Tyson Foods, Inc., Sustainable Water-Use Assessment: A Study Conducted by the Center for Agriculture and Rural Sustainability at the University of Arkansas

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People, *Planet*, *Profit*, and *Products* are the four "pillars" of sustainability at Tyson Foods, Inc. (Tyson). Sustainability touches every aspect of Tyson's operations. Accordingly, the company defines sustainability in a way that brings responsibility and accountability into every business activity and process. Tyson's core values and their focus on sustainability guide their actions on important issues such as hunger relief, food safety, environmental protection and resource conservation, animal well-being, ethical business practices, the health and safety of our team members and returning a profit to our shareholders.

Conservation, pollution prevention, and stewardship are some of the terms Tyson uses to describe the responsibility for, and commitment to, protecting and respecting the environment. As part of the company's environmental commitment, Tyson partnered with the Center for Agriculture and Rural Sustainability at the University of Arkansas to conduct a two-stage sustainable water-use assessment. Stage I involved 100 production locations, at each of which a geo-spatial analysis utilizing seven water-scarcity indices was conducted to determine the risk of water scarcity. Stage II evaluated a cross-section of eight of the 100 locations utilizing four location-specific criteria. The criteria used in stage II comprised:

- Status of available local freshwater resources;
- Annual freshwater consumption;
- Quality of wastewater effluent; and
- Industrial-sector impact.

The purpose of this assessment was to evaluate a tool that could be used as a sustainability-performance indicator. To date, a tool of this nature is not available. A measure of water usage alone is not an indicator of sustainability, conservation, or corporate responsibility. A tool that can evaluate water use, effluent treatment, implementation of best management practices, status of local freshwater resources, and sector impact could be valuable in identifying areas of opportunity in the sustainable use of water.

STAGE I

Background

Stage I utilized a suite of seven indices to evaluate whether each location was located in an area considered to be at risk for human water scarcity. Based upon agreement of the indices, the collective results provide a risk-management tool identifying future challenges to water supply of a given location. Below is a list of the indices, used as well as brief explanations.

- **Environmental Water Scarcity Index (EWSI)** is a calculation of the ratio of human water withdrawals to the total water available minus environmental water requirements. EWSI was developed by the International Water Management Institute (Alcamo *et al.*, 2000; Oki *et al.*, 2001; Smakhtim *et al.*, 2005).
- **Mean Annual Relative Water Stress Index (MARWSI)** indicates how much water is used for domestic, industrial and agricultural purposes, compared to the total runoff in the region. This is a spatial model, not a direct measurement of use (World Business Council for Sustainable Development and CH2M HILL, 2009).
- **Water Scarcity Index (WSI)** is a ratio of human water use from all sectors to the total amount of available water in the basin. An account is made for basins with strongly related flows (Phister *et al.*, 2009).
- **Annual Renewable Water Supply Per Person (ARWSP)** is the annual amount of water available in a region per person (Falkenmark, 1990).
- **Human Water Security Threat (HWST)** indicates areas that contain catchment challenges such as pollution, high dam density, high consumptive-water loss, human water stress, and biotic factors. Each challenge has a weighting factor that drives the score (Vörsömarty *et al.*, 2010).
- **Water Supply Stress Index (WaSSI)** evaluates the water demand and availability for 2100 different 8-digit hydrologic unit code (HUC) basins in the continental United States (Sun *et al.*, 2008).
- **Threatened and Endangered Species Richness (TESR)**, developed by the US Army Corps of Engineers (2005), evaluates the number of threatened or endangered species in a given 8-digit HUC basin.

Results

One hundred Tyson locations in 22 states throughout the United States were analyzed against the suite of indices. In order to evaluate agreements between indices and assess

vulnerability, if three or more of the indices indicated "extreme scarcity," "scarcity," or "stressed," the particular location was considered to be highly vulnerable to water scarcity. If two or fewer indices indicated agreement, the location was considered to have low vulnerability. It is important to note that this subjective arrangement has no correlation with the actual condition of the watershed. Distinguishing between high and low vulnerability only represents the general agreement between the indices.

Of the locations analyzed, 13 were considered to be vulnerable to scarcity by four or more of the indices. There were 21 locations in watersheds in which three of the seven indicated vulnerability to scarcity, for a total of 34 locations considered to be highly vulnerable. The remaining 66 locations were considered to have a low vulnerability to water scarcity by having 0, 1, or 2 indices indicating vulnerability.

Discussion

Due to the large land mass associated with an 8-digit HUC basin, the status of local water resources is not accurately portrayed by each index. Each of the indices is an indication of water use, not water consumption. For instance, most food plants use "x" gallons per day, but the vast majority of that water is treated either on-site or by a publicly owned treatment works and returned to the water cycle. The indices are a great tool to point out where opportunities may exist, thereby focusing attention on locations that may be at risk through developing water-conservation plans or other best management practices.

Stage II

Background

The assessment conducted as part of Stage II offered a site-specific review of sustainable water use, which is calculated by assigning a weighting for each of four factors:

- **Local Water Scarcity.** This factor comprises 51% of the total score. It is calculated by taking the average score of five of the eight indices in stage I and the blue water[1] scarcity index (BWSI) (World Resources Institute, 1998). Each of the stage-I indices and BWSI values provide a score between 0 and 1. The average of the six indices is subtracted from 1 and then multiplied by the weighting factor of 51 to obtain the Sustainable Local Resources Score.

- **Local Industrial Sector Impact.** Industrial water-use impact considers the amount of water used by the specific industrial sector and expresses it as a fraction of the total water usage. Water use is reported by the USGS at the county level for all of the US. Total industrial-sector water use is determined by reported values from industrial self-served supplies and public water use. Of the total public supply, 58% is used by domestic users, with the balance being used by agriculture and industry. It is assumed that 60% of the balance (USGS, 2005) is used for agriculture, leaving 17% for industry use. This amount of water along with total industrial self-served water use represents industry water use by county. The industrial sector impact represents 5% of the score.

[1]Blue water is fresh surface and groundwater, *i.e.* in lakes, rivers and aquifers.

- **Sustainable Water Use.** This factor takes into the account the location's blue-water footprint[2], or the actual amount of water consumption (also called water footprint). Consumption includes water incorporated in products, evaporation, or transferred to a different watershed. Consumption is expressed as a percent by dividing the blue-water footprint by total withdrawal (% Consumption = Blue-Water Footprint / Total Water Withdrawal). The sustainable water-use score is then calculated by subtracting % consumed from 1 and then multiplying by 26 (weighting factor for sustainable water use).
- **Facility Water Use.** An international guideline for effluent discharge of pH, BOD[3], TN, TP, oil and grease, and TSS was established by the International Finance Corporation World Bank Group in 2007 (see Table 1). Each location receives 3 percentage points for each water-quality parameter met as "required" by the effluent guidelines in Table 1. Locations with the "excellent" criterion in Table 1 receive an additional 2 percentage bonus points for each parameter. If a location discharges to a public or municipal wastewater-treatment system, the location receives full credit for all parameters; however, it is not eligible for bonus points. The total percentage points are then added with the other factors.

TABLE 1. EFFLUENT GUIDELINES FOR FACILITY WASTEWATER DISCHARGE (INTERNATIONAL FINANCE CORPORATION WORLD BANK GROUP, 2007).

Pollutant	SI unit	Guideline Values		
		Excellent	Required	Poor
pH			6–9	<6 or >9
BOD	mg/L	<15	30	>30
Total N	mg/L	<5	10	>10
Total P	mg/L	<1	2	>2
Total suspended solids	mg/L	<20	50	>50
Oil and grease	mg/L	<5	10	>10

Results

Tyson selected eight sites representing a business unit and geographic cross-section, comprising three poultry-slaughter, one beef-slaughter, one pork-slaughter, one rendering, and two further-process locations. Each of the individual factor scores and the total scores for each location are illustrated in Table 2.

As mentioned above, the pure use of water is not a standalone metric for sustainability. In addition to other factors, one must also consider the actual consumption of water as a measure of sustainability. As depicted in Figure 1, the amount of water consumed at each of the subject locations is a low percentage of total withdrawal.

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[2]Blue-water footprint is the volume of surface and groundwater consumed as a result of the production of a good or service.

[3]Biochemical oxygen demand, total nitrogen, total phosphorus, total suspended solids.

| | Local water-scarcity score (51) | Water-use score (26) | Wastewater-quality score | | | Industrial-impact score | Total score (5) |
State			Score	Bonus	Total		
GA	41.59	25.99	15	8	23	4.47	95
SC	41.36	19.5	18	0	18	4.54	80
NM	39.28	19.7	18	0	18	4.93	50.3
NE	38.45	22.19	12	4	16	4.57	78.9
VA	37.47	22.38	9	4	13	3.46	80.2
MO	36.13	24.87	9	4	13	3.64	80
NC	34.13	22.62	9	4	13	4.50	74.2
IA	7.66	22.62	9	4	13	4.51	79.4

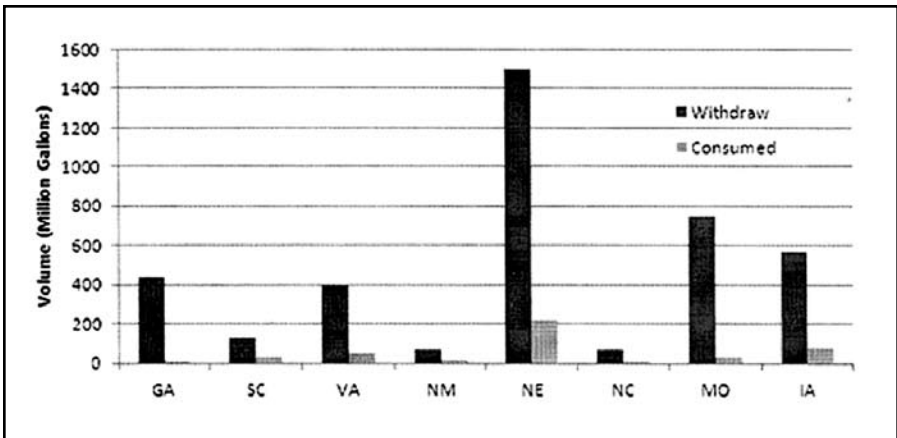*TABLE 2. SCORE OF EACH LOCATION, BROKEN DOWN BY FACTOR.*

Figure 1. Water withdrawn and consumed by location.

Discussion

The scoring system in stage II does not give a grade, nor is it indicative of poor water management or non-sustainable water-management practices. The score provides a comparison between locations and provides a baseline to identify opportunities to improve.

An area of opportunity in improving each location's score would be ensuring all wastewater-quality data are submitted. In the cases of the locations in Georgia, Virginia, Nebraska, North Carolina, Missouri, and Iowa, the scores could be improved by three to nine points if all of the wastewater-treatment data had been submitted. A comparison of the possible scores assuming full credit for all wastewater parameters, plus bonus points, is illustrated in Table 3.

	TABLE 3. CURRENT AND POTENTIAL SCORES.	
State	**Current sustainability score**	**Potential sustainability score**
GA	95	100
SC	80	80
NM	50.3	50.3
NE	78.9	90.9
VA	80.2	95.2
MO	80	95
NC	74.2	89.2
IA	79.4	94.4

Another opportunity for an increase in each location's score would be in the implementation of best management practices such as water reuse. However, one must note that the United States Department of Agriculture closely regulates water use in processing plants.

The lowest scoring location is the New Mexico site. The location lost most points due to being located in an extremely water-scarce area. The opportunity for bonus points is lost at this location due to discharging to a publicly owned treatment works. The South Carolina location is also ineligible for bonus credit due to discharging to a publicly owned treatment works; hence the reason Table 3 does not indicate an increase in potential sustainability score.

SUMMARY

The stage-I assessment provided information for 100 Tyson locations in 22 states. Utilizing the seven indices, the assessment indicated that 34 of the locations may be at risk of water scarcity. The assessment provides a tool that can be used as risk analysis; however, these indices account for withdrawal only and not for consumption of water. Due to the large area that an 8-digit HUC may cover, it is important to evaluate the local water availability to get a more accurate picture of water scarcity at the location level.

The assessment contained in stage II brings sector impact, wastewater quality, and water consumption into the equation. This allows a more detailed analysis of water sustainability. Due to the amount of data required within stage II, only eight of the 100 locations were evaluated. These eight represent a cross-section both of geographical and of business units. Results from the stage-II evaluation indicated scores between 74.2 and 95 for seven of the eight locations, and a low score of 50.3 for the eighth location due to extreme water scarcity in New Mexico. Some of the scores could have been improved if all wastewater-treatment data had been supplied.

ACKNOWLEDGMENTS

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