Agriculture Standards to Support Exports and Sustainability

A Framework for

Sustainable Agricultural Production

Through Performance Based Standards

Presenter

Randy Renze

- Principal, RJRenze, Product Services LLC
- Member, ASABE
- Docent, World Food Prize, Hall of Laureates

- Past Positions
  - Manager, Product Safety and Compliance, Crop Care Platform, John Deere
  - Chair, Technical Advisory Group, ASABE MS 23/6 Application Equipment to ISO TC 23/6, Agricultural machinery — Safety — Part 6: Sprayers and liquid fertilizer distributors
  - Chairman, ASABE, ASE-16, Engineering for Sustainability
  - Chairman, AEM, Tech & Safety, Crop Production Equipment Technical Council (CPETC)

Purpose

This presentation reviews;

- ANSI-ASABE S629: A Framework to Evaluate the Sustainability of Agricultural Production Systems,
- Field to Market's Supply Chain Sustainability Program, and,
- Insights into international standards development.

The integration of the framework standard and the supply chain sustainability program provides a pathway to meeting national and international market demands for sustainable products.

The Challenge … The Vision

… (B)ecause 84% of global food production occurs on small-holder farms (FAO), it is imperative that **new solutions be found** to **increase the productivity** of **small-scale agriculture**. Translating and adapting technical knowledge to local applications is a significant challenge and must consider local and regional resources, both physical and human, as well as cultural acceptability**.**

ASABE (2015) - Global Partnerships for Global Solutions: An Agricultural and Biological Engineering Global Initiative
http://www.asabe.org/media/195967/globalinitiative.pdf

Contributors

Marty Matlock - Executive Director, UA Resiliency Center and Office for Sustainability, University of Arkansas, USA

Scott Cedarquist - Director of Standards and Technical, American Society of Agricultural and Biological Engineering

Allison Thomson - Science & Research Director, Field to Market, the Alliance for Sustainable Agriculture

Ed Barnes - Senior Director, Agricultural & Environmental Research, Cotton Incorporated

Tom Redick - Global Environmental Ethics, Counsel

Randy Renze - RJRenze, Product Services, LLC

Import Requirements - USA

U.S. Food and Drug Administration

– Overview: Importation of Food and Cosmetics
  - https://www.fda.gov/Food/ResourcesForYou/Industry/ucm366356.htm

United States Department of Agriculture - Food Safety and Inspection Service

– Importing Meat, Poultry & Egg Products to the United States

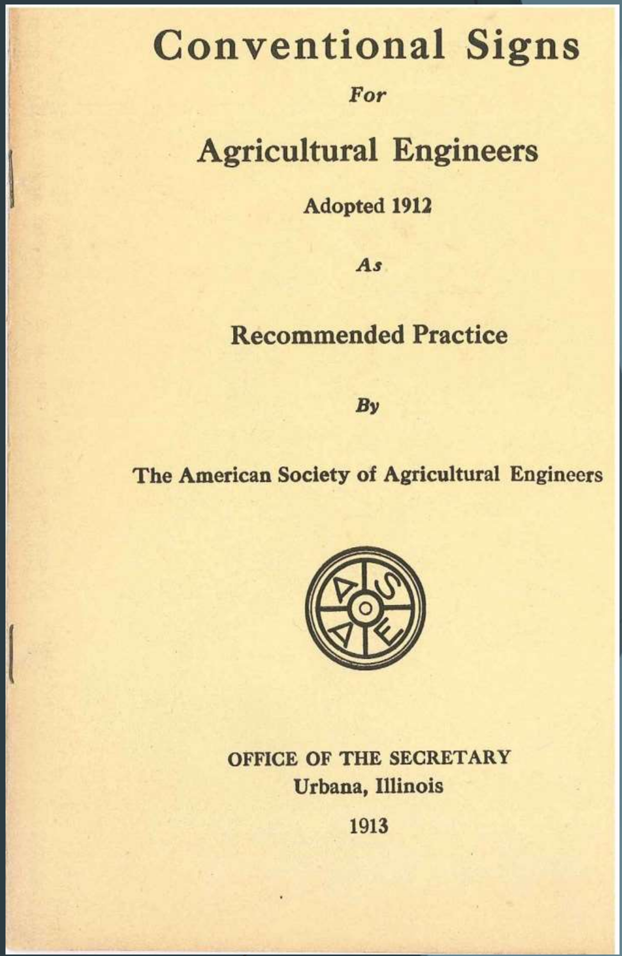
ASABE, ANSI, and ISO

How ag equipment companies participate in, lead, and contribute to standards development within and through the American Society of Agricultural & Biological Engineers

1st presented by Scott Cedarquist, Director, Standards & Technical, ASABE, 2014

Who is ASABE?

- Founded: 1907 as the American Society of Agricultural Engineers (ASAE)
- Standards - topic for 100 years
- ASAE became ASABE in 2005
- ASABE has ~8,000 Members in nearly 100 countries
  - Individuals; but we recognize that companies provided members (and sometimes pay)




Agricultural and
Biological Engineering
ASABE
Positively impacting food, water, energy and the environment.
www.asabe.org
FOUNDATIONS
Ergonomics, Safety, & Health
Education, Outreach, & Professional Development
Applied Sciences & Engineering
Information & Technology
TECHNICAL FOCUS
Facility Systems
Machinery Systems
Natural Resources & Environmental Systems
Animal Systems
Plant Systems
Processing Systems
AREAS OF IMPACT
ENERGY
SOIL
AIR
WATER
FOOD
FIBER
Benefiting
PEOPLE
of the world
American Society of Agricultural and Biological Engineers

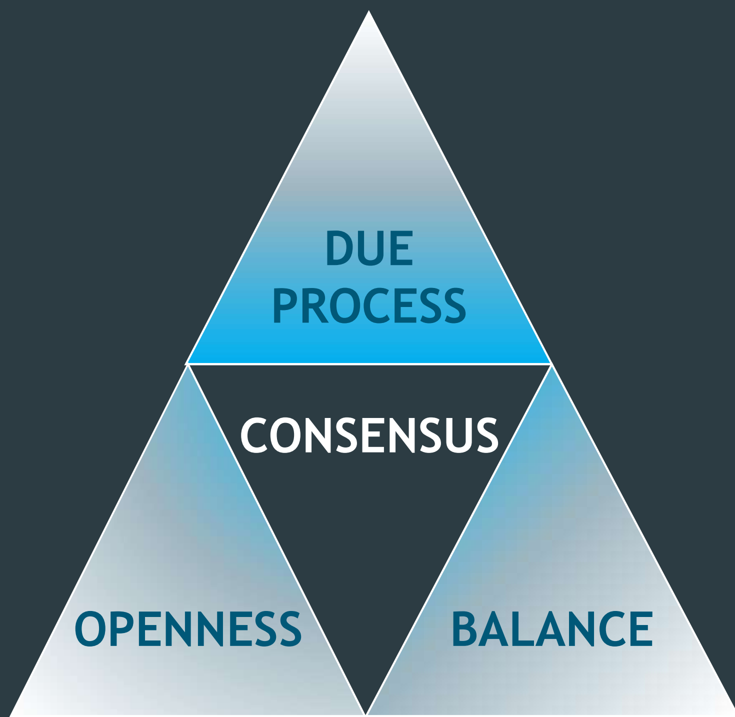
Reasons for Standards

- Provide interchangeability **between** similarly functional products and **systems**; improving compatibility, safety and performance for users;
- Improve personal safety: operating equipment & application of products & materials;
- Provide a common basis for testing, analyzing, describing, or informing regarding the performance and characteristics of products, methods, materials, or systems;
- Develop a sound scientific basis for codes, education, and legislation; promote uniformity of practice;
- Provide an technical origin for international standardization

The Role of ANSI

- ANSI, the American National Standards Institute, is the US national standards body.
  - ANSI is not the government
  - ANSI is recognized by the government and has broad interaction with numerous governmental agencies
  - ANSI membership includes many organizations such as ASABE, ASTM, ASME, IEEE and many more.

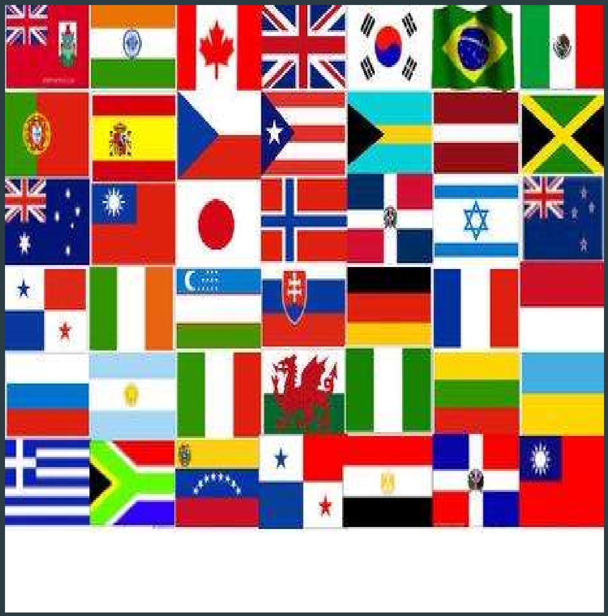
ANSI Essential Requirements



Requirements for American National Standards activities

ASABE follows for all standards

International Focus



International Standards Organizations

- Formal
  - ISO, IEC, ITU
  - OECD
  - UN/CEFACT
  - CODEX

- Self-proclaimed:
  - ASTM
  - IEEE

The Benefits of ISO

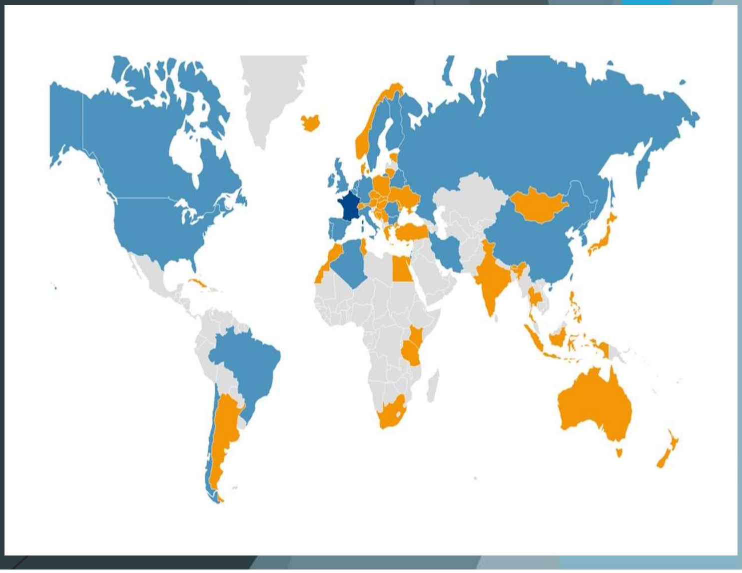
- "One Standard, One Test, One Certificate of Conformity Worldwide"
- Eliminates need to compare national, or regional, standards for different requirements
- Nearly 20,000 published standards – and expanding as needed to meet newly identified needs

Stages in ISO Standard Development

1	PROPOSAL	New Work Item NWIP
2	PREPARATORY	Working Draft WD*
3	COMMITTEE	Committee Draft CD*
4	ENQUIRY	Draft International Standard DIS
5	APPROVAL	Final Draft International Standard FDIS*
6	PUBLICATION	Publication-International Standard IS

Vote for your country!

- One vote per country
- Farming practices and regulations are different across the world
- International standards need your voice to represent your country



Work at International Level - ISO/TC 23

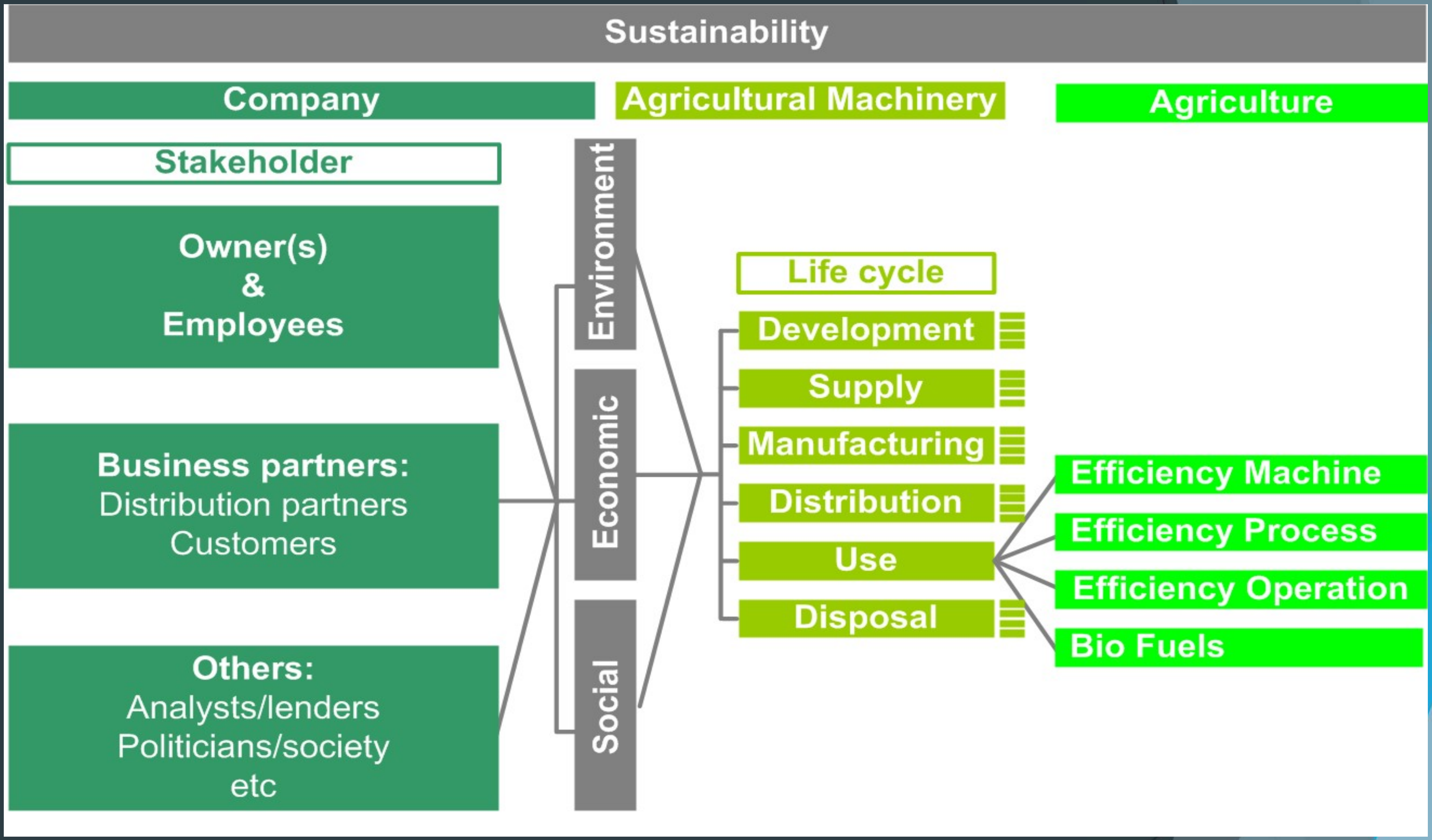
ASABE also administers the US TAG for these TC 23 subcommittees:

- SC2, Common tests
- SC3, Safety and comfort of the operator
- SC4, Tractors
- SC6, Equipment for crop protection
- SC7, Equipment for harvesting and conservation
- SC14, Operator controls, operator symbols and other displays, operator manuals
- SC18, Irrigation and drainage
- SC19, Agricultural electronics

ISO 17989
Tractors and machinery ... Sustainability

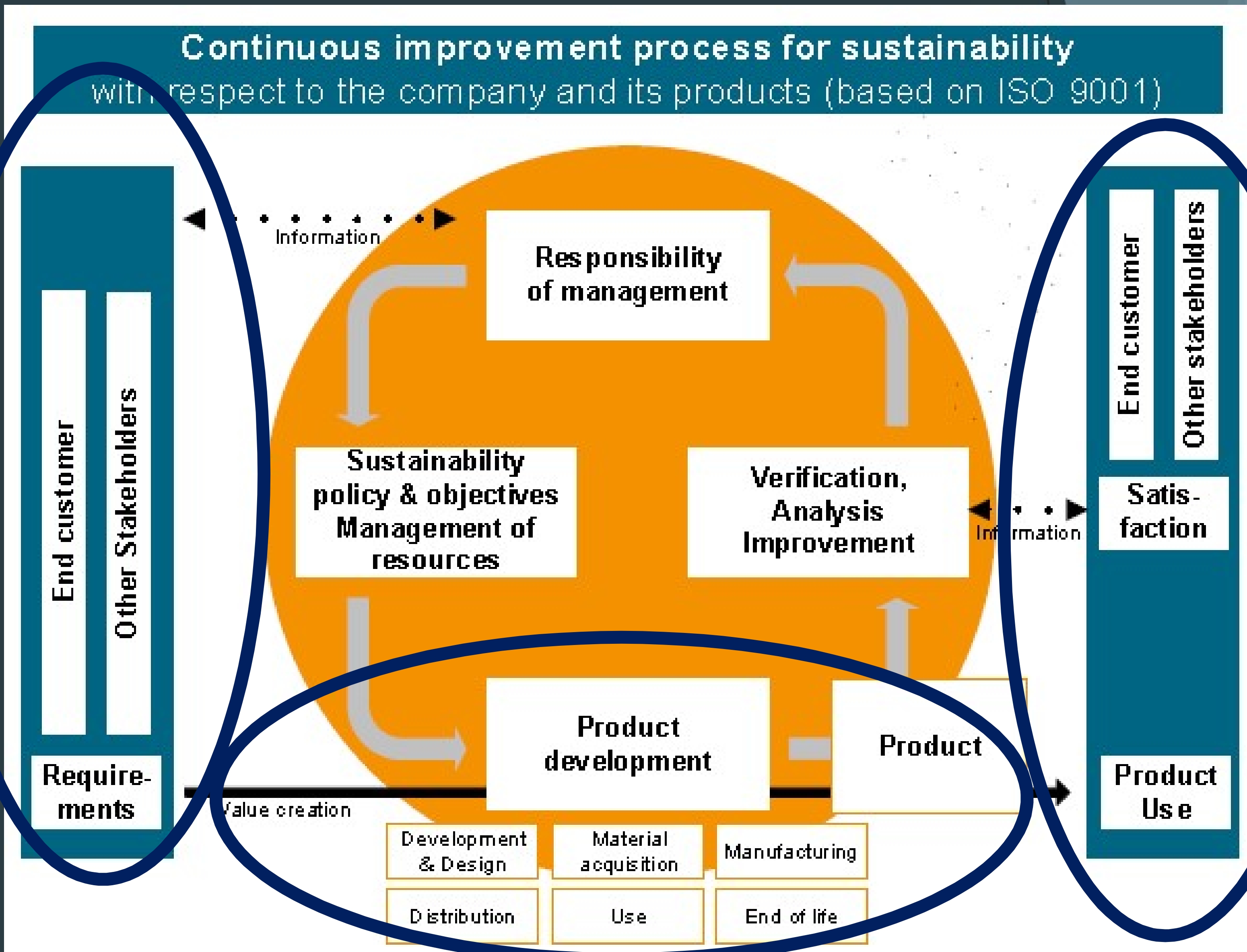
- **Objective**
  - To provide guidance for implementing the sustainability principle in the ag machinery sector
  - Develop a body of ISO standards that will have acceptable application throughout all regions of the world
  - To support the customers – agriculture / farmers – with respect to his sustainability requirements
- **With respect to the content**
  - To allow the consideration of ALL production and product related aspects of ‘sustainability‘
  - To provide the consistent approach for all TC 23 areas allowing to consider specific aspects of sectors & products

ISO 17989 Approach - Overview



- Part 1 of the standard focuses on company sustainability efforts and common aspects of product life cyle
- Future parts will focus on the specific application aspects of agricultural machines by producers in their farming practices

ISO 17989 - Continuous Improvement Focused



Questions & Discussion ?

ANSI-ASABE S629: Framework to Evaluate the Sustainability of Agricultural Production Systems

1st Presented by Marty Matlock, Executive Director, Office for Sustainability, University of Arkansas

Why did we need a Standard?

Because existing frameworks are not working

Toward Sustainability:

- Certification is driving social, environmental and economic improvements in specific commodity regions and targeted areas.
- <u>However, there is a clear lack of evidence of broader, longer-term improvements</u>.
- To date, very few certification programs have standards that measure reduced impacts.
- ***It was hard to attribute positive outcomes directly to certification***.

http://www.resolv.org/site-assessment/towardsustainability/

Why did we need a Standard?

Toward Sustainability:

- The indirect positive impacts of certifications may be far greater than the direct impacts.
- Put simply, as standalone instruments*, voluntary certification programs won't get us where we need to be* as they tend to reward the best producers rather than motivate the worst.

We needed a <u>systems approach to sustainability</u> that <u>integrates continuous improvement into a framework for sustainability</u>.

http://www.resolv.org/site-assessment/towardsustainability/

ANSI/ASABE S629:
A Continuous Improvement Framework

- The process provides a systematic way to analyze and improve results across all sectors
- Provides balance and is outcome based
- Useable within current initiatives
- Provides fact-based results

1. Define

A. Define Sustainability for the Enterprise
B. Identify Sustainability Performance Indicators
C. Select Metrics for PIs

2. Plan

A. Benchmark SPI Metrics
B. Set Goals for Each SPI
C. Develop Strategy to Meet Goals

3. Implement

A. Implement the Strategy
B. Measure, Assess and Report Results
C. Adapt Strategy to Improve Outcomes

Components

1. Key Performance Indicators (KPIs):

   Sustainability variables or conditions that are important to producers and their customers.

2. Metrics:

   Measurements of indicators.

3. Benchmarks:

   Metrics for a point in time, to be used for analysis of improvement.

Criteria for and Examples of Key Performance Indicators (KPIs)

- Outcomes Based
- Science Driven
- Technology Neutral
- Transparent

- *Greenhouse Gas Emissions*
- *Energy Use*
- *Water Use*
- *Land Use*
- *Water Quality*
- *Nutrient Use Efficiency*
- *Habitat/Biodiversity*

Indicators are Global

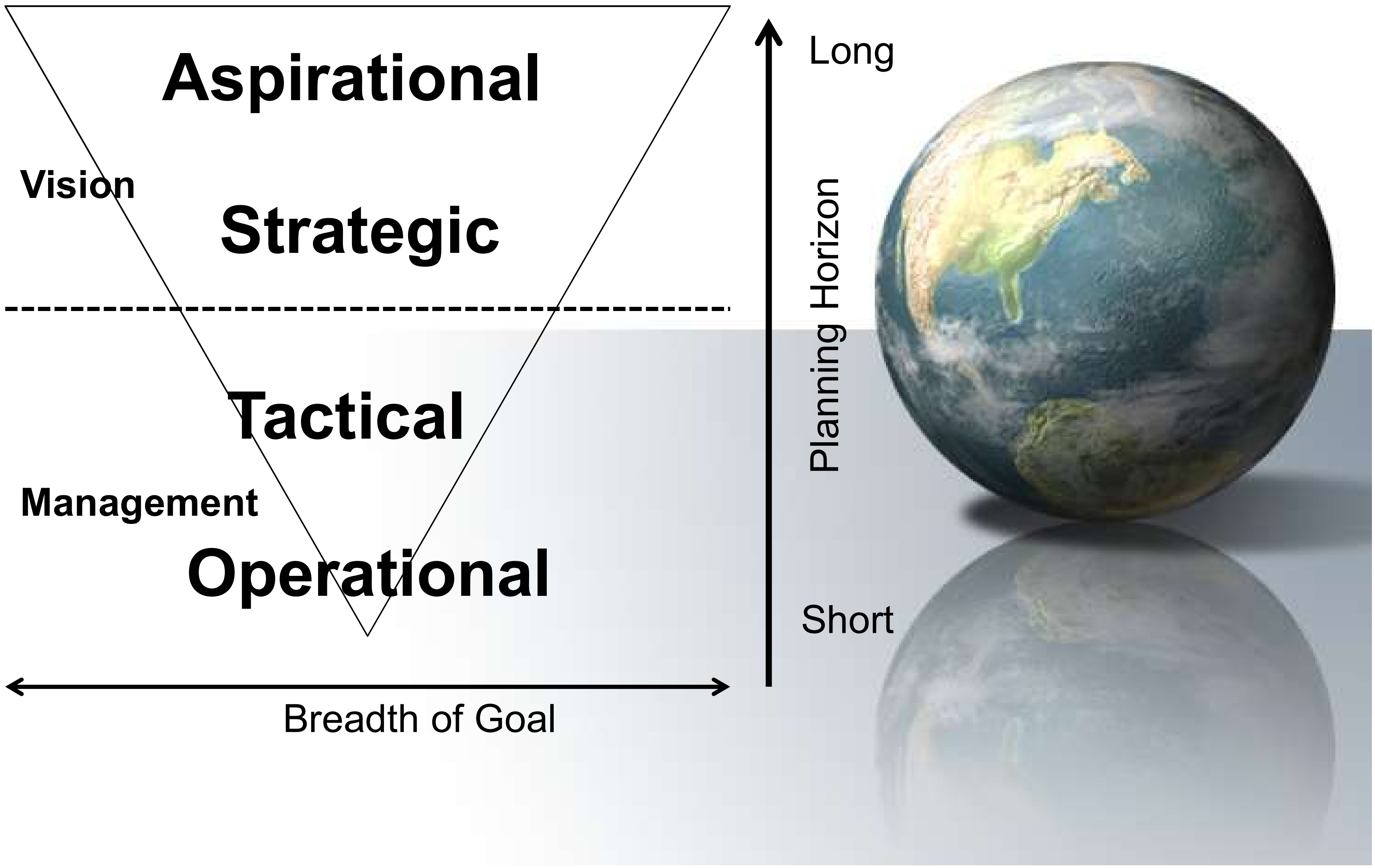
However - Metrics are context specific:

- Location
- Process
- Operation
- Scale
- Markets
- Events

Identification Process for Indicators–Multi-Stakeholder Focused

1. Engage stakeholders: interested and affected parties
   - Work with entire supply chain: producers, processors, integrators, packagers, distributors, retailers, customers, consumers
2. Select indicators that have established metrics
   - Develop experience with assessment and reporting
   - Create a process that works for everyone
3. When the first phase of indicators are established identify the second phase

Framework of Goals for Metrics



The Priorities for Any Commercial Enterprise

1. Economic Viability
2. Social License to Operate
3. Reputational Control over Brand
4. Safe, Secure, and Stable Supply Chain
5. Access to Markets

US Ag Sustainability Programs Adopting the Framework

USPOULTRY
U.S. POULTRY & EGG ASSOCIATION

NATIONAL CORN GROWERS ASSOCIATION

U.S. ROUNDTABLE FOR SUSTAINABLE BEEF

USSEC

USB UNITED SOYBEAN BOARD

NIAA National Institute for Animal Agriculture

American Peanut COUNCIL

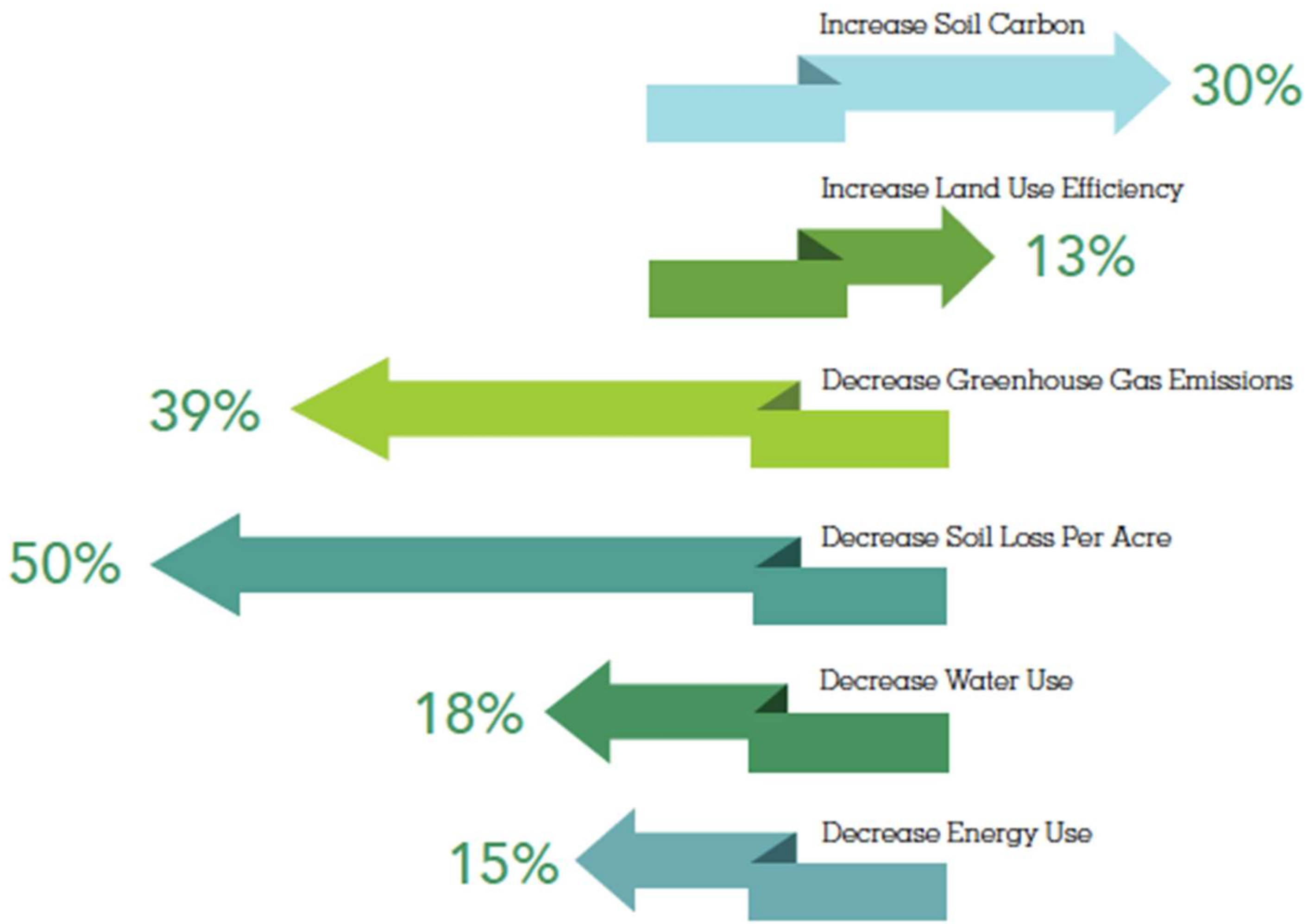
cotton Cotton Incorporated

pork checkoff.

dsf Dairy Sustainability Frame

Field to Market®
The Alliance for Sustainable Agriculture

EXAMPLE - U.S. COTTON - Ten Year Sustainability Goals



The goal setting process followed the Framework for Sustainable Agriculture standard S629

ANSI-ASABE S629

- ASABE, ASE-16, Engineering for Sustainability, is considering submission of S629 to ISO as a new work item proposal

- Questions / comments?

Field to Market Sustainability Metrics and Verified Claims Program

1st presented by Allison Thomson, Science & Research Director, 2017

Field to Market

Field to Market: The Alliance for Sustainable Agriculture focuses on defining, measuring and advancing the sustainability of food, fiber and fuel production

How we define Sustainable Agriculture

Meeting the needs of the present while improving the ability of future generations to meet their own needs by:

- Increasing productivity to meet future food and fiber demands
- Improving the environment
- Improving human health
- Improving the social and economic well-being of agricultural communities

Field to Market's Guiding Principles

- Engage the full supply chain
- Drive continuous improvement
- Focus on commodity crops
- Provide multi-stakeholder collaborative leadership
- Grounded in science
- Remain technology neutral
- Focused on outcomes
- Offer useful measurement tools & resources
- Coordinated and comprehensive approach

Supply Chain Sustainability Program

- Fieldprint® Platform is the cornerstone
- Empowers brands, retailers, suppliers and producers
- Measures the environmental impacts of production and identifies opportunities for continuous improvement
- Drives transformative change and deliver sustainable outcomes.

Ag Value Chain Participation and Projects

Field to Market® | Uniting the Supply Chain to Deliver Sustainable Outcomes for Agriculture

AGREN · AGRIAN Ag Data from Field to Fork · AGRIBLE · Agricultural Retailers Association · Agrium · AGSPRING Feeding a Changing World · American Crystal Sugar Company · American Peanut Council

American Society of Agronomy · Certified Crop Adviser · ASA American Soybean Association · ADM · Ardent Mills · Auburn University · BASF The Chemical Company · Bayer CropScience · bfa · Bio Biotechnology Industry Organization · Brown-Forman · Bunge

California Rice · Cargill · CF · CHS · C-AGG · Colorado State University · Columbia University School of Professional Studies Sustainability Management · CTIC · conservis · Context · coolplanet · Corn Refiners Association · Cotton · CropLife America

DFA Dairy Farmers of America · Dartmouth · Dow · DuPont Pioneer · Ducks Unlimited · Edge · EDF Environmental Defense Fund · Environmental Initiative · FMC · Farm Journal Media · FarmersEdge · FleishmanHillard · General Mills

GMO · Granular · GMA · HFI Healthy Food Ingredients · Hortau · Houston Engineering Inc. · Illinois Corn ilcorn.org · Illinois Soybean Association · Indiana Soybean Alliance · Ingredion · Innovation Center for U.S. Dairy · IntelliFarms

International Farming Corporation · IPNI International Plant Nutrition Institute · IAWA Iowa Agriculture Water Alliance · Iowa State University · John Deere · K-State Research and Extension · K·COE ISOM · Kellogg's · Keystone Policy Center · Land O'Lakes, Inc. · Leaf · LifeLine Foods · Marrone Bio Innovations

Mars · McDonald's · Michigan State University · AgriGrowth · MIT Joint Program on the Science and Policy of Global Change · Monsanto · Mosaic · MyFarms · Nachurs · NAFA National Alfalfa & Forage Alliance · National Association of Conservation Districts conserving natural resources for our future · NASDA

National Association of Wheat Growers · National Barley Growers Association · NCGA · National Cotton Council of America · NCFC · National Farmers Union · NMPF National Milk Producers Federation · National Sorghum Producers · Nestlé Purina · New Leader · NC State University · Penton Agriculture

PepsiCo · Pheasants Forever · Redox · Riceland · RiceTec · Simplot · Syngenta · Tate & Lyle · Texas A&M AgriLife Research | Extension · Texas Tech University · The Coca-Cola Company

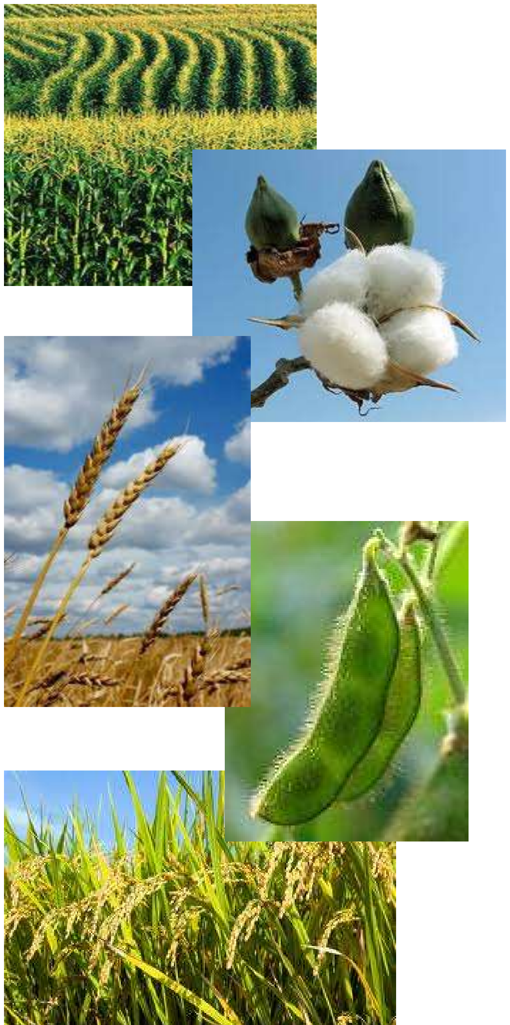
The Conservation Fund · The Fertilizer Institute · The Nature Conservancy · Thompson Coburn LLP · USA Rice Federation · U.S. Grains Council · USSEC U.S. Soybean Export Council · Unilever · United Soybean Board · USDA NRCS United States Department of Agriculture Natural Resources Conservation Service · University of Arkansas Division of Agriculture

The University of Georgia · Nebraska Extension · UT Extension · College of Agricultural & Life Sciences University of Wisconsin-Madison · Walmart Save money. Live better. · Western Sugar Cooperative (Grower Owned) · Weston Foods · WWF · Wrangler

Supply Chain Partnerships in 25 States

- Rice Stewardship Partnership
- Big Pine Watershed Partnership
- Midwest Agriculture Water Quality Partnership
- Precision Conservation Management

Field to Market®



Fieldprint Projects

- Identify a sourcing region and engage multi-stakeholder partners
- Engage farmers across geographies, crops, and supply chains
- Provide coordinated technical assistance for improvement of environmental outcomes
- Provide long-term support for multi-year engagement
- Enable supply chain sustainable sourcing claims with third party verification

    - Unilever/ADM Iowa Sustainable Soy Fieldprint Project
    - University of Arkansas Extension Cotton Fieldprint Project
    - CTIC Big Pine Creek Watershed Fieldprint Project

Field to Market®

Statistics

- **46 Fieldprint® Projects** are actively reported to Field to Market, including 14 first-year Projects
- **2,850,000 estimated enrolled acres** in Fieldprint® Projects and reported by Fieldprint Project Administrators and our Qualified Data Management Partners
- **2,400 growers** utilize the Fieldprint® Platform, either through the Fieldprint Calculator or associated farm management software

Metrics - Delivering Sustainable Outcomes

Defining and Benchmarking Environmental Outcomes at the Field Scale

Metrics Development and Revision Process

- Identifying sustainability outcomes and developing metrics is a process that begins with member priorities
  - Working groups engage members to consider a metric for development
    - Scientifics and technical advisors assist in planning and development
    - Invited experts contribute to development and provide peer review

Simple Algorithms

- Developed by Field to Market
- **Land Use** = 1/yield
  - Acres required per unit of crop output
- **Irrigation Water Use** = water applied / (irrigated yield –non-irrigated yield)
  - Amount of water applied per incremental increase in crop yield resulting from irrigation

Field to Market®

Complex Algorithms

- Developed by Field to Market
- **Energy Use** = energy used in all activities in one year for one crop, including:
  - Pre-planting activities, field operations, irrigation, nutrient and chemical applications, harvest, drying/storage, transportation to first point of sale
  - Included energy embedded in production of fertilizers, chemicals and seed
- **GHG Emissions** = all components of energy use metric, plus nitrous oxide emissions from soil and methane emissions from rice
  - Also includes CO2 emissions from lime (currently alfalfa only)

Simulation Models

- **Soil Conservation** = soil loss from water and wind erosive processes.
  - Calculated with the RUSLE2 and WEPS models
  - Models are hosted and run at an NRCS model development center at CSU
  - Exploring updating to new NRCS erosion models as they are deployed.

Field to Market®

Index-based models

- **Soil Carbon** = indicator of likelihood that the soil is gaining or losing carbon
  - Currently use the NRCS Soil Conditioning Index; exploring a move to COMET
- **Water Quality** = index of potential for loss of nutrients and chemicals from a field, based on soil properties and practices.
  - Currently use the NRCS Water Quality Index
- **Biodiversity** = Index of potential for a farm to support habitat for a diverse ecosystem
  - Index tool developed specifically for Field to Market

Agricultural Sustainability Metrics

- Field to Market Metrics are designed to measure a specific environmental outcome:
  - That is important for ensuring environmental sustainability
  - At a scale relevant to a farm operation
  - That is responsive to changes in farm management
  - Where robust scientific understanding supports high confidence in modeled results
  - Where available tools balance robustness and simplicity for broad usability by farmers and their advisors

Field to Market®

Supply Chain Sustainability Program: Delivering Sustainable Outcomes

Benchmarking Sustainability Performance

Catalyzing Continuous Improvement

Enabling Sustainability Claims

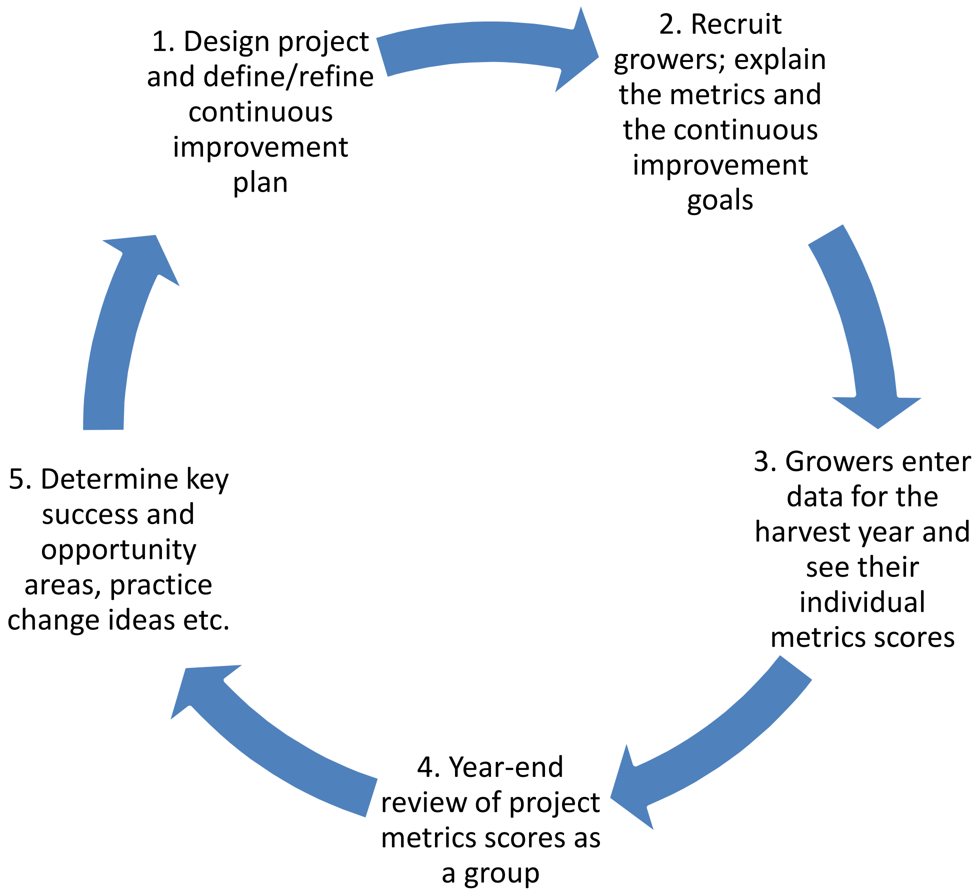
Continuous Improvement

Enabling Supply Chain Sustainability Claims

Continuous Improvement Planning

- **Measurement alone does not lead to continuous improvement**; a Continuous Improvement Plan is an essential element of a successful project
- Recognizes that all **growers are starting from different places**, allows any growers to get involved without mandating a performance level
- Defines the Continuous Improvement goals of the project and how growers will be engaged
- Requires <u>review of relevant natural resource concerns for the region</u> where the project operates
- Requires <u>review of existing grower support organizations and mechanisms</u> in the regions
- The plan has to be accepted by Field to Market as an essential element of an impact claim

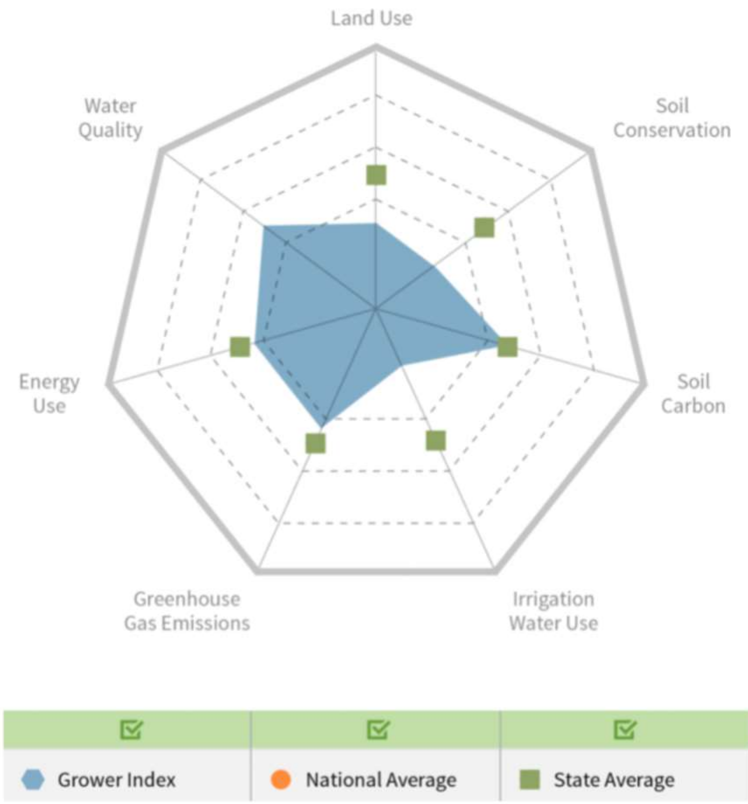
Continuous Improvement is built into Fieldprint® project design



Fieldprint® Platform – catalyzing continuous improvement

- Provides corn, cotton, potato, rice, soybean and wheat growers with a free and confidential tool to explore relationships between management practices and sustainability outcomes

- **Helps growers evaluate their farming decisions in the areas of:**
  - **Biodiversity (Piloting)**
  - **Energy use**
  - **Greenhouse gas emissions**
  - **Irrigated water use**
  - **Land use**
  - **Soil carbon**
  - **Soil conservation**
  - **Water quality**
- **Farmers can save their information and compare the environmental impact of different management decisions on their operation**

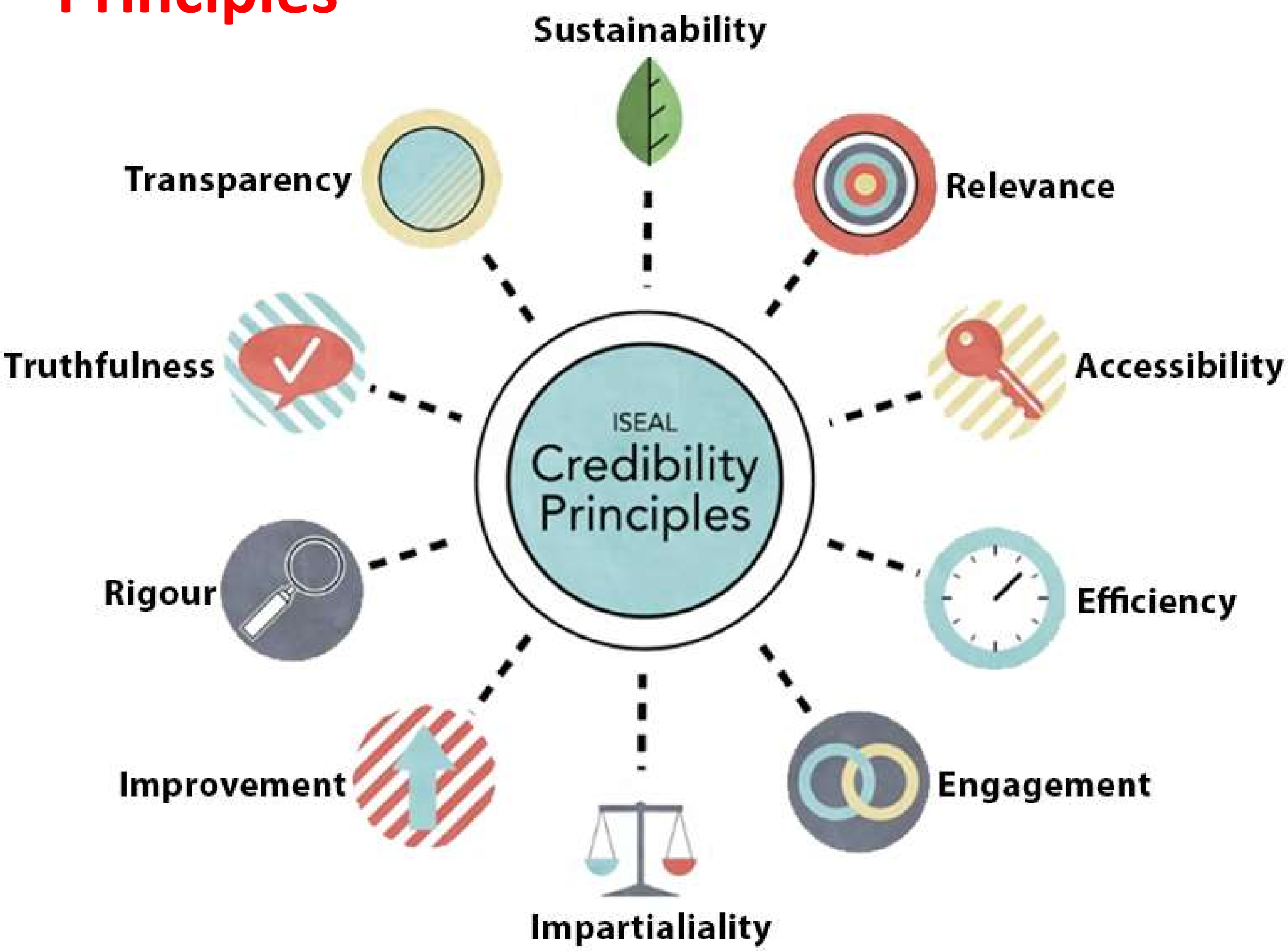


Field to Market®

Verification

Enabling Supply Chain Sustainability Claims

Claims are designed in accordance with ISEAL Credibility Principles



Participating in Steering Group on the ISEAL Assurance Code:

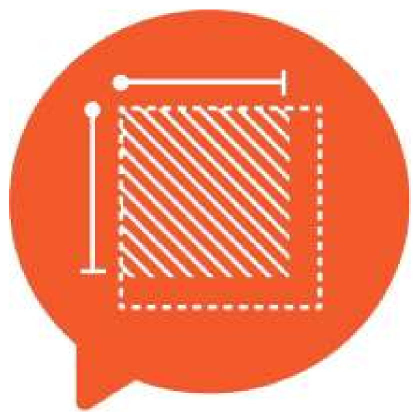
- Provides guidance for high quality assurance of sustainability and
- Improves the effectiveness of verification and certification models.

Enabling Supply Chain Sustainability Claims

- Collaboration and transparency within the supply chain is key to answering consumer questions on where and how their food, fiber and fuel are produced.
- Field to Market supports the food and agriculture supply chain in answering these questions by aggregating field-level data in a standardized and anonymized fashion to make three types of sustainability claims:

Participation Claims

Approved by Field to Market



Measurement Claims

Verified by Field to Market

Impact Claims

Verified by 3rd party

Participation and Measurement Claims: Using Fieldprint Data

- Each participating farmer must enter at least 10% of their acreage of the project crop in each year.
  - Scores can be extrapolated to the rest of their acreage of that crop.
- Companies decide how much of their supply they want to enroll in a project
  - Rules have been developed around accounting for volume of supply and avoiding double counting.
- Measurement Claims can refer to a production or area-weighted project average metric score, or a range of scores (index metrics)
  - All reporting must ensure data privacy for the growers

Impact Claims

- Scope of an Impact Claim
  - Quantifies actual sustained improvements or reductions against Field to Market's outcomes-based metrics
  - Demonstrates an improvement trend line and assesses performance against this trend line
  - Considers a Fieldprint® Project's efforts to catalyze continuous improvement by incorporating a Continuous Improvement Plan

Requirements for an impact claim

- All Field to Market required documentation submitted and approved, including a Continuous Improvement Plan submitted
- A minimum of five years of Fieldprint Project data
- A process assessment conducted by an accredited Third Party Verifier reviewing Data Input Quality, Data Output Quality (analysis), and Accounting Systems where applicable
- No on-farm assessment required

Field to Market Process

- Based on ASABE S629, Framework to Evaluate the Sustainability of Agricultural Production Systems

- Providing a framework approach to sustainability that integrates continuous improvement into a framework for sustainability

Field to Market®

Thank You

For More Information

Visit **www.fieldtomarket.org**

Resources

ANSI-ASABE S629: Framework to Evaluate the Sustainability of Agricultural Production Systems

– http://www.asabe.org/publications/order-publications/standards.aspx

Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States, Third Edition | December 2016

– http://fieldtomarket.org/national-indicators-report-2016/report-downloads/

Science in the Supply Chain: Collaboration Opportunities for Advancing Sustainable Agriculture in the United States

– https://dl.sciencesocieties.org/publications/ael/pdfs/2/1/170015

Engineering and Technology Innovation for Global Food Security - A report on the 2016 Global Initiative Conference at Stellenbosch, South Africa, hosted by the American Society of Agricultural and Biological Engineers (ASABE)

– http://www.asabe.org/media/256946/gfsc_paper_final_7.2017.pdf

U.S. Cotton 10-Year Goals (Pathways to Progress)

– http://cottontoday.cottoninc.com/wp-content/uploads/2018/02/Cotton_Sustainability_2018_low.pdf

(copy and paste links)

Meeting the challenges of a hungry world…

Dr. Norman Borlaug:
"Food is the moral right of all who are born into this world."

Thank you

Additional Metrics Slides

Land Use Metric

Designed as a measure of land use efficiency, the metric accounts for the planted area used to produce a unit of crop output

Metric is calculated as the inverse of crop yield

- Required inputs: Crop yield, or planted acreage and production

Outcome is units of planted land area per unit of production, for example acres required to produce a bushel of corn.

- Units vary based on the crop being considered to account for US standard yield and land area units

Benchmarks: State, National and Crop Reporting District level benchmarks are available, based on USDA National Agricultural Statistics Service (NASS) yields.

Initially developed in 2009; amended for double-cropping in 2016.

Energy Use Metric

Designed to measure the energy use efficiency of on-farm operations, this metric includes energy used in:

- Farm operations: Equipment usage in the field, drying and storage of harvest, transportation, irrigation
- Seed, Fertilizer and Crop Protectants: Energy used in the production of seed and products applied to the field
- Boundaries: The metric captures all energy use from pre-planting field preparation through to the first point of sale, and that represents >1% of energy use in production

Input data include producer reported activities as well as published data on energy used in production of seed, fertilizer and chemical products.

Metric outcome is reported in units of energy (BTUs; British Thermal Units) per unit of crop production

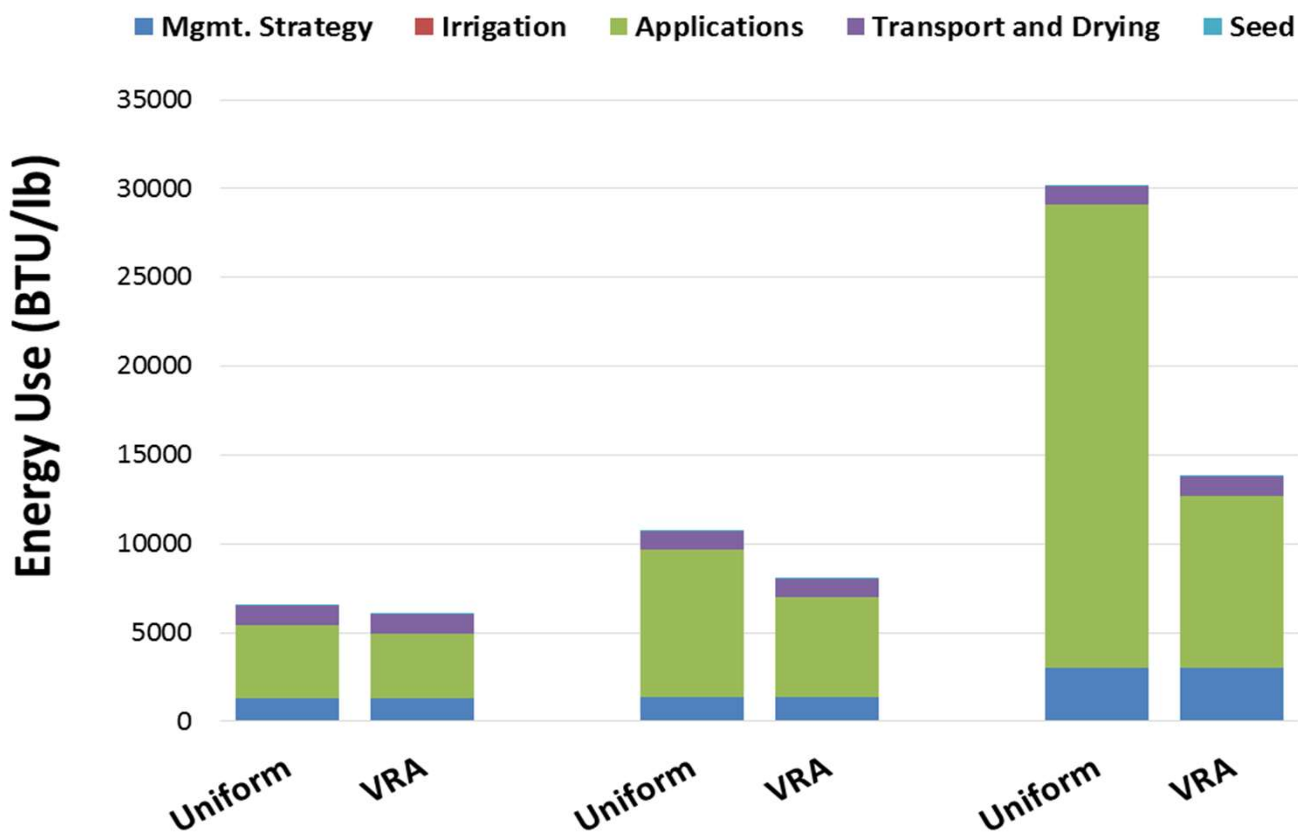
Benchmarks: National and State level benchmarks are based on USDA Agricultural Resource Management Survey data, USDA Price Paid Index, and USDA Agricultural Chemical Usage Reports

Initially developed in 2009; up for review and revision in 2017

Energy Use Metric – Example application

- Using the Fieldprint Calculator to illustrate the difference in energy use between uniform and precision nutrient application
- Energy savings varies by field

Energy used in cotton production



Field A Field B Field C

Source: Lori Duncan, University of Tennessee Extension

Greenhouse Gas Emissions Metric

Designed to provide a measure of GHG emissions from farm activities, this metric uses much of the same data and has the same boundaries as the Energy Use Metric.

Energy is transformed into emissions based on the type of energy used and published conversion factors

Additional sources of emissions that are not tied to energy use are also included: from fertilizer applications and flooded fields (rice)

- Does not currently include emissions from lime or residue burning, or carbon sequestration

Units of output are carbon dioxide equivalents (CO_2(e)) per unit of output (e.g. per bushel).

- CO_2(e) provides a common unit to represent the different radiative properties of the greenhouse gases emitted. Standard equivalents are based on IPCC methodology guidance.

Benchmarks are available at the National and State level based on USDA data and published emissions factors.

Initially developed in 2009, this metric is being reviewed and revised in 2017.

Non-energy related greenhouse gas emissions included in the metric

Nitrous oxide (N_2O) emissions from the use of nitrogen fertilizers:

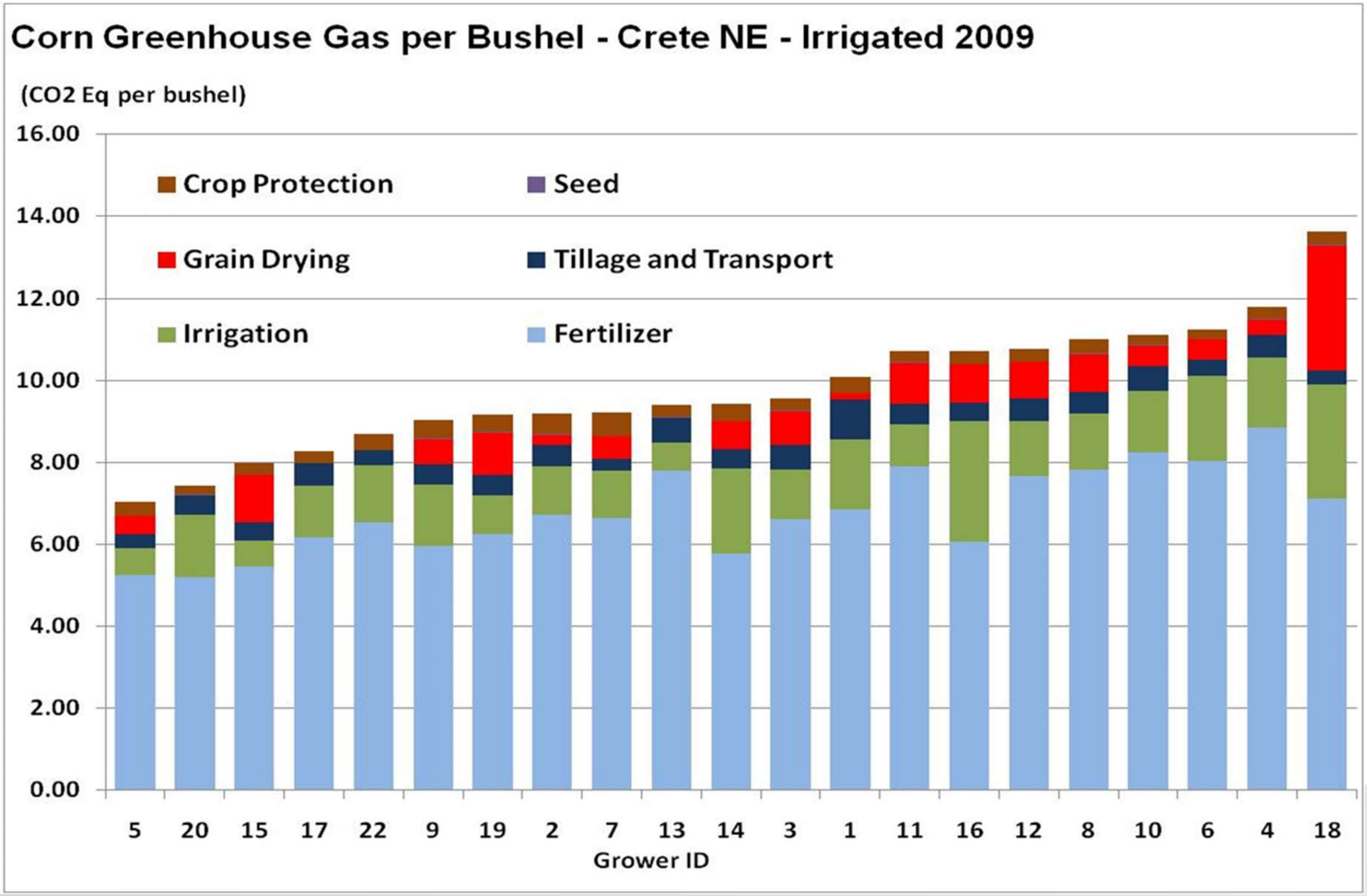
- N_2O emissions from agricultural soils occur as part of the natural biological activities of crop growth.
- The amount emitted is impacted by additions of nitrogen in fertilizer, manure, compost or residue.
- While the science of N_2O emissions is complex, important factors include the rate of application, type of fertilizer used, the time of year and number of times fertilizer is applied, and how it is applied.
- The current metric uses a standard factor for emissions based only on rate of N applied.
- This component of the metric is under revision

Methane (CH_4) emissions from flooded fields for rice production

- Methane is emitted from all natural and managed wetlands.
- For managed wetlands, such as rice, the emissions are influenced by water management
- The current metric uses a standard assumption of 70.7 pounds of carbon dioxide equivalent per hundred pounds of rice produced
- This component of the metric is under revision.

Example of GHG Metric

- Comparing across different farms in the same region and production systems helps to identify individual producer opportunities for improvement



Irrigation Water Use Metric

Designed to account for the efficiency of use irrigation water applied by measuring the effectiveness of irrigation in increasing yield.

Metric inputs include

- Volume of water applied in over the production period for that crop (including pre-planting)
- Irrigated crop yield
- Non-irrigated yield measure or estimate for the same field (e.g. a dry corner from a center pivot irrigated field)

The outcome is reported in units of volume of water applied (acre-in) per unit of increased production above a non-irrigated yield estimate

Benchmarks are available at the National and State level using NASS crop yield and USDA Farm and Ranch Irrigation Survey irrigation data

Initially developed in 2009, this metric is under review in 2017.

Water Quality Metric

This metric produces an index of water quality outcome that can be used to assess opportunities for improvement at the field scale

The current tool is the USDA NRCS Water Quality Index (WQI)

The metric inputs include soil and geographic conditions, tillage practices, conservation practices, fertilizer and crop protectant applications, crop type, residue management and cover crops

The metric output is a qualitative index of water quality that can be broken down into components. No benchmark is currently available.

The WQI was designed by NRCS as a conservation planning tool.

This metric was adopted in 2014. Field to Market has continued to assess the potential to develop a quantitative water quality outcome model and development will continue in 2017.

For more information on the WQI:

- Lal, H. and S. McKinney. 2012 WQIag- Water Quality Index for Runoff Water from Agricultural Fields. USDA-NRCS publication.
- http://wqiag.sc.egov.usda.gov/

Soil Conservation Metric

This metric was designed to measure sediment erosion from agricultural fields due to water and wind.

The metric is expressed as tons of soil loss per acre (*previously was expressed as tons of soil loss per unit of production).

The metric is calculated using the NRCS tools RUSLE2 (Revised Universal Soil Loss Equation) and WEPS (Wind Erosion Prediction System)

Metric inputs include user supplied crop type, residue management, conservation practices, cover crops and tillage practices.

Additional environmental inputs – soil properties and weather – are automatically pulled from USDA databases based on field location.

Benchmarks are available at the National and State level based on USDA Natural Resources Inventory erosion estimates by crop type.

Initially developed in 2010, revised in 2012 and will be reviewed again in 2017.

For more information

- RUSLE2: http://www.ars.usda.gov/Research/docs.htm?docid=6028
- WEPS:https://infosys.ars.usda.gov/WindErosion/nrcs/wepsnrcshtml

Soil Conservation Metric Example

For a Fieldprint Project in Iowa in 2013-2014

Soybean production under different tillage practices result in different soil erosion estimates.

Data can be aggregated across areas to illustrate trends

Soil Loss and Yield for Slopes 7% or Greater

	Average Soil Loss ton/ac/yr	Share of Fields (Percent)	Average Yield Bushels per acre
Conservation	13.4	3.4	49.9
Conventional	15.9	9.0	51.4
No-Till	8.0	87.0	48.5

Source: Stewart Ramsey, IHS Consulting

Soil Carbon Metric

This metric is currently represented by the NRCS Soil Conditioning Index (SCI)

Inputs are soil properties, field location, soil characteristics, tillage and other field management

The output is a qualitative score from +1 to -1 and is not crop-specific.

- A value between -.05 to +.05 is considered to represent zero or no change in soil carbon.
- As the value moves further away from zero, the magnitude can be interpreted as the level confidence in the trend of soil carbon increasing (+) or decreasing (-) in the soil
- The metric outcome does not indicate the rate of change or absolute amount of carbon

SCI accounts for three major factors influencing soil carbon:

- Organic matter and crop residue returned to the soil
- Soil erosion from water and wind
- Field equipment operations.

Initially incorporated into the Fieldprint Calculator in 2012, this metric underwent review in 2016 and under the proposed plan we are moving towards a quantitative soil carbon metric in 2017.

Biodiversity Metric

This metric was designed to evaluate a measureable conservation outcome of managing for biodiversity on a farm – the potential of the land to provide wildlife habitat – in a Habitat Potential Index (HPI).

This metric focuses on optimizing habitat on existing land covers.

HPI represents the whole farm, rather than a single field.

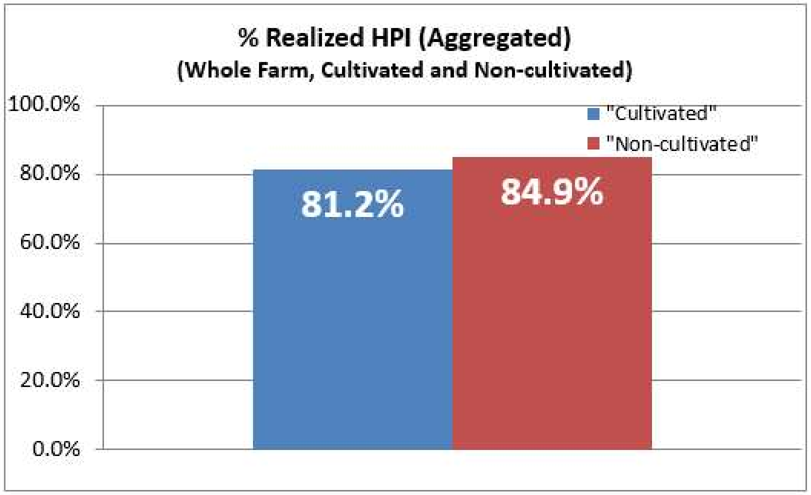
Inputs include basic information on all land on the farm: Land cover type, crops grown, management practices, conservation practices, uses of non-cropped land types, and conversion between land types in the past five years.

The results are presented as a score from 0-100 for each individual land type and for the farm as a whole.

Scores indicate the potential opportunity for improvement in management for habitat on existing lands.

This metric was developed in spreadsheet form in 2014 and is planned to be incorporated into the online Fieldprint Calculator in 2017.

Biodiversity Metric Example



HPI Scores for a 2000 acre farm in Louisiana that is actively managed to support wildlife

Indicates areas for opportunity to maximize habitat potential.