
A Producer-Led Framework to Assess Water Sustainability in Agriculture: The NISA Example

JED COLQUHOUN

*University of Wisconsin
Madison, Wisconsin*

colquhoun@wisc.edu

The trajectory of human population growth is often in stark contrast with decreasing natural resources needed to support that population. The national and global needs for food, feed, fiber and energy continue to increase relative to water availability and provide a prime example of increasing demands on limited resources. Similar resource constraints have been observed in industrial sustainability, hence the commonly used saying, “measurement equals management.” Unlike industrial efforts, agriculture has largely failed in “measurement” efforts, and, as such, it has proven difficult to capture and communicate changes in economic, environmental and social sustainability over time. The National Initiative for Sustainable Agriculture (NISA) provides a reasonable mechanism for agricultural producers to document advancements along the sustainability continuum and communicate improvements in resource use, such as water, throughout the supply chain.

CHALLENGES IN ASSESSING AGRICULTURAL SUSTAINABILITY

A Case Study: Wisconsin Central Sands Region Water and Agriculture

The central sands region of Wisconsin provides a prime example of an evolving agricultural production system in public conflict over a critical input resource: water. Wisconsin ranks second among US states for processing vegetable harvested acreage and production, and third in processing vegetable production value, the majority of which is grown in the central sands region. Common processing vegetable crops in the area include potatoes, sweet corn, green beans, green peas, carrots, cucumbers and onions. Overall, specialty crop value, including process, contributes about \$6.4 billion to the state’s economic activity and accounts for nearly 35,000 jobs (Keene and Mitchell, 2010). About half of

the processing vegetables and the vast majority of the potatoes included in calculating this value are enabled by irrigation.

The central sands region is dominated by coarse-textured soils low in organic matter and water-holding capacity. Agriculture in the region expanded greatly over the past 60 years from about 15,000 ha irrigated in the 1960s to about 74,000 ha in 2000. Groundwater serves as the irrigation source with the water table lying 3 to 20 m below the soil surface and ranging from 10- to 60-m deep. The region also contains about 80 small lakes, many wetlands, and streams of high recreational and economic value. Most surface-water bodies are supplied directly by the groundwater. Since 2000, low water levels have been observed in some streams and lakes in the region. Kraft *et al.* (2012) concluded that irrigation has decreased stream base flows and lake-water levels substantially in recent years.

Substantial historical data on depth to groundwater from monitoring wells and lake and stream levels are available for many locations across the central sands. Similar data relative to changes in agricultural production systems, water withdrawals and consumption, and cropping patterns is minimal and of questionable accuracy. For example, what is the role of diversifying crop rotations, selecting shorter-season crops and varieties, improving irrigation technology (such as low-pressure drop nozzles, nighttime irrigation scheduling, or drip) or adapting cropping systems to climate change on water use? This lack of data challenges the ability of policymakers, agricultural professionals and the public to make informed decisions on appropriate resource use and agricultural best-management practices that will protect the groundwater resource, but may be reasonably resolved by implementing a sustainability-assessment program that captures change over time.

Assessing Sustainability from Consumer and Producer Perspectives

Although sustainable agriculture certainly is not a new topic, the use of “sustainability” as a marketing concept is. Despite challenging economic times, the interest in sustainability continues to grow at a rapid pace. Yet, from producers to consumers, much confusion exists about the meaning and value of such efforts.

The vast majority of consumers are either unaware of sustainability efforts or are confused by them. While “green,” “eco-friendly,” “fair,” “sustainable” and other terms are very popular within marketing groups, consumers are not necessarily engaged at a similar level. An International Food Information Council (IFIC) consumer survey indicated that 50% of consumers knew nothing at all about the concept of sustainability in food production, while 23% knew a little (IFIC, 2010). Consumers who are aware of the concept are often confused by it, to the point where the Federal Trade Commission (FTC) proposed revisions in 2010 to their *Green Guides*—a document that provides guidance on appropriate use of the aforementioned terms in product marketing—for the first time in over a decade. According to FTC chairman Jon Leibowitz (FTC, 2010):

In recent years, businesses have increasingly used “green” marketing to capture consumers’ attention and move Americans toward a more environmentally friendly future. But what companies think green claims mean and what consumers really understand are sometimes two different things.

Thus far, sustainability in food production doesn't add value—it is an expectation. Much of the effort around sustainability in agriculture adds cost to production, such as additional labor costs that result from increased scouting to the actual process of documenting sustainability and enhancing biodiversity through non-crop habitat improvement. Unlike industrial processes, these efforts often have a poor, if any, return on investment. Consumers even expect “sustainable” products to be cheaper given that they ideally would require fewer inputs to produce. Authors of a 2009 Deloitte/Grocery Manufacturers Association (GMA) consumer survey on the subject concluded that (GMA/Deloitte, 2009):

...most shoppers would like green products to be price competitive. They often don't understand or buy into the rationale that a green product should be more expensive. Shoppers don't understand why a green product should cost more if it was manufactured with less packaging or it was transported less distance.

This survey and others suggest that there is a strong difference between what consumers say they will purchase and what is actually in their grocery carts in the checkout lane. In the 2009 Deloitte/GMA survey, 95% of shoppers indicated that they would buy green, but only 22% actually did so. Furthermore, only 2% were committed to buying green.

Similar consumer responses were observed in marketing challenges with the Healthy Grown Potato Program in Wisconsin. The program is the result of a unique collaboration of organizations, including growers through the Wisconsin Potato and Vegetable Growers Association, University of Wisconsin, Michael Fields Agricultural Institute, World Wildlife Fund, International Crane Foundation, and Defenders of Wildlife, among others. Research that provided the basis for the standards began in the early 1980s. The developed standards are rigorous and involve all aspects of potato production from seed through crop harvest and storage. They restrict pesticide use, require the adoption of integrated pest management (IPM), and require ecosystem services beyond the agricultural fields that are designed to preserve biodiversity in the landscape. By 2005, IPM adoption among program participants increased 30 to 40% compared to the first certified crop in 2001 and pesticide risk was reduced 50%. In fact, the standards are so rigorous that not all fields enrolled in the Healthy Grown Potato Program pass; in 2006, only 35% of the fields enrolled passed the minimum bar for certification. The Healthy Grown certification process is conducted by a third-party organization hired by the growers. The investment in research and rigor of the standard have not gone unnoticed. In 2003, the collaborative team received the USDA Secretary Honor Award for Maintaining and Enhancing the Nation's Natural Resources, and has since been the recipient of several other accolades.

While it may “feel right” to grow potatoes this way, it certainly isn’t cheap. Alternative pest management and production practices are often more expensive, the certification process requires employee time and a hired third-party organization, and growers are required to invest annually in the ecosystems services component of the standard.

An award-winning collaboration among academics, environmental advocates and growers, a rigorous science-based standard that has been documented to improve IPM adoption, reduce pesticide risk, and preserve ecosystem services—so, what’s the problem? First, consumers aren’t convinced about paying for environmental conservation, particu-

larly in this troubled economy. Second, the potato growers have invested in a significant amount of market research and implementation into the project. After hearing about the Healthy Grown story, 70% of consumers indicated that they were more likely to purchase Healthy Grown potatoes. Moreover, of those who were interested in purchasing the product, 88% indicated that they would be willing to pay 25 cents more per bag. In 2004 and 2005, however, just over 1% of product sold was actually sold as Healthy Grown, and certainly not at a value-added price.

Sustainability is measurable in industrial processes, but isn't easily quantified in agricultural production. Many of the inputs in industrial processes (including food processing) that pertain to sustainability, such as water, energy and fuel use, can be measured as easily as reading the utility bill. The impetus is often "measurement leads to management," and efficiencies or alternative sources are employed that have a rapid return on investment. Regardless of the input, such strategies save money. Cyber communication and monitoring technologies have made this process quite feasible and affordable. In fact, inputs are often monitored by the minute, with a red flag raised when they exceed goals. This technology also allows direct communication with, and participation by, consumers. In food processing, for example, the Kettle Brand® website (www.kettlebrand.com) includes a link to an online public monitoring system that reports electric generation from wind turbines on the roof of their Beloit potato-chip plant *by the minute*. This alternative energy generation is then equated in terms that consumers understand, such as gallons of fuel saved.

The description of these successes in industrial and food processing is not meant at all to belittle sustainability efforts, but rather to highlight them. The use of technology to improve efficiencies is good for the manufacturer, for the consumer, and for the planet. Unfortunately, such success stories are not typically reported when it comes to agricultural production. The sustainability parameters of interest, such as biodiversity, soil health and water quality, cannot be measured with a simple meter; they require expensive and cumbersome monitoring. Additionally, agricultural production systems are affected by climate, biological processes, and complex interactions across the landscape creating extreme variability by crop, production region and season. Thus, the one-size-fits-all approach commonly used in highly engineered processing and manufacturing plants is inappropriate. Agricultural sustainability efforts often focus on a practice-based approach given the challenges in measuring outcomes. In other words, while practice-based sustainability programs may not measure soil sediment in water, they instead ask producers about tillage practices. The National Organic Program is an example of such an approach.

At some point, a buyer or consumer value system guides choices around sustainability. Agriculture is a complex biological system, confounded by broad seasonal variation and overlaid with management systems that vary by farm. Actions taken to improve an individual sustainability metric often affect several other parameters, and not always in a positive manner. For example, reducing herbicide use in favor of increased cultivation may reduce overall pesticide use, but may also increase risk of soil erosion.

Greenhouse-gas emissions in agriculture provide a striking example of the potential role of consumer values in sustainability metrics. Weber and Matthews (2008) compared the greenhouse-gas emissions associated with food production with those of food

distribution. They reported that 83% of the household carbon footprint associated with food is in production and only 11% in what is considered “food miles.” Four percent of the greenhouse-gas emissions were associated with transport from producer to retailer. Furthermore, the authors report that red-meat production is about 150% more greenhouse-gas-intensive than for chicken or fish. The authors conclude that:

...dietary shift can be a more effective means of lowering an average household's food-related climate footprint than "buying local." Shifting less than one day per week's worth of calories from red meat and dairy products to chicken, fish, eggs, or a vegetable-based diet achieves more GHG reduction than buying all locally sourced food.

Currently, there exists a wide gap between high-altitude metrics programs designed to capture change on a national scale and local, practice-based sustainability efforts. Several national efforts, currently underway, are developing programs that will capture broad change, such as at the watershed level, in typical sustainability parameters such as land and water use, energy and carbon footprint. These programs have made great headway in recent years and will be critical in the efforts to communicate advancements in agriculture to regulators, environmental advocates and the general consumer. They do not, however, instigate local engagement and change at the field level, as the intention has never been to advise someone on how to farm or develop “best management practices.” Local change requires local grower engagement, regionally- and crop-appropriate best management practices and prioritization of efforts around values that are locally important. For example, the majority of the economic impact from potato and vegetable production in Wisconsin is enabled by irrigation, thus water is held as having high value by the agricultural community. In contrast, labor constraints are of relatively less concern given the mechanized nature of production in this area. The downside to local, practice-based sustainability programs is that the impact of such efforts is often not captured or communicated beyond agriculture. Additionally, the multitude of local sustainability efforts in various crops, by several entities (public and private) and without a consistent framework or process has led to challenges in duplicative programs and messaging (*i.e.* one production region is unintentionally put forward as “more sustainable” than other regions for the same crop, further confusing all involved).

NISA AS A PRODUCER-LED FRAMEWORK TO ASSESS SUSTAINABILITY BEHIND THE FARM GATE

NISA is a producer-led federation that will harmonize sustainability efforts within a common framework, regardless of cropping system, region or farm scale, and address the challenges outlined above. The goal is not to judge the “sustainability” of agriculture, but to provide growers with an opportunity to account for their advancements over time and communicate them broadly. Participants are developing a roadmap of farm-management systems that will help producers to achieve verifiable sustainability outcomes, improve the environmental services and productivity of their farms, help their rural communities thrive, and satisfy sustainability expectations of the value chain.

These efforts will operate at the farm level; incorporate a framework of tools and technical information from a wide base of expertise and programs; and, with the support of regional and national experts, communicate sustainability-management systems that are valid across crops and regions.

As indicated earlier, several agricultural sustainability programs have emerged in recent years, ironically in part to reduce the likelihood that producers will have to fill out multiple assessments for a single raw agricultural product. The NISA approach is unique in several ways.

NISA is producer-driven and adaptable to changing times. This bottom-up approach allows producers to be at the table in designing sustainability assessments that are regionally- and crop-appropriate, scaled to improve sustainability at the field level, founded on the best available science and balanced among the social, environmental and economic sustainability pillars. Such an approach also accounts for the diversity of agriculture, is neutral to production techniques, and won't competitively pit production regions or crops against each other. The alternative—those outside agriculture determining producers' fate—isn't appropriate or sustainable itself.

NISA is complementary to other sustainability programs, such as Field to Market and the Stewardship Index for Specialty Crops, and not redundant or overly cumbersome. The assessment-based approach implemented by NISA will cover the gaps that currently exist in outcome-based programs. Several of these gaps exist because outcomes are difficult, expensive or invasive to quantify. The combination of assessment- and outcome-based data will create a holistic sustainability message. Sustainability assessments cannot be overly cumbersome, otherwise increased costs will be realized by the producer and the supply chain, thus limiting implementation.

NISA efforts will streamline sustainability efforts with customer expectations. This approach will reduce redundant requests for sustainability metrics and provide a balanced way forward that includes producers in the developmental stage, thus ensuring that the process is not overly cumbersome. The request for such information continues to grow despite down economies, suggesting a resilient and long-term commitment by customers to developing such programs. In reality, this is consistent with the continually evolving agricultural systems across the United States, owned and operated by producers who are committed to the economic, environmental, and social well-being of their land and communities.

NISA will result in a communications conduit to customers and the general public that has been significantly missing for agricultural producers. Industrial sustainability efforts have successfully focused on communicating improvements over time. Agriculture has yet to develop such a plan or communicate the gains already achieved by producers in typical sustainability parameters. The assessment-based approach, combined with appropriate outcome-based programs and a solid communications effort, will deliver a message of long-term commitment to sustainability by agricultural communities.

NISA will address the entire farm, and not require multiple assessments for the diversity of crops produced within the farm gate. This approach will improve the efficiency of assessments, account for the complex interactions among crop rotations and livestock

enterprises, and emphasize the environmental and social value of land on the farm not in production.

The NISA business model is simple:

- Educate.
 - NISA will support the development of new crop- and region-specific sustainability programs through sharing of education, research and design. New and existing sustainability-assessment tools may be incorporated into a whole-farm program as appropriate to eliminate redundant questions and meet customer needs.
- Validate.
 - Independent, expert advisory panels will inform and validate the assessment survey process on a crop- and region-specific basis. This effort will not only ensure the research basis for sustainability practices, but also gauge the process against customer expectations.
- Harmonize.
 - The results of crop- and region-specific sustainability-assessment programs will be communicated to the supply chain and others within a common framework of expected outcomes, thus allowing agriculture to account for advancements in social, environmental and economic sustainability parameters through time.

While the formal NISA efforts are rather new, the initiative has attracted significant attention and engagement from numerous food-, feed- and fiber-producer organizations and others in the supply chain. Leaders are currently implementing a lean and nimble organizational structure that will achieve the business model and allow agricultural producers to reasonably assess sustainability and resource use, such as water, and report on advancements through time to customers and consumers.

POTENTIAL IMPROVEMENTS FROM A BIOTECHNOLOGY AND SUSTAINABILITY STANDPOINT

The ultimate goal of sustainability endeavors is to *consistently* improve output per unit of input in response to global population growth. For example, fuel use in potato production and processing may be expressed as liters of diesel per bag of potato chips. Several of the input-per-unit-of-output measurements commonly used in agricultural sustainability could be addressed in part by advancements in crop biotechnology (Table).

CONCLUSION

In a broader and often less-popular sense, great strides could be made in sustainable natural-resource use from agricultural and societal standpoints with a few relatively simple choices. From an agricultural standpoint, if the goal is to reduce water use and crop yield is improved through biotechnology and innovative practices, then land should be taken out of production. Using the same amount of a resource such as water to produce more will

TABLE. EXAMPLES OF AGRICULTURAL SUSTAINABILITY GOALS AND RELATED OUTPUT PER UNIT OF INPUT PARAMETERS.

Agricultural sustainability goal	Output per unit of input parameter
Drought tolerance	Crop yield/liter of water
Nutrient-use efficiency	Crop yield/kilogram of fertilizer
Pest tolerance or resistance	Crop yield/kilogram of pesticide
Increased plant density	Crop yield/liter of fuel
Crop recovery, waste reduction	Crop yield/hectare
Nutritious crops	Human nutrition/calorie

address some of the needs of a growing population, but will not address the limitations of that resource. From a societal standpoint, we can address a good portion of agricultural water use by simply not throwing our food away. As Jonathan Bloom points out in *American Wasteland* (2010), those well beyond the farm gate can play a significant role in conserving water resources as it relates to food production. Agriculture is the greatest user of water in the United States. Some experts estimate that up to 40% of the food produced is never consumed, and much of this waste ends up in the home garbage.

The first steps, however, are to adequately document and assess advancements in agricultural sustainability over time in a way that accounts for differences among regions and commodities. This needs to be done in a manner reasonable for the producer, consistent with expectations of others in the supply chain and through a process that is itself not burdensome. The National Initiative for Sustainable Agriculture provides an opportunity to meet these goals.

REFERENCES

- Bloom J (2010) *American Wasteland: How America Throws Away Nearly Half of Its Food (And What We Can Do About It)*. Cambridge, MA: Da Capo Press.
- Federal Trade Commission (2010) News Release. <http://www.ftc.gov/opa/2010/10/greenguide.shtm>.
- Grocery Manufacturers Association/Deloitte (2009) Finding the Green in Today's Shoppers: Sustainability Trends and New Shopper Insights. <http://www.gmaonline.org/news-events/newsroom/more-than-half-of-shoppers-consider-product-sustainability-attributes-in-pu/>.
- International Food Information Council (2010) Consumer Perceptions About Food Technology. http://www.foodinsight.org/Resources/Detail.aspx?topic=2010_Consumer_Perceptions_of_Food_Technology_Survey.
- Keene A Mitchell P (2010) Economic Impact of Specialty Crop Production and Processing in Wisconsin. Madison: Department of Agricultural and Applied Economics.
- Kraft GK et al. (2012) Irrigation effects in the northern lake states: Wisconsin central sands revisited. *Ground Water* 50 308–318.
- Weber C Matthews H (2008) Food miles and the relative climate impact of food choices in the United States. *Environmental Science and Technology* 42 3508–3513.



As director of Agricultural Systems Programming for the College of Agricultural & Life Sciences at the University of Wisconsin-Madison, **JED COLQUHOUN** provides leadership for the Wisconsin Institute for Sustainable Agriculture, the Environmental Resources Center and the Integrated Pest Management Program. His work on sustainability focuses on the intersection of food-production systems and environmental challenges, such as water quantity. Dr. Colquhoun also provides leadership for the National Initiative for Sustainable Agriculture, a producer-led, research-based framework for assessing agricultural sustainability at the farm level and communicating advancements in agriculture. He also has a faculty appointment in the Department of Horticulture and holds the Gottschalk Endowed Chair. Colquhoun received his BS and MS degrees from Cornell University and his PhD from the University of Wisconsin-Madison. Prior to returning to Madison, he was a faculty member at Oregon State University.