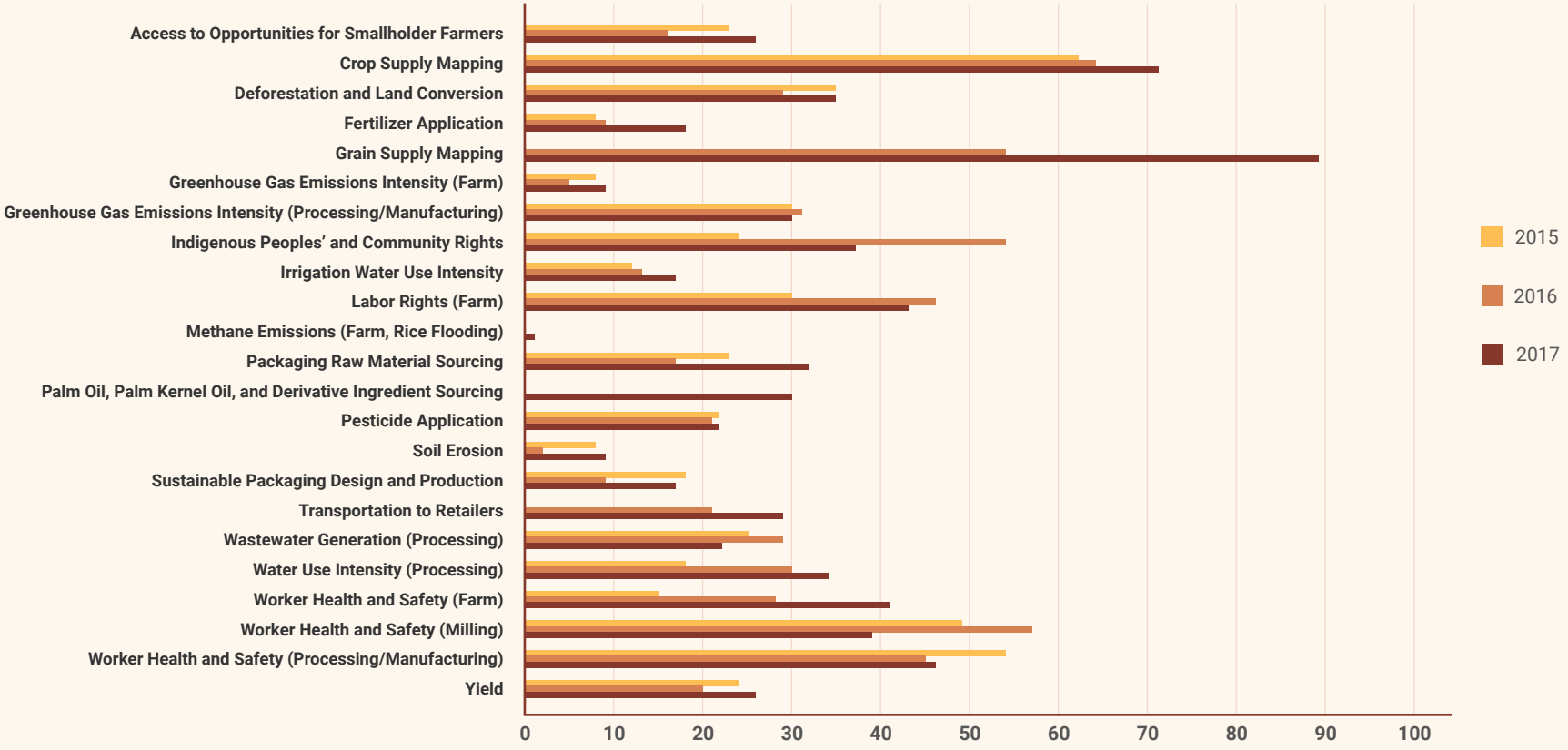

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Figure 6: Average KPI scores for KPIs in TSC's specialty crop product categories.

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As previously stated, the goal of this project was to facilitate the flow of farm-level data to food companies that utilize TSC KPIs by improving data systems connectivity in the agricultural sector. TSC and project participants engaged in five key activities to advance this goal:

- Developed a **systems landscape map** that identifies the key systems and platforms currently in place to collect and manage on-farm data;
- Conducted **case study interviews** to better understand how farm management software and sustainability data collection and reporting platforms function, where system connectivity and compatibility already exist, and where and how it can be improved;
- Compiled **data elements documentation** that identifies the data input requirements across five farm sustainability metrics tools and how those tools can be used to respond to TSC KPIs;
- Built an **Application Programming Interface (API)** that automates the process of translating data from select farm sustainability metrics tools into five TSC KPIs;
- Developed a spreadsheet-based **respondent tool** to simplify the process of aggregating farm-level data when reporting into TSC KPI's Fertilizer Application KPI.

As a result of these activities, which are each described in greater detail below, TSC anticipates a reduction in the number of "We are unable to determine at this time" responses to the Food, Beverage, and Agriculture KPIs over time. However, TSC recognizes that improvements in supplier response rates cannot be attributed to this project alone. Ongoing efforts to create additional supplier support tools, improve KPI questions and guidance as appropriate, and collaborate with the Metrics Providers Project to identify further metrics alignment and communication opportunities will also contribute to improved KPI responses. In the long-term, this and other TSC projects will result in the creation of procurement and data collection systems that deliver quality sustainability information to support business decision-making and impact-driven performance across all TSC sectors.

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Systems Landscape Map

The purpose of the systems landscape map was to highlight the key systems and platforms that are currently in place to collect and manage on-farm data and to identify opportunities for creating greater data mobility and connectivity in agricultural supply chains.

TSC drew on findings from previous research on how data flows in agricultural supply chains to outline the structure of the systems landscape map.[3] Using this information, TSC identified six supply chain nodes within which agricultural data is generated, analyzed, and reported:

1. Modeling and Precision Ag Technology
2. Farm Management Software
3. Farm Sustainability Metrics Tools & Programs
4. Supply Chain Software & Reporting Platforms
5. Consumer Packaged Goods (CPG) Company Software & Programs
6. Retail Software & Programs

TSC used a combination of internet searches, partner knowledge, and institutional knowledge to identify technologies, software, and IT platforms that gather and transfer data through agricultural supply chains. These technologies and platforms were then placed under the appropriate node in the systems map (Figure 7). Given the abundance of digital solution providers in the global agricultural sector, TSC focused primarily on technologies and platforms that are available in the U.S.; however, some technologies and platforms identified in the map are also used globally.

TSC's preliminary analysis of the agricultural data systems landscape revealed that there are many more digital solutions available for commodity crop growers than there are for specialty crop growers. This is likely due to the significantly higher volume of production and number of acres dedicated to commodity crops in the U.S. relative to specialty crops. Also, within each node, there appears to be a high degree of repetition across the functions and capabilities that each technology and platform offers, though unique features are presumably revealed with use. Lastly, many of the farm management software platforms identified in the map are currently not providing sustainability data reporting services. Feedback received throughout the course of this project indicates that this may result from an inconsistent demand signal for sustainability information from downstream customers, as well as the lack of a clear value proposition for growers to share sustainability data – both of which contribute to the perception that there is minimal business value in incorporating sustainability into farm-level software platforms. It should be noted that TSC did not evaluate each software or platform for sustainability metrics or compare the details of their respective functionalities. This level of analysis will be included in a future iteration of the systems landscape map.

A second map depicting systems connectivity between ag-focused technologies and platforms was created using information obtained through internet searches and communications from project participants (Figure 8). Notably, this map indicates that a fair degree of connectivity between modeling and precision ag technologies

[3] How to Get Sustainability Data Flowing in Agriculture Supply Chains, 2016

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Figure 7: Systems Landscape Map for U.S.

Modeling & Precision Ag Technology	Farm Management Software	Farm Sustainability Metrics Tools & Programs	Supply Chain Software & Programs	CPG Company Software & Programs	Retail Software & Programs
Adapt-N	Agrian	BASF AgBalance +	Athena Intelligence +	Agrible +	Carbon Disclosure Project (CDP) +
Agrible	Agrible	Bonsucro *	Carbon Disclosure Project (CDP) +	MGIS (Mars) +	Global Reporting Initiative (GRI) +
Arable	AgriEdge Excelsior	Bunge Centerfield +	Ecoinvent +	PRè Sustainability * +	SAP +
aWhere	Agrivi	California Almond Sustainability Program * +	EcoPractices * +	Quantis +	The Sustainability Consortium (TSC) * +
Case IH Advanced Farming Systems tech	AgSolver	California Sustainable Winegrowing Alliance * +	Ecovadis +	SAP +	
Compass Grower Advanced	AgSquared	COMET-Farm +	ExtendAg +	Sow Organic +	
Echelon	AgVerdict	Cool Farm Tool +	Global Reporting Initiative (GRI) +	SureHarvest Sustainability MIS +	
Encirca	AgWorks	EDF N Balance +	MyFarms +		
Farmers Business Network	Agworld	Field to Market * +	Muddy Boots +		
Farmers Edge Smart Solutions	Case IH Advanced Farming Systems software	Land O'Lakes SUSTAIN/Truterra * +	PRè Sustainability +		
FarmShots	Climate Fieldview	NRCS Resource Stewardship Evaluation * +	Proagrica +		
FarmWorks	Compass Grower Advanced	Pesticide Risk Tool +	Quantis +		
FieldReveal	Conservis	Potato Sustainability Initiative * +	ResourceMAX +		
John Deere technologies	Encirca	Protected Harvest *	SAP +		
MapShots	Farm at Hand	SureHarvest Sustainability MIS +	SimaPro +		
New Holland technologies	FarmLogs	SAI Platform * +	Sow Organic +		
OptiGro	Farmplan Gatekeeper	Stewardship Index for Specialty Crops +	SupplyShift +		
Pioneer Field360	Farmers Edge FarmCommand		SureHarvest Sustainability MIS +		
Raven	Granular Business		Thinkstep +		
SureHarvest Farming MIS	John Deere AgLogic				
WEEDSCOUT	John Deere Operations Center				
Winfield United R7 Tool	Land.db				
Zoner	myAGCentral				
	New Holland				
	Pioneer Field360				
	Proagrica				
	SAP				
	SureHarvest Farming MIS				
	Trimble				

* Program or initiative

\+ IT platform or software

Note: For purposes of this map, TSC defined a program or initiative as a set of standards, industry code of practice, and/or sustainability assessment that includes metrics and that uses farm-level information to identify opportunities for the implementation of best practices, development of continuous improvement strategies, grower education, and communications. TSC defined IT platforms and software as systems that are focused on data collection for purposes of measurement or reporting only. The companies and organizations that developed the platforms and software identified in the systems landscape map might oversee or implement sustainable agriculture programs, but these programs are not linked to the tool or platform itself or the data that the tool or platform handles. Also, platforms listed under the Modeling & Precision Ag Technology and Farm Management Software nodes are not denoted with a "+", since all are IT platforms or software to varying degrees.

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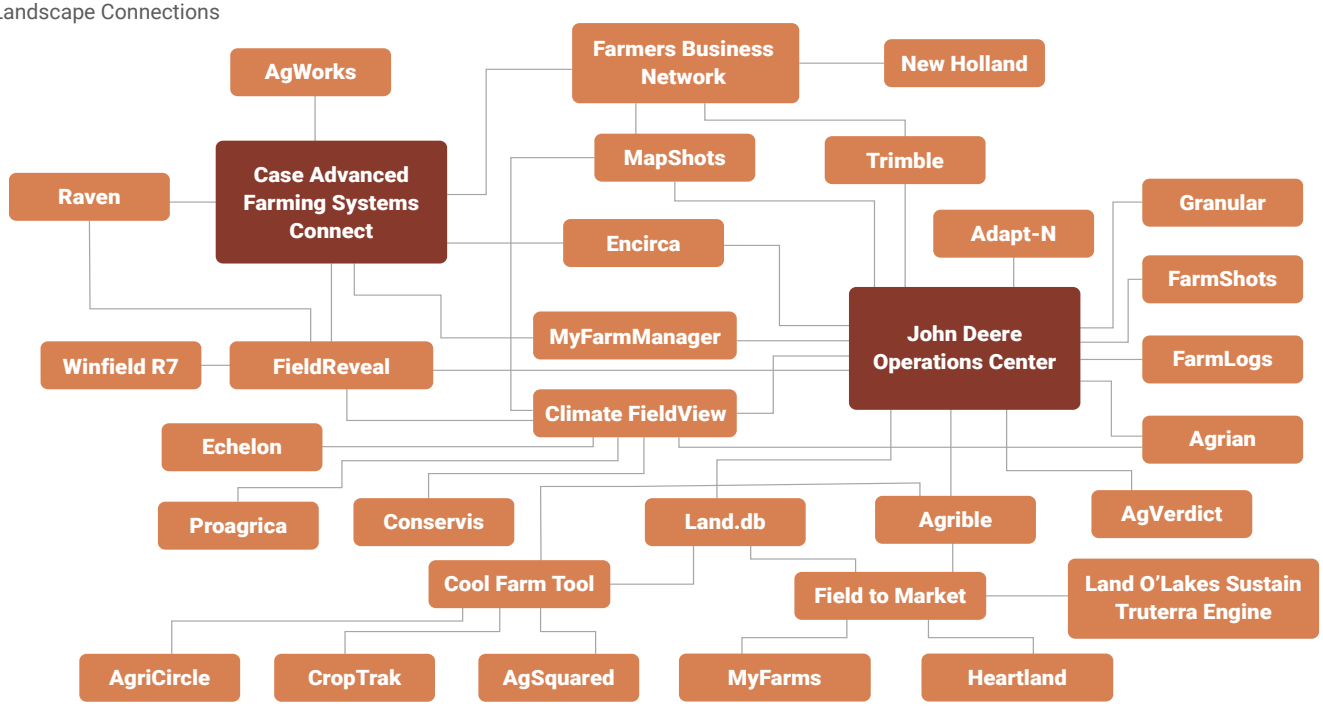
Figure 8: Systems Landscape Connections



and farm management software programs currently exists. There is also some connection activity occurring between farm management software programs and farm-level sustainability tools and programs. Both types of connectivity are essential for reducing the data management burden for growers and allowing them to focus more on the farm management activities that drive sustainability.

A key finding of the systems landscape mapping is that the digital technology space for the agriculture sector is dynamic and rapidly evolving. New companies that offer novel solutions for data collection, information management, and decision support are steadily emerging, particularly at the farm-level, while established technologies and platforms are frequently acquired by companies that seek to bolster their digital offerings to growers and other entities across the agricultural value chain. Moreover, connectivity between technologies and platforms at various nodes in the digital solutions landscape continues to improve. Consequently, a static systems landscape and connectivity map quickly becomes obsolete. Throughout this project, TSC made numerous modifications to the systems and connectivity maps, and the ones presented here represent the state of landscape as of December 31, 2018.

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Case Study Interviews

The goal of the case study interviews was to better understand the nature of existing data systems connectivity and compatibility and where and how this can be improved across agricultural supply chains. Given TSC's in-depth knowledge of many of the farm sustainability metrics tools and programs depicted in Figure 7, case study interviews were targeted toward farm management software companies and consumer packaged goods (CPG) companies to fill in information gaps. Companies of interest were identified through a review of TSC's membership, in addition to recommendations from project participants. This process resulted in a list of twelve potential companies, eight of which accepted invitations for an interview. TSC conducted interviews with six farm management software companies (AgConnections; Agrible, Inc.; Granular; MyFarms; SureHarvest; and The Climate Corporation) and two CPG companies (Campbell Soup Company and Mars, Incorporated).

Interview questions for farm management software companies were aimed at understanding the purpose of the software and the basic demographics of the growers who use it; how the software platform gathers data; whether the software provides benchmarking functionality or other forms of information feedback; and modes of data transfer to farm-level sustainability tools and/or downstream customers. In addition, interviewees were asked to share both their and their customers' perceptions of the value proposition related to sustainability data-sharing, as well as their ideas for solutions to help ease the data reporting burden for growers.

Interview questions for CPG companies focused on the types of software platforms used to manage sustainability data; the modes of data transfer from suppliers to the CPG company and ultimately to retail customers; and whether the software platforms provide benchmarking functionality or other forms of information feedback to upstream suppliers. Interviewees were also asked to describe how they use the sustainability information they collect from suppliers, their suppliers' perceptions of the value proposition related to sustainability reporting, and their ideas for solutions to help ease the data reporting burden for them and their suppliers.

For a full list of case study interview questions, refer to Appendix C.

Case Study Findings

Insights from the case study interviews with farm management software companies are shown in Table 2.[4] In terms of purpose, each software platform provides crop production planning and decision support, nutrient management capabilities, and whole farm management. One software platform also includes contract management functionality that tracks crop quality specifications and progress made in meeting the harvest volume stated in the contract. Specific features offered by the software platforms range from performance benchmarking (6 companies), report generation for customers (5 companies), and recommendations for best management practices (4 companies) to profitability evaluation (3 companies), task management (2 companies), regulatory compliance monitoring and reporting (2 companies), and tracking for certification

[4] All attributes linked to farm management software companies in Table 2 were determined based on interview responses. Additional attributes may apply.

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Table 2: Summary of findings from farm management software company interviews

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
PURPOSE OF SOFTWARE PLATFORM						
Contracts management			✓			
Crop production planning/decision support	✓	✓	✓	✓	✓	✓
Nutrient management	✓	✓	✓	✓	✓	✓
Pest management			✓	✓	✓	✓
Predictive analytics (e.g., profitability, yield)			✓	✓	✓	✓
Whole farm management	✓	✓	✓	✓	✓	✓
PRIMARY USERS						
Ag retailers						✓
CPG companies					✓	✓
Growers (commodity crops)	✓	✓	✓	✓	✓	✓
Growers (specialty crops)		*	✓	✓		
Smallholders		✓	✓	✓	✓	
FEATURES						
Best management practice recommendations		✓	✓		✓	✓
Certification/audit program compliance tracking			✓			
Customer reports	✓		✓	✓	✓	✓
Data sharing with grower network					✓	
Market data					✓	
Performance benchmarking (internal to grower's operation)	✓	✓	✓	✓	✓	✓
Performance benchmarking (external to peer growers)				✓	✓	✓
Production planning			✓	✓	✓	
Profitability evaluation	✓			✓	✓	
Recordkeeping (e.g., agronomic practices, crop quality, yield)			✓	✓	✓	✓
Regulatory compliance monitoring/reporting			✓	✓		
Seed selection		✓				
Sustainability metrics/reporting	*		✓	✓	✓	✓
Task management	✓		✓			
Weather data		✓	✓		✓	
Yield prediction and/or evaluation	✓	✓	✓		✓	
SUSTAINABILITY METRICS PLATFORM INTEGRATION						
Cool Farm Tool				✓	✓	
EDF N Balance						✓

Table 2 continued

	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
Fieldprint Platform				✓	✓	✓
SAI Farm Sustainability Assessment				*		
Stewardship Index for Specialty Crops			*			
DATA ENTRY & TRANSFER						
APIs with farm sustainability calculators (e.g., Cool Farm Tool, Fieldprint Platform)	*			✓	✓	✓
APIs with other systems		*	✓	✓	N/A	
Cloud connectivity with field equipment or equipment software platforms	✓	✓	✓	✓	N/A	*
Drone imagery/remote sensing		✓			N/A	✓
Farm management software company has access to grower data	✓	✓	✓	✓	✓	✓
Manual data entry	✓		✓	✓	N/A	✓
Security provisions in place to protect grower identity	✓	✓	✓	✓	✓	✓
DATA SYSTEMS SOLUTIONS						
Automated data entry and export	✓		✓	✓	✓	
Fewer data points requested within and across systems		✓		✓		
Integration with social media			✓			
Rely less on IT and more on the grower's story						✓
Report customization for specific end users				✓		
Voice dictated data entry			✓			
VALUE PROPOSITION OF FARM-LEVEL DATA MANAGEMENT FOR GROWERS						
Crop production planning insights		✓		✓	✓	✓
Improves communication with customers			✓	✓		
Profitability insights	✓			✓		
Resource use efficiency insights			✓			✓
Risk management insights			✓			
VALUE PROPOSITION OF SUSTAINABILITY DATA SHARING FOR GROWERS						
Cooperative risk management					✓	
Decision support					✓	
Improved communication with business partners (e.g., lenders, crop advisors, landowners)			✓	✓		
Market access/brand equity			✓	✓		
Performance benchmarking and insights			✓	✓	✓	
Value proposition is currently unclear	✓	✓		✓	✓	✓

* Indicates future addition to software platform

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program compliance (1 company). Notably, four farm management software platforms currently include sustainability metrics, and one company has plans to integrate sustainability metrics into their software in the future.

Five of the six farm management software companies reported that their platforms serve farming operations of all scales, from very small to very large. Only one company serves primarily larger farms. Regardless of size, case study participants stated that performance feedback and benchmarking information provided by their software influences growers to adjust their farm management practices. In almost all cases, growers can set permissions within the software platforms to enable others, such as ag retailers, crop consultants, or other trusted advisors, to directly access the grower's data or to see specified information about their operations. Each of the six companies reported having access to the data that growers enter into their software platforms, yet each has security measures in place to protect grower identity. Anonymizing and aggregating data is the primary method of protecting grower identity. Additionally, one software company conducts a third-party audit on grower data privacy and confidentiality, and two others are certified under the American Farm Bureau's Ag Data Transparent program.

For data entry and transfer, the two most common approaches are manual data entry (4 companies) and cloud connectivity with field equipment or equipment software platforms (4 companies). Three software platforms have APIs to transfer data from their platforms into farm sustainability calculators, such as the Cool Farm Tool and Field to Market Fieldprint Platform, and one platform has plans to develop APIs with farm sustainability calculators in the future. Two software platforms have APIs with other ag-based IT systems, and two platforms integrate data from drone imagery or remote sensing systems. In spite of these existing connections across systems, case study participants noted that broad connectivity is still lacking. Proposed solutions for improving data systems connectivity include automated data entry and export, voice-dictated data entry, and greater integration with remote sensing systems. Two interviewees also suggested that fewer data points requested within and across software platforms would help to improve connectivity across systems.

Lastly, the six farm management software case study participants shared their perspectives on the value proposition related to farm-level data management and sustainability data sharing for growers. Four participants agreed that, currently, the strongest value proposition for growers to manage farm-level data is obtaining crop production planning insights. Additionally, farm-level data management can offer insights related to resource use efficiency and profitability and can help to improve communication with customers. With respect to the value proposition for sustainability data sharing, three case study participants suggested that performance benchmarking and insights currently provide the strongest value. Two participants agreed that market access and brand equity are critical to the sustainability data sharing value proposition, and one participant indicated that cooperative risk management also provides value back to the grower. Importantly, five of the six participants expressed concern that, overall, the value proposition of sustainability for growers remains largely unclear.

Findings from the case study interviews with CPG companies are shown in Table 3. The purpose of the software platforms utilized by the

[5] One farm management software company declined to share their specific modes of data entry and transfer for proprietary purposes, which is denoted by N/A in Table

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two companies interviewed range from tracking raw materials supply, supplier resource use, and product quality to aggregating farm-level information to estimating upstream supply chain impacts. Specific features offered by the software platforms used by CPG companies include Global Information Systems (GIS) integration, life-cycle assessment (LCA) integration, supplier performance benchmarking, and sustainability metrics integration. One case study participant indicated that it has the ability, through its software platforms, to provide supplier performance benchmarking for several key sustainability indicators, including fertilizer use, water use, and yield.

Regarding data entry, both CPG companies shared that manual data entry is the primary mechanism for assimilating information into their software platforms, followed by APIs with farm management information systems and transmitting and extracting data via spreadsheets. Currently, neither company has APIs with farm-level sustainability calculators.

In terms of the value proposition for sustainability reporting for CPG companies and their suppliers, case study participants noted performance benchmarking, the ability to identify and manage supply chain risks, and using reporting data to reinforce sustainability commitments and external communications. Like the farm management software company case study participants, the CPG companies interviewed expressed concern that connectivity across data systems in agricultural supply chains needs improvement. Proposed solutions to enhance connectivity included automating data entry, increasing reliance on satellite information, and integrating farm-level data with LCA databases. The second component of this project – data elements documentation and API development – addressed two of these proposed solutions: automating data entry and, by extension, improving data quality.

Table 3: Summary of findings from consumer packaged goods (CPG) company interviews

	Comp.1	Comp. 2
PURPOSE OF SOFTWARE PLATFORM(S)		
Aggregate farm-level agronomic and sustainability information		✓
Estimate upstream supply chain impacts	✓	
Track (farm-level) supplier resource use		✓
Track product quality information		✓
Track raw materials supply data (e.g., source, volume purchased, estimated impacts)	✓	
Track supplier risk and improvement opportunities		✓
FEATURES		
GIS integration	✓	✓
LCA integration	✓	
Supplier performance benchmarking		✓
Sustainability metrics platform integration		✓
MODES OF DATA ENTRY AND TRANSFER		
APIs with farm management software platforms		✓
Manual data entry	✓	✓
Spreadsheets		✓
VALUE PROPOSITION OF SUSTAINABILITY REPORTING FOR CPG COMPANY & SUPPLIERS		
Create awareness of opportunities to become more efficient with resource use		✓
Identify and manage supply chain risks	✓	
Performance benchmarking		✓
Reinforce sustainability commitments and communications	✓	
DATA SYSTEMS SOLUTIONS		
Automate data entry		✓
Develop supplier data accounting methodology	✓	
Improve data accuracy	✓	
Improve data quality and verification mechanisms	✓	
Increase reliance on satellite data		✓
Integrate farm-level data with LCA databases	✓	
Support actionability for upstream suppliers (i.e., shift focus from product assessment to driving and improving management decisions)		✓

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Data Elements Documentation and API Development

Building on TSC's previous metrics alignment work with the Metrics Providers Project, TSC developed data elements documentation to demonstrate how data from five farm-level sustainability measurement platforms (Cool Farm Tool, Field to Market Fieldprint Platform, Potato Sustainability Initiative, Sustainable Agriculture Initiative, and Stewardship Index for Specialty Crops) can be translated to select quantitative KPIs within TSC's Food, Beverage, and Agriculture product categories. The data elements documentation identifies the farm-level metrics within each of these platforms that correspond with TSC's Fertilizer Application, Greenhouse Gas Emissions Intensity, Irrigation Water Use Intensity, Soil Erosion, and Yield KPIs, as well as each metric's scope and measurement period and the specific data inputs that are required to calculate each metric. The documentation also classifies the degree of alignment between each farm-level metric and the corresponding TSC KPI and describes how the metric output or other relevant data can be used to respond to the KPIs. TSC identified three potential use cases for the information contained in the data elements documentation:

1. Develop IT solutions that facilitate data mobility and remove sustainability reporting barriers in ag supply chains
2. Collaborate with Metrics Providers Project to address any outstanding areas where farm-level metrics alignment can be improved

Table 4: Example of data elements documentation, using TSC's Yield KPI and the Stewardship Index for Specialty Crops (SISC) corresponding yield metric.

TSC KPI	TSC Metric	TSC Scope	TSC Measurement Period	SISC Indicator	SISC Metric	SISC Scope	SISC Measurement Period	SISC Metric Input Field Name	SISC Metric Input Type	Alignment Status
Yield	Metric tonnes of crop supply harvested per hectare planted	Crop supplied to brand manufacturer or retail	Single crop cycle within 12-month reporting period	Yield	Tonnes harvested per acre planted	Field / management area	Single crop cycle. Includes amount harvested between date of last harvest in previous year and date current harvest was completed	Acres planted	Numeric entry	Full alignment on output
Yield	[same as above]	[same as above]	[same as above]	Yield	[same as above]	[same as above]	[same as above]	Date harvest completed	Text entry (mm/yy/dd)	Full alignment on output
Yield	[same as above]	[same as above]	[same as above]	Yield	[same as above]	[same as above]	[same as above]	Date of last harvest in previous year	Text entry (mm/yy/dd)	Full alignment on output
Yield	[same as above]	[same as above]	[same as above]	Yield	[same as above]	[same as above]	[same as above]	Tons harvested	Numeric entry	Full alignment on output
Yield	[same as above]	[same as above]	[same as above]	Yield	[same as above]	[same as above]	[same as above]	Grown from transplant or seed	Select: seed; transplant	Full alignment on output

* Each line represents an individual data input for SISC's yield metric. Accordingly, some data components are repeated from row to row.

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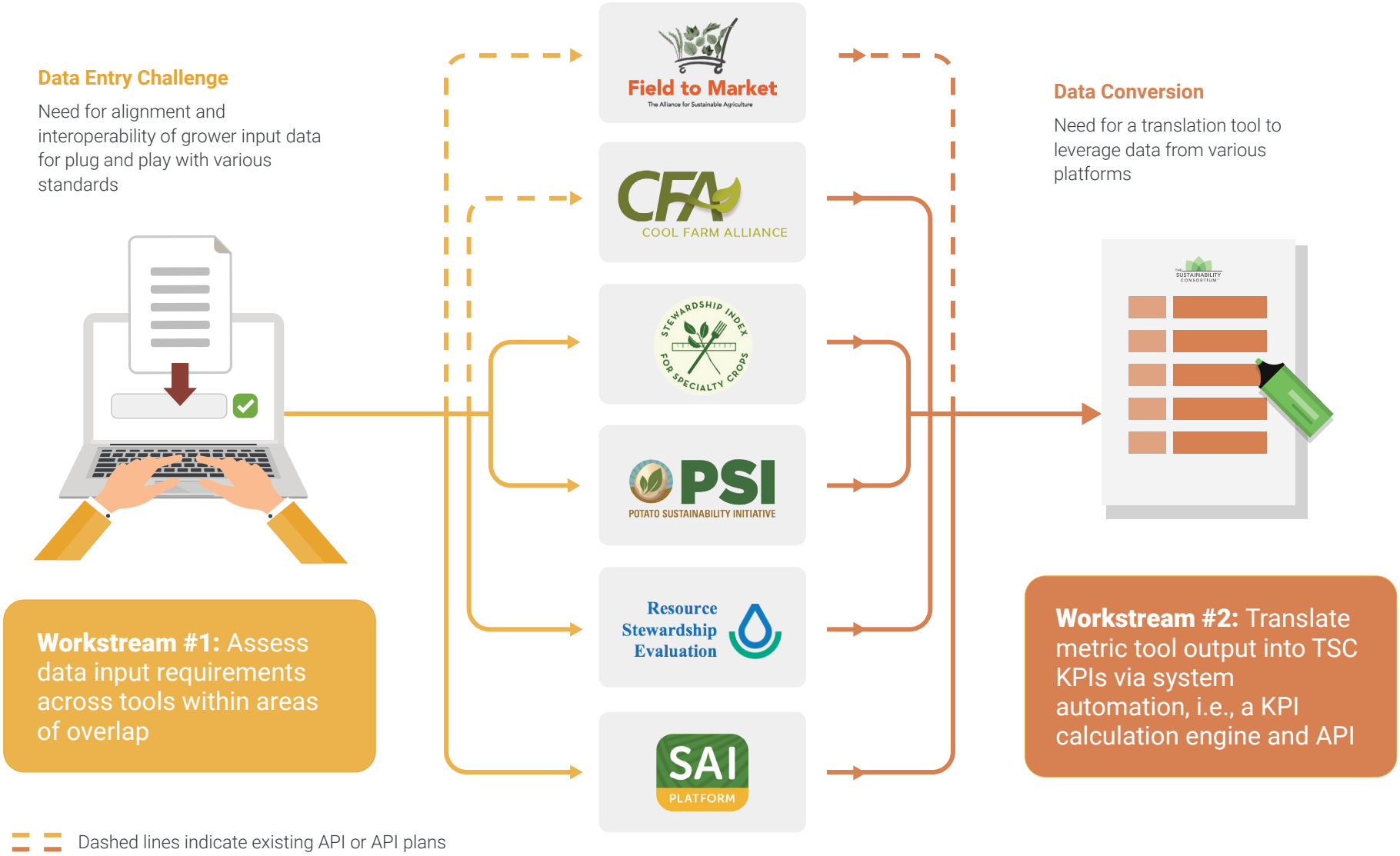
Figure 9: Workstreams related to Data Elements Documentation and API.



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3. Where relationships with farm-level sustainability platforms do not already exist, engage farm management software developers that are interested in incorporating sustainability reporting into their platforms to ensure that they are integrating the necessary data elements required to generate the metrics listed above.

For this project, TSC focused efforts on the first use case – Develop IT solutions that facilitate data mobility and remove sustainability reporting barriers in ag supply chains. To this end, TSC collaborated with Anthesis Group to build an Application Programming Interface (API) and supplementary web-based interface, collectively called the *TSC Ag Metrics Translator*, using the data elements documentation as the foundation. Figure 9 shows how the data elements documentation is used in the API. The purpose of both the API and the web-based interface is to translate output from each of the five farm-level sustainability metrics platforms listed above into five TSC KPIs:

- Fertilizer Application (nitrogen use efficiency and phosphorus surplus)
- Greenhouse Gas Emissions Intensity for farming operations
- Irrigation Water Use Intensity
- Soil Erosion
- Yield

Figure 10 highlights which of the farm-level metrics currently available in the Ag Metrics Translator are addressed by each sustainability metrics platform. Figure 11 depicts the calculation and translation functions of the Ag Metrics Translator.

Figure 10: Farm-level sustainability metrics currently provided by the Ag Metrics Translator.

Metrics	CFA COOL FARM ALLIANCE	PSI POTATO SUSTAINABILITY INITIATIVE	SAI PLATFORM	Stewardship Index for Specialty Crops	Field to Market
Fertilizer Application	✓	✓	✓	✓	—
GHG Emissions	✓	✓	✓	✓	✓
Irrigation Water Use	✓	✓	✓	✓	✓
Soil Erosion	—	—	—	—	✓
Yield	✓	✓	✓	✓	✓

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Figure 11: Diagram of the calculation and translation functions of the TSC Ag Metrics Translator webform and API.

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The API can be integrated into software platforms to automatically calculate and aggregate responses to the above KPIs, using farm-level sustainability data contained within their own applications. The web-based interface allows organizations that are using offline tools to manually enter their farm-level sustainability data and generate results that are compliant with the five TSC metrics currently included in the Translator. A critical component of the Ag Metrics Translator is its unit conversion capability, which allows users to provide data in the format in which they have it. The Translator will convert the user's units appropriately before generating aggregated results that can be used to report into TSC KPIs. All features of the Ag Metrics Translator and an example of data conversion are shown in Figure 12.

Effectively, the Ag Metric Translator provides for consistent, automated data calculation and aggregation for companies that are reporting to TSC KPIs. The Translator can be used by brand manufacturers that are responding to retailer requests for sustainability information, by commodity aggregators that are reporting information to brand manufacturers, and by growers that are reporting directly to brand manufacturers or retailers. Importantly, the Ag Metrics Translator does not store any user data, either in the web-based interface or in the API. However, the web-based interface does allow the user to store a local copy of the information they have manually entered and upload it back to the interface as needed. Additionally, the Translator asks only for the information that is required to calculate the KPI results; no farm data or personally identifying information is transmitted between the Translator and integrated systems.

Implementation of the API within farm-level sustainability measurement platforms will enable growers to more readily convert their on-farm data to TSC metrics and allow them to share their sustainability data with their customers. Implementation within other reporting platforms will support more consistent calculations for food and agriculture companies that are participating in retail sustainability reporting. In general, the API will standardize how TSC's farm-level KPIs are calculated, easing a substantial aspect of the reporting burden for suppliers and growers. Until the API is integrated into upstream platforms, the web-based interface will enable manual entry of data to calculate responses to TSC KPIs. This will be especially useful for suppliers that are using offline calculation tools. In the coming years, TSC will monitor API implementation efforts to determine if and how retail supplier scores improve as a result of enhanced data systems connectivity.

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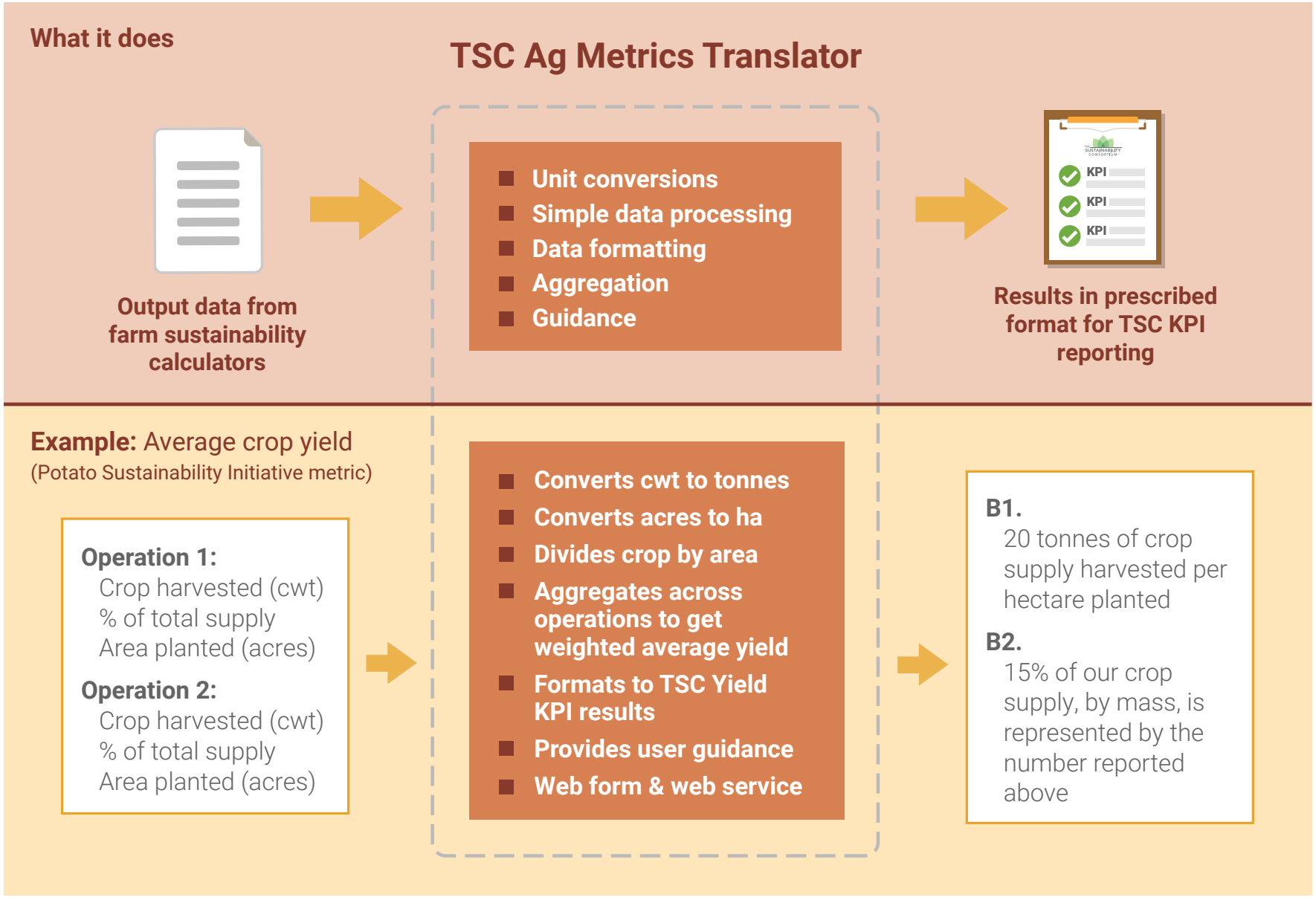
Figure 12: Features of the TSC Ag Metrics Translator with an example inputs and outputs for yield.



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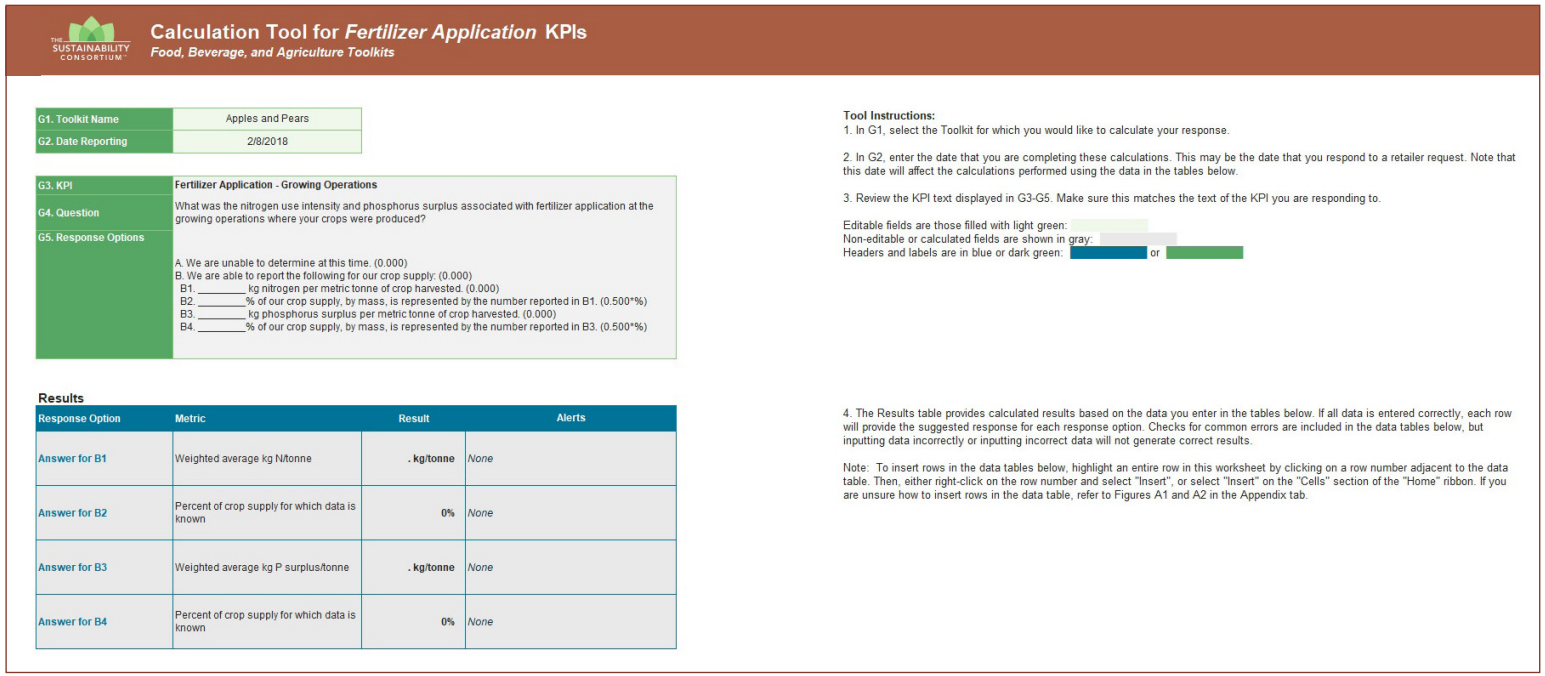
Fertilizer Application KPI Calculation Tool

At the outset of the Data Landscape Mapping Project, TSC planned to to develop a comprehensive "Farm Wizard Tool" consisting of spreadsheet-based calculation tools for the on-farm Fertilizer Application, Greenhouse Gas Emissions Intensity, Irrigation Water Use Intensity, Soil Erosion, and Yield KPIs. TSC developed the first calculation tool, for the Fertilizer Application KPI, in 2017. The tool is available on TSC's website and has been downloaded over 400 times by suppliers.[6]

To use the Fertilizer Application KPI tool, suppliers first select the name of the Toolkit they are responding to and then enter the date they are reporting the information to their customer. The KPI question, response options, and guidance change slightly depending on the Toolkit selected (Figure 13). A series of data tables follows, accompanied by instructions, to guide the user through the process of entering the information needed to calculate results for the four response options associated with the KPI (Figure 14). Users enter data

Figure 13: Initial data entry fields, results, and user instructions for the Fertilizer Application KPI Calculation Tool.



Calculation Tool for *Fertilizer Application* KPIs
Food, Beverage, and Agriculture Toolkits

G1. Toolkit Name	Apples and Pears
G2. Date Reporting	2/8/2018

G3. KPI	**Fertilizer Application - Growing Operations**
G4. Question	What was the nitrogen use intensity and phosphorus surplus associated with fertilizer application at the growing operations where your crops were produced?
G5. Response Options	A. We are unable to determine at this time. (0.000) B. We are able to report the following for our crop supply: (0.000) B1. _____ kg nitrogen per metric tonne of crop harvested. (0.000) B2. _____% of our crop supply, by mass, is represented by the number reported in B1. (0.500*%) B3. _____ kg phosphorus surplus per metric tonne of crop harvested. (0.000) B4. _____% of our crop supply, by mass, is represented by the number reported in B3. (0.500*%)

Results

Response Option	Metric	Result	Alerts
Answer for B1	Weighted average kg N/tonne	. kg/tonne	*None*
Answer for B2	Percent of crop supply for which data is known	0%	*None*
Answer for B3	Weighted average kg P surplus/tonne	. kg/tonne	*None*
Answer for B4	Percent of crop supply for which data is known	0%	*None*

Tool Instructions:
1. In G1, select the Toolkit for which you would like to calculate your response.

2. In G2, enter the date that you are completing these calculations. This may be the date that you respond to a retailer request. Note that this date will affect the calculations performed using the data in the tables below.

3. Review the KPI text displayed in G3-G5. Make sure this matches the text of the KPI you are responding to.

Editable fields are those filled with light green:
Non-editable or calculated fields are shown in gray:
Headers and labels are in blue or dark green: or

4. The Results table provides calculated results based on the data you enter in the tables below. If all data is entered correctly, each row will provide the suggested response for each response option. Checks for common errors are included in the data tables below, but inputting data incorrectly or inputting incorrect data will not generate correct results.

Note: To insert rows in the data tables below, highlight an entire row in this worksheet by clicking on a row number adjacent to the data table. Then, either right-click on the row number and select "Insert", or select "Insert" on the "Cells" section of the "Home" ribbon. If you are unsure how to insert rows in the data table, refer to Figures A1 and A2 in the Appendix tab.

[6] https://www.sustainabilityconsortium.org/what-we-offer/measurement-reporting-system/respondenttools/

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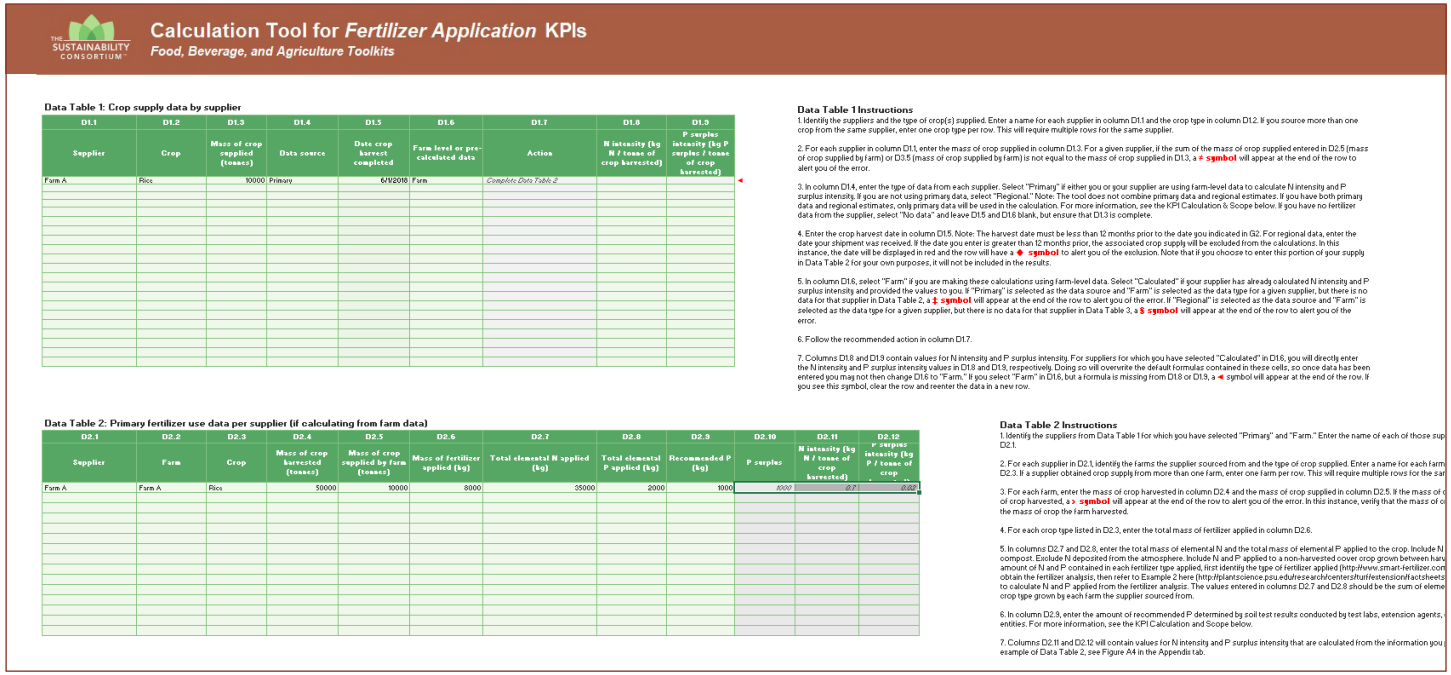
Figure 14: Data tables and user instructions for the Fertilizer Application KPI Calculation Tool.



Calculation Tool for *Fertilizer Application* KPIs

Food, Beverage, and Agriculture Toolkits

Data Table 1: Crop supply data by supplier

D1.1	D1.2	D1.3	D1.4	D1.5	D1.6	D1.7	D1.8	D1.9
Supplier	Crop	Mass of crop supplied (tonnes)	Data source	Date crop harvest completed	Farm level or pre-calculated data	Action	N intensity (kg N / tonne of crop harvested)	P surplus intensity (kg P surplus / tonne of crop harvested)
Farm A	Rice	10000	Primary	6/1/2018	Farm	*Complete Data Table 2*		

Data Table 1 Instructions

1. Identify the suppliers and the type of crop(s) supplied. Enter a name for each supplier in column D1.1 and the crop type in column D1.2. If you source more than one crop from the same supplier, enter one crop type per row. This will require multiple rows for the same supplier.

2. For each supplier in column D1.1, enter the mass of crop supplied in column D1.3. For a given supplier, if the sum of the mass of crop supplied entered in D2.5 (mass of crop supplied by farm) or D3.5 (mass of crop supplied by farm) is not equal to the mass of crop supplied in D1.3, a ≠ **symbol** will appear at the end of the row to alert you of the error.

3. In column D1.4, enter the type of data from each supplier. Select "Primary" if either you or your supplier are using farm-level data to calculate N intensity and P surplus intensity. If you are not using primary data, select "Regional." Note: The tool does not combine primary data and regional estimates. If you have both primary data and regional estimates, only primary data will be used in the calculation. For more information, see the KPI Calculation & Scope below. If you have no fertilizer data from the supplier, select "No data" and leave D1.5 and D1.6 blank, but ensure that D1.3 is complete.

4. Enter the crop harvest date in column D1.5. Note: The harvest date must be less than 12 months prior to the date you indicated in G2. For regional data, enter the date your shipment was received. If the date you enter is greater than 12 months prior, the associated crop supply will be excluded from the calculations. In this instance, the date will be displayed in red and the row will have a ◆ **symbol** to alert you of the exclusion. Note that if you choose to enter this portion of your supply in Data Table 2 for your own purposes, it will not be included in the results.

5. In column D1.6, select "Farm" if you are making these calculations using farm-level data. Select "Calculated" if your supplier has already calculated N intensity and P surplus intensity and provided the values to you. If "Primary" is selected as the data source and "Farm" is selected as the data type for a given supplier, but there is no data for that supplier in Data Table 2, a ‡ **symbol** will appear at the end of the row to alert you of the error. If "Regional" is selected as the data source and "Farm" is selected as the data type for a given supplier, but there is no data for that supplier in Data Table 3, a § **symbol** will appear at the end of the row to alert you of the error.

6. Follow the recommended action in column D1.7.

7. Columns D1.8 and D1.9 contain values for N intensity and P surplus intensity. For suppliers for which you have selected "Calculated" in D1.6, you will directly enter the N intensity and P surplus intensity values in D1.8 and D1.9, respectively. Doing so will overwrite the default formulas contained in these cells, so once data has been entered you may not then change D1.6 to "Farm." If you select "Farm" in D1.6, but a formula is missing from D1.8 or D1.9, a ◄ symbol will appear at the end of the row. If you see this symbol, clear the row and reenter the data in a new row.

Data Table 2: Primary fertilizer use data per supplier (if calculating from farm data)

D2.1	D2.2	D2.3	D2.4	D2.5	D2.6	D2.7	D2.8	D2.9	D2.10	D2.11	D2.12
Supplier	Farm	Crop	Mass of crop harvested (tonnes)	Mass of crop supplied by farm (tonnes)	Mass of fertilizer applied (kg)	Total elemental N applied (kg)	Total elemental P applied (kg)	Recommended P (kg)	P surplus	N intensity (kg N / tonne of crop harvested)	P surplus intensity (kg P / tonne of crop
Farm A	Farm A	Rice	50000	10000	8000	35000	2000	1000	1000	0.7	0.02

Data Table 2 Instructions

1. Identify the suppliers from Data Table 1 for which you have selected "Primary" and "Farm." Enter the name of each of those sup
D2.1.

2. For each supplier in D2.1, identify the farms the supplier sourced from and the type of crop supplied. Enter a name for each farm
D2.3. If a supplier obtained crop supply from more than one farm, enter one farm per row. This will require multiple rows for the sar

3. For each farm, enter the mass of crop harvested in column D2.4 and the mass of crop supplied in column D2.5. If the mass of c
of crop harvested, a ≠ **symbol** will appear at the end of the row to alert you of the error. In this instance, verify that the mass of c
the mass of crop the farm harvested.

4. For each crop type listed in D2.3, enter the total mass of fertilizer applied in column D2.6.

5. In columns D2.7 and D2.8, enter the total mass of elemental N and the total mass of elemental P applied to the crop. Include N
compost. Exclude N deposited from the atmosphere. Include N and P applied to a non-harvested cover crop grown between harv
amount of N and P contained in each fertilizer type applied, first identify the type of fertilizer applied (http://www.smart-fertilizer.com
obtain the fertilizer analysis, then refer to Example 2 here (http://plantscience.psu.edu/research/centers/turf/extension/factsheets
to calculate N and P applied from the fertilizer analysis. The values entered in columns D2.7 and D2.8 should be the sum of eleme
crop type grown by each farm the supplier sourced from.

6. In column D2.9, enter the amount of recommended P determined by soil test results conducted by test labs, extension agents,
entities. For more information, see the KPI Calculation and Scope below.

7. Columns D2.11 and D2.12 will contain values for N intensity and P surplus intensity that are calculated from the information you
example of Data Table 2, see Figure A4 in the Appendix tab.

on a per farm basis, and the spreadsheet automatically aggregates the information from each farm into a weighted average in the results. Users are alerted if they have entered information, or neglected to enter information, that would produce a calculation error. The primary benefit of using the tool is that it offers suppliers a consistent methodology for aggregating farm-level data and calculating responses to the Fertilizer Application KPI.

Due to the progress made in developing the Ag Metrics Translator (described above), we anticipate that fully building out the Farm Wizard Tool will not be necessary since the Ag Metrics Translator enables automatic calculation of responses to the Fertilizer Application, Greenhouse Gas Emissions Intensity, Irrigation Water Use Intensity, Soil Erosion, and Yield KPIs. Accordingly, additional spreadsheet-based calculation tools were not developed as initially planned, though the Fertilizer Application Respondent Tool will remain available to interested users.

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The Business Case for Systems Connectivity

To build on the outcomes of the Data Landscape Mapping in Agricultural Supply Chains project, and to further underscore why systems connectivity is critical for improving data flow through agricultural supply chains, TSC hosted a workshop in May 2018 titled "Why Brands and Retailers Need Farm-Level Sustainability Data – Use Cases for IT Solutions." The purpose of the workshop was to gather insights from TSC members, precision agriculture equipment manufacturers, farm management and supply chain software providers, producers, and brand manufacturers on the business case for mobilizing sustainability data between farms, brands, and retailers. During the workshop, brand manufacturers shared their needs for farm data, how they use it, and how it can help them achieve their sustainability commitments and goals. Farm management software companies explained why they are investing in sustainability solutions and why sustainability presents a strategic opportunity. Both growers and farm-level metrics tool providers discussed how data can help with farm management and decision-making and the importance of communicating a clear value proposition for agricultural producers. TSC summarized the workshop findings into three business cases that identify why connectivity across data systems in agricultural supply chains is important, how to make sustainability data and reporting work for producers, and the IT needs and solutions that are necessary to support increased connectivity across agricultural supply chains.

In collaboration with TSC members, data partners, and members of the Metrics Providers Project, TSC will use the three business cases presented here as a roadmap to continue to address IT needs related to sustainability reporting in agricultural supply chains; to further advance connectivity, interoperability, and data alignment across ag-focused digital platforms; and to explore creative solutions to the value proposition for engaging in sustainability, particularly at the farm-level.

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Business Case #1: Brand Perspectives on the Need for IT Solutions in Agricultural Supply Chains		
Why brands need farm data	**Brand-specific IT needs**	**General supply chain IT needs**
■ To identify and address supply chain risk ■ To increase supply chain efficiencies ■ To track sustainability commitments and address pressure from consumers ■ To respond to investors ■ To identify opportunities to innovate ■ To pre-empt regulation ■ To educate consumers on farm practices	■ Standardized sustainability reporting frameworks for the food industry ■ Simplified processes for collecting and reporting supplier data ■ IT systems that ensure data quality (accuracy, reliability, consistency), which is necessary for informing decisions	■ Harmonized data collection and sharing processes ■ Streamlined data entry to reduce the time involved in sustainability reporting ■ Focus on 3-5 priority metrics that represent value from farm to consumer, such as nitrogen and phosphorus use, water use efficiency, and GHGs ■ Secure data systems that provide confidence to parties all along the supply chain

Business Case #2: Why Companies are Investing in Farm-Level Sustainability Software, Tools, and Platforms		
The strategic opportunity of investing in IT for sustainability	**Farm-level IT needs for sustainability reporting**	**Solutions that software companies can offer**
■ Draw clientele by digitizing and streamlining farm-level data collection and recordkeeping ■ Help producers extract value from high-quality data ■ Leverage sustainability metrics in a way that maximizes return on investment ■ Help producers mitigate risk and maintain a competitive edge using the power of data ■ Help producers demonstrate environmental stewardship and tell their story to customers and consumers	■ Data standards ■ Streamlined data entry and automated processes that use existing data from farm software, tools, and platforms to respond to customer and retail KPIs ■ Ability to auto calculate sustainability metrics and generate baseline comparisons in farm software to allow producers to efficiently integrate sustainability into routine business processes ■ Alignment of sustainability content across software, tools, and platforms	■ App-based platforms to allow for in-field, real-time data collection and reporting ■ Secure credit and discounted insurance policies and inform crop pricing strategies using the data collected by farm-level software, tools, and platforms ■ Demonstrate regulatory compliance and progress against public environmental and social targets using farm-level data

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Business Case #3: What Agricultural Producers Need from Farm Data and Sustainability Reporting		
Making the data work for producers	**Farm-level IT needs for sustainability reporting**	**Solutions that software companies can offer**
■ Validate model predictions to demonstrate and incentivize improvements in farm management ■ Leverage sustainability metrics and data as a farm management tool to track performance, support decision-making, unlock opportunities for resource use efficiency, and improve profitability ■ Use farm data to communicate sustainability performance to customers and consumers; create meaningful case studies; and help improve access to resources, finance streams, and new buyers ■ Provide incentives for implementing sustainability and sharing data (e.g., premiums, cost-sharing, technical assistance, ecosystem services payments, rent credits, discounted loan/insurance rates, improved/increase access to markets)	■ Standardized reporting systems ■ Alignment and integration across digital platforms ■ Simplified data input processes with a focus on data that producers are already tracking ■ Reporting systems that consider the context of the crops produced (e.g., growing region, climate, weather) ■ Reporting systems that frame sustainability in terms that producers use (e.g., risk management, conservation, food safety) ■ Reporting platforms that quantify the value of implementing conservation practices ■ Innovative tools that gather information that growers do not already track, e.g., pollinator habitat ■ Equitable access to technology and data for farming operations of all sizes ■ IT representatives that visit farms to better understand the needs and modify their digital solutions accordingly ■ Data security: treat farm information as IP; ensure that producers own their data; ensure anonymity to protect producers from scrutiny; allow producers to opt-in/opt-out of data sharing	■ Online and offline capabilities ■ Integrate sensors and hardware with software platforms to streamline data flow ■ Integrate information from USDA and other relevant government agencies ■ Make data previously entered easy to reuse and adjust ■ Benchmarking functionality ■ Dashboard that shows producers the sustainability outcomes of their activities, including cost savings, ROI, and year-over-year change in performance from adopting new practices ■ Provide producer-specific recommendations based on their sustainability outcomes ■ Rate acreage by conservation value to help target sustainability decisions ■ Package data in ways that facilitate relationships with different entities that producers interact with (e.g., landowners, lenders, customers, regulatory agencies)

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Looking Ahead

Developing technical solutions is paramount to achieving the five goals of TSC's Agricultural Metrics Task Force outlined at the beginning of this report. The aim of the Data Landscape Mapping in Agricultural Supply Chains project was to improve data alignment and systems interoperability by mapping the current landscape of data systems, documenting the features and uses of those systems, determining how connectivity can be improved, and creating technical solutions to facilitate the flow of farm data to retail. TSC is committed to implementing the findings and solutions developed during this project to help reduce the data reporting burden for growers and commodity aggregators and to improve the ability of food companies to report farm sustainability metrics to retail. Ultimately, the data transmitted through agricultural supply chains must enable actions that advance the sustainability of global food systems.

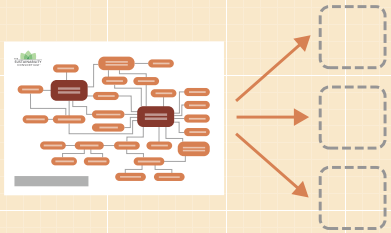
To that end, priority next steps for TSC and the Agricultural Metrics Task Force include:

1. **Implement the API:** Several farm management software companies have committed to implementing the API to ease the burden of compiling and aggregating farm-level data and to enable more consistent calculations when responding to TSC's KPIs. TSC will assist these companies in the API implementation process as

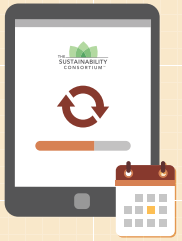
NEXT STEPS

Implement the API

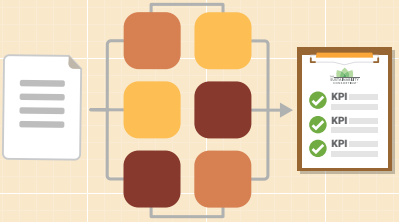
Continue to focus on systems connectivity



Explore additional uses for the systems landscape map



Produce annual content updates



Revisit farm metrics alignment and harmonization

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needed. Additionally, TSC will track implementation progress through annual KPI data reporting to demonstrate that the ability to report farm-level data to retail is, in fact, improving.

2. **Continue to focus on systems connectivity:** TSC's Ag Metrics Translator is one of many solutions that are needed to improve systems connectivity in agricultural supply chains. The three business cases presented above can be used as a roadmap to further advance connectivity, interoperability, and data alignment across ag-focused digital platforms. Together with members and data partners, TSC will continue to explore solutions that improve data flow, such as collaborating on data definitions documentation and encouraging the development of additional APIs between farm management software and farm-level sustainability metrics platforms.

3. **Explore additional uses for the systems landscape map:** Many project participants are using the systems landscape map to better understand existing connections between data platforms and to identify areas where connectivity could be improved or developed where it does not already exist. TSC will continue to support these efforts and will also explore whether a dynamic map that can pivot complementary information about each platform, such as intended users, crops covered, functionality, and sustainability services offered, would be useful to further facilitate systems connectivity and interoperability.

4. **Produce annual content updates:** TSC will continue to monitor changes to metrics developed by partner organizations, as well as new additions, in order to maintain and enhance alignment. TSC will ensure that any changes are reflected accordingly in the Ag Metrics Translator and will also update the systems landscape map on a periodic basis.

5. **Revisit farm metrics alignment and harmonization:** Over the course of this project, participants indicated that there is still room for additional metrics alignment and harmonization across the data points that growers are expected to track for sustainability reporting purposes. TSC will continue to collaborate with members of the Metrics Providers Project to address these issues, with the goal of simplifying the data collection and reporting process for growers while also ensuring that a consistent demand signal for sustainability information is being sent throughout agricultural supply chains.

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Appendices

Appendix A: Project Participants

TSC thanks the following companies and organizations for attending workshops and webinars related to this project, participating in case study interviews, serving on the technical committee, and providing valuable feedback.

* Case study participant
+ Technical committee

AgConnections +
AgGateway
Agrible, Inc. *
Agribusiness Market Ecosystem Alliance
Agrinos
Antares Group Inc.
Anthesis Group +
Arable Labs Inc. +
ASR Group
BASF
Bayer Crop Science *
Bunge North America
Campbell Soup Company *
Cavu
CDP
Committee on Sustainability Assessment
Cool Farm Alliance
Corteva Agriscience
Cotton Inc.
Crossland Consulting
Dartmouth College
DowDuPont
EcoVadis
Environmental Defense Fund
ExxonMobil
Farm Journal Media
Field to Market +
Fruit of the Loom
General Mills
GlobalG.A.P.
Granular, Inc. *
Hanes
Houston Engineering, Inc.
International Ingredient Corporation
International Trade Centre
IPM Institute of North America
JG Consulting Services LLC
K • Coe Isom
KFC
Kroger
Land o'Lakes
Mars, Incorporated *
Michigan Milk Producers Association
MillerCoors
MyFarms * +
National Pork Board
North Carolina State University
Ohsa
PepsiCo
Perdue Farms
Potato Sustainability Initiative +
PRè Sustainability +
Pure Strategies
SAI Platform
SES, Inc.
Smuckers
Simplot
Soil Health Institute
Stewardship Index for Specialty Crops
SureHarvest *
Sustainable Forestry Initiative
Syngenta * +
Taco Bell
The Agribusiness Group
The Context Network
The Nature Conservancy
Triple Bottom Line Commodities
Trucost
Unilever
United Soybean Board
University of California Statewide IPM Program
U.S. Farmers & Ranchers Alliance
VF Corporation
Vimpex
Workplace Options
World Wildlife Fund

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Appendix B: Summary of Webinars and Workshops

August 17, 2017: Launch webinar

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/August%2017%202017_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Launch%20Deck.pdf

- Notes available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/August%2017%202017_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Launch%20Notes.pdf

November 2, 2017: Update webinar

Topic: Review preliminary systems landscape map; discuss data compatibility pilot concept

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%202%202017_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Deck.pdf

- Notes available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%202%202017_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Notes.pdf

November 13, 2017: Workshop

Topic: Review project objectives; review preliminary systems landscape map; discuss data compatibility pilot concept

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%2013%202017_%20Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_%20Project%20Workshop%20Slides.pdf

- Notes available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%2013%202017_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Workshop%20Notes.pdf

February 6, 2018: Update webinar

Topic: Review updates to systems landscape map; discuss data compatibility pilot and data elements documentation

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/February%206%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Deck.pdf

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- Notes available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/February%206%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Notes.pdf

April 17, 2018: Update Webinar

Topic: Review progress on systems landscape map and case study interviews; discuss elements documentation; present concept for API development

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/April%2017%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Deck.pdf

May 1, 2018: Workshop

Topic: Discuss API development progress; identify business cases for IT solutions in agricultural supply chains

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/May%201%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Workshop%20Slides.pdf

- Notes available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/May%201%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Workshop%20Notes.pdf

July 31, 2018: Update Webinar

Topic: Review progress on systems landscape map and case study interviews; discuss API development progress; present findings from May 1 workshop

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/July%2031%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains%20Project%20Update%20Deck.pdf

November 1, 2018: Update Webinar

Topic: Present case study findings; discuss API development progress

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%201%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Project%20Update%20Deck.pdf

November 12, 2018: Update Webinar

Topic: Present final draft of systems landscape map; review case study findings; discuss API development progress and implementation

- Slide deck available at:

  http://tscmembers.org/amtf/dlmp/Working%20Documents/November%2012%202018_Data%20Landscape%20Mapping%20in%20Ag%20Supply%20Chains_Workshop%20Slides.pdf

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Appendix C: Case Study Interview Questions

Questions for Farm Management Software Companies
1. What is the purpose of your software? (e.g., nutrient management, pest management, yield monitoring, whole farm management, etc.)
2. Who uses your software?
3. Are there differences in your customer base in terms of farm size or farm income?
4. How much does it cost to use your software? (optional)
5. What features of your software do you market to growers?
6. Does your software provide feedback or benchmarking to growers? If so, **a.** Does this information influence growers to adjust their management practices to improve performance? **b.** Does your software suggest best management practices to help growers reduce their impacts?
7. Does your software include sustainability metrics? If so, which metrics?
8. How does your software platform gather information? **a.** Manual entry **b.** Plugins to precision ag technology **c.** Sensors **d.** Other
9. Do you have an API or plugin to transfer the data captured in your software to a farm-level sustainability tool? If so, **a.** Which tools do you connect with? **b.** What was the process for implementing the API/plugin? **c.** What security provisions do you have in place to protect grower identity? If no, what are the barriers to connecting these systems? (e.g., lack of demand, insufficient technology, proprietary concerns, etc.)
10. Do you have access to the data that growers enter into your software? If so, what do you use this data for?
11. In your experience, what value do growers derive from managing farm-level data?
12. In your experience, do growers understand the value proposition related to data-sharing for sustainability reporting purposes? Why or why not?
13. What kinds of solutions would ease the data reporting burden for growers, IT or otherwise?
14. Does your software enable reporting to a grower's customer such as a commodity company or brand? If so: **a.** Which companies/brands? **b.** What types of data can be reported (sustainability, etc.)? If not, why not (no demand, growers reluctant to share data, etc.)?

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Questions for Consumer Packaged Goods Companies	
1.	What software platforms do you use to capture and report sustainability data from your suppliers?
2.	Are any of these platforms proprietary?
3.	Do you use different data systems for your U.S. supply vs. global supply? If so, why?
4.	How do your software platforms gather information from suppliers? a. Manual entry b. Plugins to farm management software or metrics calculators c. Other
5.	If you receive data from commodity companies, do you know how they collect information from their growers?
6.	Do you have an API or plugin to transfer data from farm-level software or metrics calculators to your software platform? If so, a. Which tools or platforms are connected to your system? b. What was the process for implementing the API/plugin? c. What security provisions are in place to protect supplier identity? If no, what are the barriers to connecting these systems? (e.g., lack of demand, insufficient technology, proprietary concerns, etc.)
7.	Does your software provide feedback or benchmarking to your suppliers? If so, what type of feedback?
8.	Do you compare the sustainability performance of your suppliers using the information you collect? a. If yes, do you use sustainability performance information to guide purchasing decisions for your product supply? b. If no, what actions are you taking to ensure your suppliers that you aren't comparing them on the basis of sustainability?
9.	Who is currently bearing the cost of the time and resources you invest in capturing and reporting sustainability data? Are these costs spread throughout your supply chain?
10.	In your experience, do your suppliers understand the value proposition related to data-sharing for sustainability reporting purposes? Why or why not?
11.	What kinds of solutions would ease the data reporting burden for you and your suppliers, IT or otherwise? What is your ideal system?

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The Sustainability Consortium (TSC) is a global organization transforming the consumer goods industry to deliver more sustainable consumer products. We are dedicated to improving the sustainability of consumer products. Our members and partners include manufacturers, retailers, suppliers, service providers, NGOs, civil society organizations, governmental agencies and academics. TSC convenes our diverse stakeholders to work collaboratively to build science-based decision tools and solutions that address sustainability issues that are materially important throughout a product's supply chain and lifecycle. TSC also offers a portfolio of services to help drive effective implementation. The Sustainability Consortium has more than 100 members and there are over 2,000 users of TSC tools worldwide.

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