Energy & Manufacturing Competitiveness Partnership

Leverage.

Phase II Sector Study: Agricultural and Consumer Water Use

U.S. Council on Competitiveness

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Phase II Sector Study: Agricultural and Consumer Water Use

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Printed in the United States of America

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Phase II Sector Study: Agricultural and Consumer Water Use

U.S. Council on Competitiveness

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Letter from the Co-Chairs

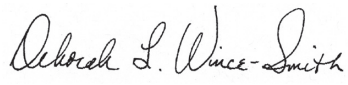
On behalf of the U.S. Council on Competitiveness (Council), The Scotts Miracle-Gro Company, Monsanto Company, Texas A&M AgriLife and the University of California, Davis, we are pleased to present the final report of the Energy and Manufacturing Competitiveness Partnership (EMCP) sector study on Agricultural and Consumer Water Use, held on January 11, 2017 at Scotts' headquarters in Marysville, OH. *Leverage: Agricultural and Consumer Water Use* provides a summary of the discussion, and the analysis, findings and recommendations related to sustainably managing water quality and quantity in the agriculture, lawn and garden, and related industries.

Leverage: Agricultural and Consumer Water Use provides an overview of the current challenges and opportunities faced by the agriculture, lawn and garden, and related industries in a time of increasingly unpredictable weather patterns, an ever-growing population and an age of open knowledge sharing. From lawn and garden products to food production processes, resource management is critical to the nation's competitiveness. Among the key themes identified were: Building the capacity to better predict and plan for climate change; increasing water use efficiency through irrigation and technological innovation; and adapting to meet changing and growing consumer demands.

This sector study builds on the Council's EMCP sector study and report, *Leverage: Water & Manufacturing*, conducted in 2016 with co-chairs Marquette University and A. O. Smith Corporation. Similar to themes in that discussion, this report analyzes water as a highly-valued resource needed for business and communities to function. Overall, water management is an issue of stewardship rather than compliance, and there is a greater need to preserve water quality and conserve water through various measures that promote efficiency not only in the agriculture, and lawn and garden sectors, but across every industry.

We recognize that none of this would be possible without the support of our members and key experts that provided their valuable input and unique perspectives, and we thank them all for their continued work with us. We look forward to continuing engagement with national and regional leaders in industry, academia, national laboratories and government as we capture insights and recommendations across our sector dialogues and put forward an action plan to drive U.S. productivity and prosperity.

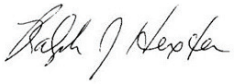
Sincerely,



The Honorable Deborah L. Wince-Smith
President & CEO, U.S. Council on Competitiveness

Mr. James S. Hagedorn
Chairman and CEO, The Scotts Miracle-Gro Company

Mr. Hugh Grant
Chairman and CEO, Monsanto Company



Dr. Ralph Hexter
Acting Chancellor, University of California, Davis

Dr. Mark Hussey
Dean & Vice Chancellor, Texas A&M University

Introduction

American agriculture—including the related industries and value-add sectors that fuel and depend upon it—is a case study in innovation-driven productivity and competitiveness, and one of the United States' largest exports. Since World War II, investment and R&D in agricultural science, technology, and land and resource management have increased the agricultural industry's energy productivity by nearly 100 percent.[1] Agricultural products and technologies remain a key component of American exports, and are a key factor in the growth of the domestic service and manufacturing economy, supporting restaurants, tourism, apparel, furniture and design.[2]

Competition for water, climate change and new consumer demands are also driving change in the agriculture, lawn and garden, and related industries, including greater interest in new products and sustainable production processes. A changing legal and regulatory environment is facilitating the entry of new products into the market, while increasing the already competitive demand for water and energy. Inputs across the agricultural value chain are evolving, which begs a new set of questions regarding innovation and efficiency in growing and manufacturing processes.

The EMCP sector study dialogue on agricultural and consumer water use gathered national leaders and experts on water as it relates to these industries to discuss the implications for U.S. competitiveness.

Hugh Grant, Chairman and Chief Executive Officer, Monsanto Company, addresses participants.

The day-long session focused on the role of subsidies in driving or hindering sustainable water use, the implications of increasingly unpredictable weather patterns for the agriculture, lawn and garden, and related industries, and the need for infrastructure—both regulatory and physical—and a workforce appropriately equipped with the skills necessary to manage water quality and quantity. The resulting recommendations will be incorporated into the Council's competitiveness agenda and, if adopted, will help U.S. companies and consumers better plan for the pressures of future uncertainty and increased competition for water on a local and global scale.

1 *U.S. Agricultural Output, Input, and TFP Indexes, 1948-2010, Public Agricultural Research Spending and Future U.S. Agricultural Productivity Growth: Scenarios for 2010-2050* U.S. Department of Agriculture, July 2011.

2 *The Economic Contribution of America's Farmers and the Importance of Agricultural Exports*, Joint Economic Committee, United States Congress, September 2013

Findings & Recommendations

- **Invest in the technology needed to better model climate data.** As an issue that impacts the competitiveness of multiple U.S. industries, the government and the private sector must invest in the development and deployment of technologies that monitor total soil health, ocean temperatures and other climate predictors to allow farmers and researchers to better monitor and model weather patterns.
- **Create a verification system for crowd-sourced data related to weather patterns and agricultural processes and inputs to facilitate a trustworthy knowledge database that comprises public- and private-sector information.** Collaborative public data can significantly increase precision and automation in water management and improve modeling capabilities and predictive future planning of crops, while improving climate forecasting in the critical three to nine month period. A verification system around individually reported data would filter quality data and allow for better, more efficient convergence of public- and private-sector data.
- **Leverage high-value crops as a test bed for innovation.** New, advanced materials such as smart membranes, fertilizers and pesticides can improve water efficiency, but research and development is often cost-prohibitive. Testing smart materials and other high-cost innovations on high-value crops would promote innovation by reducing the financial risks in the early stages of product development.
- **Better align subsidies on agricultural products with water efficiency and conservation goals.** Financial incentives and regulations must look at the entire landscape comprehensively to encourage smart water management and insulate against negative externalities, including heavy water use in water-stressed areas and spiraling commodity prices.[3]
- **Develop industry standards and disclosure processes for water use.** Financial disclosure, and more recently carbon and other climate-related disclosures, are important aspects of a company's license to operate. Using baseline measurements can improve overall understanding of water use and allow for better monitoring of business operations' effects on the quantity and quality of the water they use and return to the environment. These baselines also encourage cost-saving efficiency improvements with the co-benefit of positive environmental and community-level impacts.

3 *Amid Record-Setting Corn Boom, Subsidies Soar*, by Colin O'Neil, Environmental Working Group, August, 2016.

- **Encourage the use of reclaimed water in place of potable water where possible for landscaping needs.** Using reclaimed wastewater, which is most commonly used in irrigation, has the potential to significantly lower landscaping costs. Increasing urban and industrial use of recycled water can be a cost-effective way to increase water supply without drawing from a limited supply of groundwater and freshwater. Many states throughout the U.S. have adopted guidelines for recycled water use.[4]
- **Better-align training and education programs to increase the pool of experts with skills in water management.** Educational requirements at state colleges, junior colleges and universities in horticulture and related areas often lack the appropriate level of focus on water conservation and management. This is in part due to a lack of state-level funding[5] in the absence of extreme conditions such as drought. Increased alignment between industry and academia at the undergraduate and postgraduate levels is necessary to produce a strong talent pipeline.
- **Train upper-level managers with the skills needed to recognize the technical requirements around water management during the hiring process.** While the pool of engineers and professionals trained in water management is small, there is also a gap in knowledge among upper-level managers with regard to hiring employees with the proper skills to implement sustainable water systems and practices. A top-down approach is needed to better integrate water management into core business strategy, particularly in less densely populated areas where there is increased difficulty attracting top talent.

4 *Water Recycling FAQs*, by Channah Rock, Jean E. McLain and Daniel Gerrity, The University of Arizona, College of Agriculture and Life Sciences, May 2012.

5 *Sustainability Curriculum in Higher Education: A Call to Action*, Association for the Advancement of Sustainability in Higher Education, 2010.

Setting the Stage

In a world in which climate and weather patterns are growing increasingly uncertain, competition between companies, consumers, the environment and other stakeholders—particularly in water-scarce areas—is intensifying. As information is being gathered and shared faster and more widely than ever before, the challenges to and opportunities for managing water in a way that ensures preservation of quality and quantity are vast.

Scenarios such as the recent drought across Nevada and California, the impact of lawn and garden and home septic systems in Florida and the Chesapeake Bay, and declining water levels in major U.S. aquifers[6] can have a major impact on nature, business operations and livelihoods. Urbanization is also increasing the need for innovative products and technologies. From a water perspective, management of quality and quantity across different cities and municipalities varies significantly.[7] With regard to quantity, there is a lack of consumer knowledge about their level of water consumption. Understanding and measuring usage is the first and most important step in managing water conservation and incentivizing mindfulness and better practices.[8]

In response to changing climates and landscape conditions, farmers are choosing to alter their crops, which has the potential to cause significant shifts in the availability and price of agricultural products—which impacts the entire global food system.[9] But collaborative public data is helping companies develop and deliver new products that allow growers to optimize land use in a way that was not previously possible.[10] For example, as a consequence of changing climate and genetic improvements, North Dakota now has some of the largest growing soybean counties in the United States in areas where 20-30 years ago soybeans were not a commonly planted crop.[11] This ability to look at critical data is making private industry, farmers and consumers smarter, ultimately influencing the direction of research and development, and determining the success of long-term business models needed to keep pace with changing climate patterns and rapid population growth.

While much is known about the challenges around water as it relates to the agriculture, lawn and garden, and related industries, there is still significant value in gathering a diverse community of experts for productive and collaborative conversations on ways in which stakeholders can capitalize on opportunities while simultaneously addressing three major issues: climate change, food production and water scarcity.

6 *Groundwater Depletion, Where Does Groundwater Depletion Occur in the United States?* U.S. Geological Survey, 2016.

7 *The Water Efficiency and Conservation State Scorecard: An Assessment of Laws and Policies*, Alliance for Water Efficiency and the Environmental Law Institute, 2012.

8 *Water Sustainability: Environmental Attitude, Drought Attitude and Motivation*, by Erin D. Dascher, Jiyun Kang and Gwendolyn Hustvedt, International Journal of Consumer Studies ISSN 147-6423, 2014.

9 *Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region*, by Scott Malcolm, Elizabeth Marshall, Marcel Aillery, Paul Heisey, Michael Livingston, and Kelly Day-Rubenstein, Economic Research Service, U.S. Department of Agriculture, July 2012.

10 *Using Big Data to Inform Agricultural Decisions*, by Laurie Houston, AGree (Food and Agriculture Policy), March 2015.

11 *North Dakota Farm Reporter, Issue: 06-11*, U.S. Department of Agriculture, 2011.

Dion McBay, Global Sustainable Development Lead, and Giovanni Piccini, Global Production Sustainability Lead, Monsanto, lead a discussion on investment in agricultural and consumer water use.

A Global Competition

Given the nature of water as a scarce commodity, there is a tendency to look at water efficiency measures as a pre-competitive issue. Globally, there has been much cooperation and sharing of information and best practices when it comes to water conservation. The United States, however, has been lagging behind other parts of the world, like the European Union, when it comes to developing and implementing the technology needed for weather forecasting and climate modeling.[12] This has left a gap in the three to nine month time forecast—the period perhaps most essential to growers during the decision-making process.

The United States is also falling behind other countries—particularly Australia and Israel—when it comes to measuring water quality and scarcity, and implementing strategies to mitigate risk in these areas. In Australia, the government has taken a coordinated approach to managing the country's irrigation systems that allows for significant cost-savings associated with avoided water loss through poor infrastructure.[13] In both countries, these strategies have been largely in response to a sense of urgency around water scarcity frequently unrealized in the United States. There is, however, a significant advantage to acting preemptively to these and other potential issues, especially as climate patterns become increasingly unpredictable and the threat of drought grows.

Ultimately, better water management—both in terms of quality and quantity—is necessary for any company, industry or country to remain competitive. Without innovation in technology and management practices, and the talent and infrastructure to support this advancement, demand for water will continue to increase while supply will grow increasingly limited.[14]

12 *Continental Divide: Europeans do not just talk about the weather more than Americans do, They Are better at forecasting it as well*, The Economist, 2015.

13 *Applying Integrated Urban Water Management Concepts: A Review of Australian Experience*, V. Grace Mitchell, Institute for Sustainable Water Resources.

14 *The Path to Water Innovation*, by, Newsha K. Ajami, Barton H. Thompson Jr., David D. Victo, The Hamilton Project and Stamford Woods Institute for the Environment, October 2014.

Stakeholder Dialogue

Agricultural & Consumer Water Use—Technology

When it comes to enacting sustainable water practices in the agriculture, lawn and garden, and related industries, there are two distinct, but heavily linked areas that must be addressed: water quality and quantity. There are many methods for improving water use efficiency and reducing total water consumed while protecting quality, but perhaps the most impactful opportunities for technological innovation are through improved climate data, targeted irrigation, enhanced sensing, plant breeding, and selection and strategic use of hydroponics.

Ever-increasing availability of information and the growing use of modeling in industrial and consumer crops also allow for increased uptake of automated water management. As companies continue to invest in the technologies needed to design and implement these automated systems, it becomes increasingly more important to not only use historic data, but also be able to gather data in real time to improve predictability in a given period of time and adjust accordingly. The ability to collect data through sensors, real-time data science, farming equipment and meteorological tracking is transforming the world of data science as it relates to manufacturing, agriculture and water.

Additionally, companies are increasingly relying on crowdsourced information to gather this real-time data needed for the modeling and simulation of crop use and to improve precision in water management.[15]

Merging public- and private-sector data with crowdsourced data and creating a platform to share this data, however, presents a unique challenge. Farmers and growers are measuring data and sharing it on different online platforms, but uncertainty as to the quality of self-reported data and optimal use of their land creates a need for a system that verifies or puts in place standards for such information.

While the amount of knowledge continues to grow, increasing uncertainty around weather patterns has become a persistent challenge when it comes to predictive and automated water management. A lack of forecasting data in the medium term of three to nine months, the time frame often most relevant to growers, impacts stakeholders across the board. Early springs, cold Aprils in the Midwest and Northeast, and long, dry summers are continually impacting farmers' ability to implement water efficiency measures, and require advances in technology to monitor, measure and predict these shifts in climate. Industry must prepare growers, farmers and consumers for these changes by providing the information needed to make these decisions.

Agencies, companies and universities, particularly NASA and land grant universities, are working to fill the information gap. NASA's global earth monitoring system, for example, is monitoring soil moisture and its impact on weather patterns.[16] The Department of Energy's climate modeling and exascale computing have identified temporal and spatial gaps around the size of the landscape that can be managed.[17]

15 *Improving Analytics Capabilities Through Crowdsourcing*, by Joseph Byrum and Alpheus Bingham, MIT Sloan Management Review, Summer 2016.

16 *NASA Launches Groundbreaking Soil Moisture Mapping Satellite*, NASA, 2015.

17 *Accelerated Climate Modeling for Energy*, U.S. Department of Energy, Office of Science, 2016.

Hugh Grant, Chairman and Chief Executive Officer, Monsanto Company.

With regard to efficient delivery of water, there are significant opportunities not only around installation of pivots and irrigation systems, but also in the development of new materials that improve efficiency. A smart membrane that senses soil moisture levels and releases water only when needed, for example, would be much more beneficial than a pressurized system that can break, overwater or use excessive amounts of energy. These materials are not science fiction—they already exist, but come at relatively high costs versus traditional irrigation methods.[18]

While such materials are high-cost on the front end, there is a real opportunity to push innovation by testing smart materials and innovations in urban landscaping, or with high-value crops such as cannabis. While field-scale testing and implementation is typically cost-prohibitive, these high-value crops—grown on a smaller scale and posing less of a risk with regard to cost—are a prime testing grounds for smart materials and innovative technologies.

Innovation and improved technology are not enough in themselves, though. For one, installing irrigation systems that are improperly managed may result in adverse effects. With irrigation, there is a significant issue of knowledge and policy. Irrigation is declining in the West at the same rate it is increasing in the East.[19] Despite its ability to increase yield by an average of 2.3 times more than rain-fed ground, the potential problems, including overwatering and nutrient runoff, indicate that education and outreach are necessary to ensure the technology is being implemented and maintained.[20]

Agricultural & Consumer Water Use—Investment

Companies not only in the agriculture, lawn and garden, and related industries, but throughout all sectors of the U.S. economy are increasingly realizing the value of sustainable water use. Increasing awareness of high levels of inefficiency, illuminated by an uptake in the practice of conducting baseline measurements needed to make such commitments, has successfully begun to incentivize changes in behavior.

18 *Research Advances in Sustainable Micro Irrigation, Volume 10, Innovation in Micro Irrigation Technology*, Edited by Megh R. Goyal, Vishal K. Chavan, Vinwood K. Tripathi, 2016.

19 *U.S. Irrigation Pushed Eastward by Drought and Financial Risks*, by Brett Walton, Circle of Blue, July 2014.

20 *The Impact of Irrigated Agriculture on a Stable Food Supply*, by Michael F. Dowgert Ph.D., Proceedings of the 22nd Annual Central Plains Irrigation Conference, Kearney, NE. February, 2010.

Much of this change can be associated with the potential financial incentives associated with increased efficiency. The potential return on investment, however, is not always understood or guaranteed.

Another important consideration is the alignment of actual and intended outcomes of crop subsidies and incentives. Subsidies on corn, for example, along with improvements in genetics, farm practices and the use of irrigation have arguably driven production at a higher pace than global demand. Several years of high yields of a water-intensive crop can diminish commodity prices and create market imbalances throughout the agriculture economy. Importantly, the Agriculture Risk Coverage and Price Loss Coverage programs authorized by the 2014 Farm Bill buffer farmers' risks and protect against dramatic price and yield swings, and therefore acres may remain stable even as supply and price fluctuate. Some could argue that this policy allows for a false stability in planted acres and could be a factor contributing to unsustainable water practices.

In addition to agricultural subsidies that unintentionally drive water use, local tax policy and a misalignment of incentives have also caused water overuse in environmentally sensitive areas. Therefore, federal agriculture incentives must promote water efficiency and system improvements, and be cautious and proactive in assessing potential unintended consequences.

If properly implemented, subsidies and incentives can drive economic and environmental benefits simultaneously. The Natural Resources Conservation Service within the U.S. Department of Agriculture, for example, incentivizes crop diversity through rotations, reducing tillage and using cover crops, which has the marked benefit of reducing and sequestering carbon from the environment.[21] At the same time, it helps with water appropriation, storage and soil health, which mitigates erosion and runoff. The co-benefit structure of many modern agriculture practices deserves additional consideration from policymakers and potentially a different and definitive way of presenting the subsidy-to-benefit structure.

Companies are increasingly looking at venture capital to finance data science gathering for new technologies such as osmosis, desalination and reclamation in the absence of sufficient federal funds.[22] Programs such as the Small Business Innovation Research program (SBIR) through the National Institutes of Health and Clean Tech group, which tracks venture capital investment, act as sources of early-stage capital for technology commercialization in the United States. However, they are not fully appreciated nor leveraged by the private sector.[23] Despite this limitation, these programs can seed early-stage water technology companies and work with researchers. The EPA's Environmental Technology Innovation Cluster Development and Support Program tracks water technology awards under SBIR and has a national-scale inventory that tracks the kinds of technologies that are being funded in this space on a federal level. But venture capital investment in this area is very small relative to the clean energy opportunity.[24] Evidence also suggests that venture capital losses between 2006 and 2011 contributed to a decline in investment, thus further pointing to the need for robust public-private partnerships.[25]

21 *Natural Resources Conservation Service, Conservation Practice Standard, Code 328*, U.S. Department of Agriculture.

22 *The US Water Sector on the Verge of Transformation, Global Cleantech Center White Paper*, EY, 2013.

23 *Subcommittee on Research and Science Education, House Committee on Science and Technology, "From the Lab Bench to the Marketplace: Improving Technology Transfer"* testimony of Keith L. Crandell, U.S. House of Representatives, 2010.

24 *Clean Energy Finance: Challenges and Opportunities of Early-Stage Energy Investing,* National Renewable Energy Laboratory Industry Growth Forum, 2013.

25 *Venture Capital and Cleantech: The Wrong Model for Clean Energy Innovation*, by Dr. Benjamin Gaddy, Dr. Varum Sivaram, Dr. Francis O'Sullivan, MIT Energy Initiative Working Paper, July 2016.

Building the Infrastructure and Brainpower to Manage Water

While awareness and implementation of measures to protect water quality and quantity are growing among the agriculture, lawn and garden, and related industries, there are numerous hurdles to and opportunities for operating within the existing physical and regulatory infrastructure.

Physical water infrastructure presents its own challenges. In the upper part of the Midwest, a very small portion of the large amount of grain lands are water or drainage controlled.[26] While relevant stakeholders are in the beginning stages of discussing control structures and how to manage water impacts of farming, recent increases in land productivity have also greatly increased the potential water runoff that could cause the release of excess phosphorous and nitrogen into the Mississippi and the gulf.[27] A holistic approach to incentives and water management structures is needed to manage dams for irrigation and water in draining systems, and to steady the supply and reduce runoff.

With these challenges, however, come opportunities. One area in which the agriculture, lawn and garden, and related industries can look to contribute to water conservation and efficiency is reclamation and reuse. Recycled water, which is most commonly used in irrigation, has the potential to significantly lower landscaping costs.[28] In South Florida, 28 percent of the water cycled back through public treatment systems is used for agriculture and other irrigation needs.[29] Reno, NV has a "purple pipe system" in which everything from golf courses to municipal landscaping is irrigated with reclaimed wastewater.

By using reclaimed water that is treated to a secondary standard, heavy water users have the opportunity to increase water supply for landscaping while remaining cost effective. While many states have adopted guidelines for recycled water use, regulations vary widely, and as of 2012, California, Florida and Texas account for 90 percent of water recycled in the United States.[30]

Public awareness around water issues related to drought, scarcity and quality in the agriculture, lawn and garden, and related industries is important for sustainable water management. Particularly when it comes to drought and water scarcity, knowledge and understanding tends to be a significant barrier to better practices. California, for example, is still experiencing significant and persistent drought conditions that demand alternative water management practices on the part of both industrial and individual users. Awareness and education are necessary in order to function in a world in which business-as-usual is no longer sufficient.[31]

On the industry side, there is an appetite for disclosure processes and standards around water similar to those that exist for financial activity and, more recently, carbon emissions. Climate-related financial disclosures throughout the value chain are currently voluntary, but may become mandatory in the future and could have a major impact on brand value. Organizations like the Carbon Disclosure Project and the Alliance for Water Stewardship are looking at new disclosure mechanisms and standards throughout all industries.[32]

26 *Improving Water and Nutrient Use Efficiency with Drainage Water Management*, by Tanner Ehmke, American Society of Agronomy, 2013.

27 *How Nitrogen & Phsphorus Pollution Affects the Mississippi River*, Mississippi River Collaborative.

28 *Capturing and Recycling Irrigation Runoff as a Pollution Prevention Measure*, by Sandra K. Wilson, Sharon von Broembsen, Oklahoma State University.

29 *Follow the Purple Pipe*, by Amanda Richter, Irrigation and Green Industry Magazine, May 2008.

30 *Water Recycling FAQs*, by Channah Rock, Jean E. McLain and Daniel Gerrity, The University of Arizona, College of Agriculture and Life Sciences, May 2012.

31 *Impacts of California's Ongoing Drought: Agriculture*, by Heather Cooley, Kristina Donnelly, Rapichan Phurisamban and Madhyama Subramanian, Pacific Institute, August 2015.

32 *The CEO Water Mandate: Corporate Water Disclosure Guidelines Toward a Common Approach to Reporting Water Issues*, Pacific Institue, CDP, World Resources Institute and PWC, September 2014.

New infrastructure, technology and disclosure measures in the water space must also be accompanied by development of management practices and the skills needed to maximize these new systems. While there has been a push to educate irrigation professionals, it is often the case that high-level managers lack technical expertise necessary to hire professionals with the proper skill set. In addition to a skills gap in technical expertise, with computing systems and data management becoming more accessible, the use of computer learning is going to become more important as knowledge increases exponentially in this space. There is also a lack of ongoing state funding appropriated to research and education in horticulture, as these programs are typically financed through bonds voted in as a reactionary measure to addressing short-term crises such as the drought in California—an inherently unsustainable model.[33]

Mark Slavens, Vice President, Research & Development–Lawns & Environmental Affairs, The Scotts Miracle-Gro Company, leads a discussion on technology and innovation.

Another challenge is that often the curricula at state colleges, junior college and universities is misaligned with priorities and needs around managing water in the agriculture, lawn and garden, and related industries.[34] Knowledgeable workers in the water space are needed in many industries and areas. Both as a sector and skill set, though, these needs are poorly defined. As it is difficult to identify market demand for "water" jobs and skills, it is difficult for universities to point to a specific job market that requires these skills, meaning there is low demand on the part of students. Companies are often unable to recruit people out of graduate school and Ph.D. programs that have a genuine interest in and knowledge of these areas. More alignment and collaboration is needed between industry, academia and communities to identify and capitalize on this opportunity.

33 *Proposition 51, the $9-billion School Bond, wins*, Liam Dillion, The Los Angeles Time, November 2016.

34 *Sustainability Curriculum in Higher Education: A Call to Action*, Association for the Advancement of Sustainability in Higher Education, 2010.

Moving Forward

Leverage: Agricultural and Consumer Water Use is the first sector study dialogue held during Phase II of the EMCP. This dialogue integrated the findings of year one and reinforced a series of common themes and recommendations that came out of the first three sector studies. As the Council's EMCP builds upon the success of the first phase of sector studies on water and manufacturing, advanced materials and bioscience, we transition into the second phase of studies with the release of this report. We look forward to continuing these deep-dive discussions on American competitiveness and, among other key policy efforts, engaging the new Congress and Administration.

Phase II sector studies will continue with a strategic focus on:

Energy

The Council will continue Phase II with a sector study on energy on May 31, 2017 with co-chairs Chris Crane, President & CEO of Exelon Corporation, Eric Barron, President of Penn State University and Paul Kearns, Interim Director, Argonne National Laboratory. Energy is an economy-wide competitiveness linchpin and a formidable, diverse and transforming industry in its own right. This sector study will look at continuing challenges posed by evolving consumer behavior and expectations and a changing regulatory landscape while seeking to drive a more dynamic and resilient energy system in which emerging technologies lead to new business models, energy products and services that increase U.S. energy security.

Aerospace

As the U.S. aerospace sector seeks more energy-efficient fleets and continues to rely on energy-intensive raw materials, manufacturers must out-innovate their global competitors. The competitiveness of the American aerospace sector over the next decade will be defined by the ability to develop, standardize and deploy advanced materials, technologies and processes on a broad scale supported by a highly skilled workforce. Building on some of the findings of the EMCP's Phase 1 sector study on advanced materials, the aerospace sector study will look at how the design and manufacturing of products and the associated physical and regulatory infrastructure will define the competitiveness of this sector as it seeks to out-innovate its global competition.

Pharmaceuticals and Healthcare

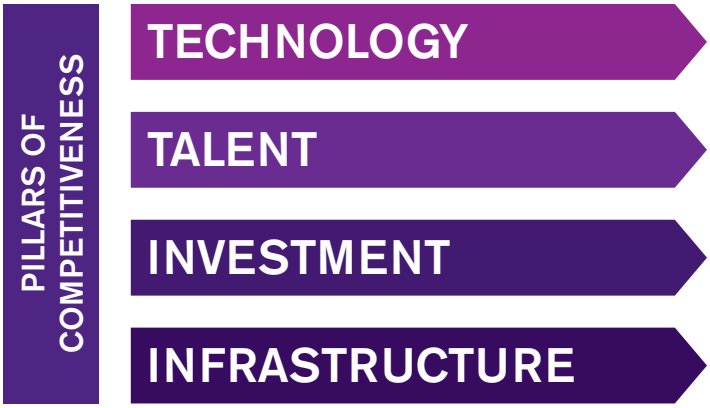
With multifaceted industries such as biotechnology, drug manufacturing and medical laboratories & research, the United States healthcare sector can be seen as one of the most complex yet robust sectors in the world. As an energy-intensive sector and one with significant opportunities for advancement, this sector study will look at the pharmaceutical industry and the overall healthcare sector in the United as an opportunity to leverage new production processes, prototype and test new technologies and alternate fuel sources to hone its competitive cost-edge over competitors in Europe, India and East Asia and drive productivity and prosperity for the U.S. economy.

About the Energy & Manufacturing Competitiveness Partnership (EMCP)

The agricultural and consumer water use sector study is part of a larger initiative of the U.S. Council on Competitiveness (Council) known as the Energy and Manufacturing Competitiveness Partnership (EMCP). The EMCP unites Council members to focus on the shifting global energy and manufacturing landscape and how energy transformation and demand is sharpening industries critical to America's prosperity and security.

The EMCP taps into a diverse membership of leaders from business, academia, national laboratories and the labor community to understand the discrete and distinct challenges critical sectors of the U.S. economy face in the energy-manufacturing convergence and how decision-makers can bolster the critical pillars of competitiveness—technology, talent, investment and infrastructure.

Given the ongoing transition in Washington and the uncertain legislative agenda, the work of the EMCP to identify and advocate for critical recommendations to turbocharge America's advanced manufacturing capability is extremely relevant and timely. Using the expertise of its members and building on the Council's long-standing work on energy and manufacturing, the EMCP is especially designed to deliver a concrete competitiveness agenda for decision-makers at the highest levels of government and industry, detailing and prioritizing the policies, tools and partnerships the new Congress and administration should leverage to unleash a sustainable manufacturing renaissance in the United States.



The Energy & Manufacturing Competitiveness Partnership Concept Paper, August 2015.

About the U.S. Council on Competitiveness

Who We Are

The U.S. Council on Competitiveness is a nonpartisan leadership group of CEOs, university presidents, labor leaders and national lab directors working to ensure U.S. prosperity. Together, we advance a pro-growth policy agenda and promote public-private partnerships in the emerging "innovation ecosystem" where new technologies are born.

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How We Operate

The Council Operates by:

- Identifying emerging competitive challenges.
- Generating new policy areas to shape the competitiveness debate.
- Forging public-private partnerships to drive consensus.
- Galvanizing stakeholders to translate policy into action and change.

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APPENDIX B

Dialogue Participants

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John Tracy
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Deborah Wince-Smith
President & CEO
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APPENDIX C

Dialogue Agenda

MORNING

9:00 Welcome and Opening Remarks

Mr. Jim Hagedorn
Chairman & CEO
The Scotts Miracle-Gro Company

Mr. Hugh Grant
Chairman & CEO
Monsanto Company

The Honorable Deborah L. Wince-Smith
President & CEO
U.S. Council on Competitiveness

9:15 Defining the Critical Goals and Objectives: Agricultural & Consumer Water Use Sector Study

The Honorable Deborah L. Wince-Smith
President & CEO
U.S. Council on Competitiveness

The Energy and Manufacturing Competitiveness Partnership (EMCP), led by a C-Suite peer group from industry, academia, labor and the national laboratories, analyzes critical sectors of the economy shaped by an altered energy landscape coupled with a focus on energy productivity and an emergent advanced manufacturing sector. The Agricultural & Consumer Water Use dialogue is the latest in a series of sector studies, and will look to identify key challenges and threats to our water supplies, opportunities to innovate and implement improved management practices, and leverage policy recommendations that will form the basis of a competitiveness road map for Congress and the next Administration.

9:30 Agricultural and Consumer Water Use—Assessing the Landscape

Mr. James Hagedorn
Chairman & CEO
The Scotts Miracle-Gro Company

Mr. Hugh Grant
Chairman & CEO
Monsanto Company

Surface and groundwater resources across the U.S. have dwindled to historic lows. In many parts of the country, America's 21st century agriculture industry, and related industries like lawn and garden, competes with energy, construction and other sectors for water resources. As domestic energy production rises, society must balance competing needs for access to fresh water at the local, state, and national level. These industries face serious challenges and tremendous opportunities, including the need to double food production by 2050 and adapt to a changing climate.

This discussion will:

- Examine the link between water and advanced manufacturing and how to balance the needs of the manufacturing sector with the agriculture sector
- Address sustainable and efficient water management in the context of the tight linkage between energy and water and the expansion of new products and farming practices
- Identify to what extent policy, regulations, agriculture production, and consumer water use cause waste to the hydrological system

10:00 Agricultural and Consumer Water Use—Technology

Dr. Mark Slavens
Vice President, Research & Development – Lawns & Environmental Affairs
The Scotts Miracle-Gro Company

Agricultural products and technologies remain a key component of American exports, and are a factor in the growth of the domestic service and manufacturing economy, supporting restaurants, tourism, apparel, furniture and design.

This session will:
- Identify grand challenges that might inspire disruptive new technologies or processes in this sector that will significantly reduce impacts to water quality or water quantity
- Assess the role of "big data" collection and analysis in (1) optimizing the use, storage (above and below the ground) and movement of water in the United States and (2) unlocking new insights on what, when, and where to plant, when to fertilize, irrigate, and plough and when to harvest

10:45 Coffee Break

11:00 Agricultural and Consumer Water Use—Investment

Mr. Dion McBay
Global Sustainable Development Lead
Monsanto Company

Since World War II, investment and R&D in agricultural science, technology, and land and resource management have increased the sector's energy productivity by nearly 100 percent.

This session will:
- Address the positive and negative role of subsidies in distorting the marketplace and the incentives these subsidies create
- Identify innovative financing mechanisms that will enable an increase in development and deployment of new technologies and processes across the agricultural value chain and related sectors
- Identify strategies can for those involved in the R&D process to invest smarter and get more out of each dollar invested in R&D

11:45 Building the Brainpower and the Backbone to Support Sustainable Agricultural and Consumer Water Use

Dr. John Tracy
Director—Texas Water Resource Institute
Texas A&M Agrilife

Dr. David Fujino
Executive Director, California Center for Urban Horticulture
University of California, Davis

Changes in products and processes across the agriculture sector have changed the way the U.S. needs to think about educating for jobs in agriculture and related industries. Additionally, we need to ensure the infrastructure is in place to deliver important inputs like water, and ultimately consumer-ready products, to market.

This session will:
- Address policies and initiatives at the intersection of industry and academia designed to meet the talent needs across agriculture and related sectors
- Identify the physical and regulatory infrastructure needed to ensure sustainable and efficient water use in a way that protects water quality.

AFTERNOON

12:30 Lunch and Presentation

1:30 Connecting Key Themes & End of Day Summary

William Bates
Executive Vice President and Chief of Staff
U.S. Council on Competitiveness

Staff will capture main themes of the day and gather closing thoughts, key ideas, and insights to facilitate a final wrap-up discussion.

2:00 Meeting adjourns

APPENDIX D

U.S. Council on Competitiveness

Agricultural & Consumer Water Use

A Sector Study of the Energy & Manufacturing Competitiveness Partnership

American agriculture—including the related industries and value-add sectors that fuel it and depend upon it—is a case study in innovation-driven productivity and competitiveness, and our largest export. Since World War II, investment and R&D in agricultural science, technology, and land and resource management have increased the sector's energy productivity by nearly 100 percent. Agricultural products and technologies remain a key component of American exports, and are a factor in the growth of the domestic service and manufacturing economy, supporting restaurants, tourism, apparel, furniture and design.

Collaboration between the private sector, government, labor and educational institutions has been key to this success. Technology innovations from John Deere's plow to education policies such as the creation of America's land-grant university system have driven meteoric growth in both output and productivity. Today, advanced fields such as biotechnology and genetic engineering are accelerating the process to squeeze yet greater efficiencies in labor, energy, and enhanced nutrition and flavor to feed America; and nanotechnology holds great promise for water purification and treatment. Yet, traditional scientific fields such as irrigation engineering, plant sciences and water resources management still can play a significant role with foundational knowledge using cutting edge tools and analysis available through computational advances.

However, America's 21st century agriculture industry, and related industries like lawn and garden, faces serious challenges and tremendous opportunities, including the need to double food production by 2050 in order to feed the world. Temperature and precipitation variability are impacting American agriculture and industry. More than 80 percent of the contiguous U.S. has experienced abnormally dry conditions since 2012, and nearly 65 percent have been designated in drought. In spring 2014, 100 percent of California—America's most agriculturally productive state—is in severe drought.

Elsewhere, groundwater resources—including the massive Ogallala Aquifer, the life-blood of the Great Plains—have dwindled to historic lows. And in many parts of the country, agriculture competes with energy, construction and other sectors for water resources. As domestic energy production rises, society must balance competing needs for access to fresh water at the local, state, and national level.

Consumer demand also is driving change in the agriculture/lawn and garden/water sectors, including greater interest in organic products and sustainable production processes. A changing legal and regulatory environment is facilitating the entry of new products into the market, while increasing the already competitive demand for water and energy. The way we look at the inputs across the agricultural value chain is evolving, which begs a new set of questions regarding innovation and efficiency in growing and manufacturing processes.

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Key Questions for the Sector Study to Address

1. Given the tight linkage between energy and water, how can water be managed and used more efficiently and sustainably?

2. What role do subsidies pay in distorting the marketplace both positive and negative; and are they creating the right incentives?

3. What role can "big data" collection and analysis play in (1) optimizing the use, storage (above and below the ground) and movement of water in the United States and (2) unlocking new insights on what, when, and where to plant; when to fertilize, irrigate, and plough; and when to harvest.

4. What is the link between water and advanced manufacturing and how do we balance the needs of the manufacturing sector with the agriculture sector?

5. Is consumer water at odds with agriculture and/manufacturing? How might legal and regulatory changes affect this dynamic?

6. Are we deploying all available technologies to addressing the water/agricultural challenge and what investments in R&D need to be made?

7. What education and training is needed to ensure the best and brightest are engaged in this sector?

8. Are there grand challenges that could inspire disruptive new technologies or processes in this sector?

The EMCP Methodology

Energy and manufacturing are inextricably linked with America's new found energy abundance creating a window of opportunity for the nation. How this opportunity manifests across different sectors of the economy is the central question of the EMCP. For each sector study, the EMCP will explore four cross-cutting pillars—technology, talent, investment and infrastructure—with the end goal to find commonalities across sectors as well as key differences or even policy conflicts.


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