Western Sugar Cooperative
(Grower Owned)

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September 10, 2022

Testimony of Rebecca L. Larson, Ph.D.
Chief Scientist and Vice President of Governmental Affairs
Western Sugar Cooperative
House Agriculture Committee Hearing on Soil Health Practices and Programs that Support Regenerative Agriculture

Chairman Scott, Ranking Member Thompson, and Members of the Committee, thank you for inviting me today. I have a Ph.D. in Plant Science and 22 years' diverse experience with sugarbeets. I'm work for the 800 small family farmer-owners of the Western Sugar Cooperative. The cooperative spans 110,000 acres across Colorado, Nebraska, Wyoming, and Montana. I help measure the environmental impact of our farmers' practices and guide their investment in public research. Included with my written testimony is the data substantiating the gains our farmers have made in soil health and regenerative agriculture.

Soil health is critical for farmers and the environment. For the farmer healthier soil reduces crop inputs, increases crop productivity, and instills resiliency in the agroecosystem. For the environment, it can help mitigate climate change, using the soil as a sponge to absorb carbon from the atmosphere.

The USDA recognizes four soil health principles: 1) keep soil covered, 2) minimize soil disturbance, 3) employ diverse crop rotation, and 4) maintain living roots[1]. Tillage, mechanical working of the soil, works against three of the four principles making it arguably the biggest threat to soil health.

I am here to provide concrete examples from our cooperative and national trends that demonstrate conventional farming has made significant gains in soil health. Since the 1950s[2], modern agriculture has enabled exponential adoption of conservation tillage across the U.S.[3] Today, a majority of conventionally produced U.S. commodity crops use conservation tillage; one out of five acres is no till. Clearly, farmers value soil health, as a third of conservation tillage was adopted with zero outside incentive.[4] I see similar trends for sugarbeet; 82% of Western Sugar growers use conservation tillage (**Figure 1**). The switch to conservation tillage improved soil health and imparted other dramatic environmental benefits: 1) erosion is down 90% (**Figure 2**), 2) soil microbial diversity and function is up 6-fold (**Figure 3**), 3) fuel consumption and greenhouse gas emissions are down 40% (**Figure 4**), and 4) water use efficiency is up 30%. Concurrently, yield has climbed from 8,000 to more than 11,000 pounds of sugar per acre[5], true sustainable intensification (**Figure 5**). Conventional agriculture paved the way with conservation tillage. More recently no till organic cropping has emerged.[6] However, most organic systems[23] still rely on tillage,[7,8] especially row crops, small grains, and

[1] https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=stelprdb1048783
[2] Islam, R., Reeder, R. (2014). No-till and conservation agriculture in the United States: An example from the David Brandt Farm, Carroll, Ohio. International Soil and Water Conservation Research. 2(1):97-107.
[3] https://www.no-tillfarmer.com/articles/11095-timeline-of-the-no-till-revolution
[4] [Tillage Intensity and Conservation Cropping in the United States (usda.gov)]
[5] Pulled from USDA ERS and NASS reporting for sugarbeet production in Montana, Wyoming, Nebraska & Colorado
[6] https://www.no-tillfarmer.com/articles/11095-timeline-of-the-no-till-revolution
[7] [What is "Organic No-till," and Is It Practical? | eOrganic]

vegetable crops. For both conventional and organic farms, adoption of conservation tillage is highly dependent on soil type, climate, scale, and cropping system[4,6,9,10]. Ultimately, for Western Sugar farmers, the adoption genetically engineered sugarbeets with glyphosate tolerance allowed for widespread elimination of plowing and conversion to conservation tillage.

Some claim pesticides are harmful to soil health. We have not found that to be true. On farm measurement across Western Sugar shows microbial diversity and function is up 6-fold following the adoption of conservation tillage (**Figure 3**), despite judicious use of pesticides. The data suggests tillage is far more detrimental to soil health than pesticides (**Figure 9**), consistent with reports in the literature.[11,12,13,14,15,16] Despite that, in the last decade and a half Western Sugar farmers have cut the quantity of pesticides applied by 40% and reduced the overall environmental impact by 92%, similar to national trends in conventional farming.[17] Western Sugar, like all beet sugar cooperatives, determines what seeds can be planted on our farms. We require the seed largely defend itself against prevalent pests and diseases, allowing for robust integrated pest management. Combined with disease prediction models and precision application tools, pesticides are used with the highest levels of stewardship. Technology on the horizon will further reduce reliance on pesticides in the future.[18,19,20] However, mandates against pesticides today will hurt, not help climate smart agendas, most critically in the areas of food waste[21] and land conversion.[22]

Cover crops also promote soil health. Most closely associated with organic farming, it is also used in conventional systems across the U.S.[23,24] Implementation varies by region and cropping system, [25] as does method of cover crop termination. Western Sugar farmers use cover crops under a variety of circumstances: 1) 15-20% of sugarbeet harvest occurs early enough to be followed by a fall-seeded crop like winter wheat, 2)

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[8] Farming Systems Trial - Rodale Institute

[9] Uri, N.D. (1999) Factors affecting the use of conservation tillage in the United States. Water, Air and Soil Pollution. 116: 621-638.

[10] Carr, P.M., Gramig, G.G., Liebig, M.A. (2013) Impacts of organic zero tillage systems on crops, weeds, and soil quality. Sustainability. 5(7):3172-3201.

[11] Barre, K., Le Viol, I., Julliard, R., Chiron, F., Kerbiriou, C. (2018) Tillage and herbicide reduction mitigate the gap between conventional and organic farming effects on foraging activity of insectivorous bats. Ecology and Evolution. 8(3):1496-1506.

[12] Babujia et al (2016) Impact of long-term cropping of glyphosate-resistant transgenic soybean on soil microbiome. Transgenic Research. 25: 425-440

[13] Gornish et al (2020) Buffelgrass invasion and glyphosate effects on desert soil microbiome communities. Biological Invasions. 22: 2587-2597.

[14] Schlatter et al (2017) Impacts of repeated glyphosate use on wheat-associated bacteria are small and depend on glyphosate use history. Applied and Environmental Microbiology.

[15] Lupwayi et al (2020) Profiles of wheat rhizobacterial communities in response to repeated glyphosate applications, crop rotation and tillage. Canadian Journal of Soil Science. https://doi.org/10.1139/cjss-2020-0008

[16] Wilkes et al (2020) Tillage, glyphosate and beneficial arbuscular mycorrhizal fungi: optimizing crop management for plant-fungal symbiosis. 10(11):520.

[17] Brooks, G., Barfoot, P. (2020). Environmental impacts of genetically modified (GM) crop use 1996-2018: impacts on pesticide use and carbon emissions. GM Crops and Food. 11(4): 215-241.

[18] See & Spray™ Ultimate | Precision Ag | John Deere US

[19] Carbon Robotics

[20] Zabala-Pardo, D., Gaines, T., Lamego, F.P., Avila, L.A. (2022) RNAi as a tool for weed management: challenges and opportunities. Advances in Weed Science.40(Spec1):e020220096

[21] https://www.fao.org/family-farming/detail/en/c/1203273/

[22] Willet et al (2019) Food in the Antrhopocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. The Lancet Commission. 393(10170):447-492.

[23] https://www.sare.org/wp-content/uploads/2019-2020-National-Cover-Crop-Survey.pdf

[24] Cover Crop Trends, Programs, and Practices in the United States (usda.gov)

[25] USDA ERS - Chart Detail

where irrigation allows, fall-seeded cover crops are planted following regular harvest as well, and 3) spring planted rye is used to protect delicate seedlings from prevalent, seasonal winds and shows promise for additional weed management (**Figure 7**). However, our primary soil armor is the residue left from the previous crop (**Figure 1**) which also serves to promote soil health.[26,27] Across Western Sugar, crop residue allows for the integration of livestock through managed grazing further building soil health.[28]

The USDA recognizes conservation crop rotation[29] is also key to soil health. All Western Sugar growers engage in this practice, rotating small grains, corn, dry edible beans, and sugarbeets. Many also integrate perennial crops such as alfalfa in the rotation. These diverse rotations such as these that include high residue and low nitrogen demand crops are paramount for soil health by balancing nutrient demands in the agroecosystem and protect biodiversity important to crop health.[30,31]

The evolution of conventional ag practices has reduced soil erosion by 35% across the U.S.[32] It is important to recognize the U.S. is a leader in climate smart ag, [33,34,35] and farmers are accepting of further improvement. Innovations in modern, conventional agriculture are primed to achieve climate smart goals. Programs authorized by this Committee—the Conservation Innovation Grants (CIG), the Sustainable Ag Research and Education (SARE) program, and the Environmental Quality Incentives Program (EQIP) have been highly effective in helping growers adopt climate-smart practices. Western Sugar has used these programs to improve nutrient stewardship and implement high carbon soil amendment[36] to regenerate soil health (**Figure 8**). As you turn your attention to drafting the next Farm Bill, I encourage you to continue to support programs like these and invest in outcome-based solutions that keep the farmer in the driver's seat as they understand the nuance of their production system. It is also imperative to increase investment in agricultural research to develop frontier technologies that will drive the next step change in farming. In summary, conventional farming practices have improved soil health by employing conservation tillage, cover cropping and diverse crop rotations and are continuing to innovate. Again, thank you for inviting me to be here today. I look forward to taking questions.

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[26] Melman, D.A., Kelly, C., Schneekloth, J., Calderon, F., Fonte, S.J. (2019) Tillage and residue management drive rapid changes in soil macrofauna communities and soil properties in a semiarid cropping system of Eastern Colorado. Applied Soil Ecology. 143: 98-106.

[27] Nunes, M.R., Karlen, D.L., Veum, K.S., Moorman, T.B., Cambardella, C.A. (2020) Biological soil health indicators respond to tillage intensity: A US meta-analysis. Geoderma. 369: 114335.

[28] Carvalho, P.C.d.F., et al. (2010) Managing grazing animals to achieve nutrient cycling and soil improvement in no-till integrated systems. Nutrient Cycling in Agroecosystems. 8con8: 259-273.

[29] Conservation Choices: Crop Rotation (usda.gov)

[30] Yang, T., Siddique, K.H.M., Liu, K. (2020) Cropping systems in agriculture and their impact on soil health-A review. Global Ecology and Conservation. 23: e01118

[31] Nunes, M.R., van Es, H.M., Schindelbeck, R., Ristow, A.J., Ryan, M. (2018) No-till and cropping system diversification improve soil health and crop yield. Geoderma. 328(15): 30-43.

[32] 2017NRISummary_Final (1).pdf

[33] Kassam, A., Friedrich, T., Derpsch, R. (2022) Successful experiences and lessons from conservation agriculture worldwide. Agronomy. 12(4): 769.

[34] https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=98305#:~:text=U.S.%20agriculture%20emitted%20698%20million,greenhouse%20gas%20emissions%20in%202018.

[35] Global Greenhouse Gas Emissions Data | US EPA

[36] Paustian, K., Larson, E., Kent, J., Marx, E., Swan, A. (2019) Soil carbon sequestration as a biological negative emission strategy. Frontiers in Climate 1:8.

(Figure 1)

Figure 1. Photos from a Western Sugar farm using conservation tillage. (A) sugarbeets planted into previous crop's wheat stubble. (B) zoomed in image of sugarbeets growing in wheat stubble. Residue prevents wind/water erosion and evaporative loss of water; remaining roots feed the micro/microbiome & build organic matter.

(Figure 2)

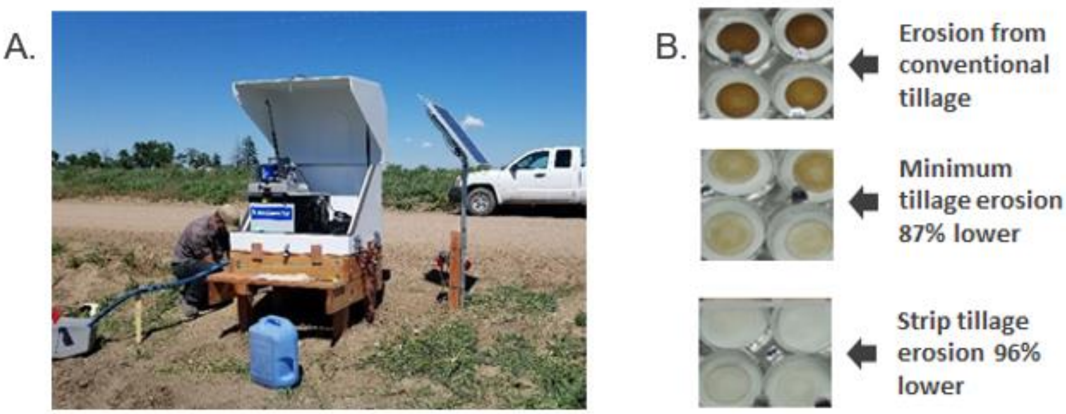

Figure 2. Western Sugar partnered with the Irrigation Innovation Consortium (FFAR project, Dr. Jay Hamm, Colorado State University) on a three-year study collecting samples in edge-of-field monitoring to determine the impact of conservation tillage on irrigation-based soil erosion. Water was collected during each rain and irrigation event (A). Sediment and nutrient load were analyzed following filtration of the samples (B). Conservation tillage significantly reduces erosion and therefore protects water quality.

(Figure 3)

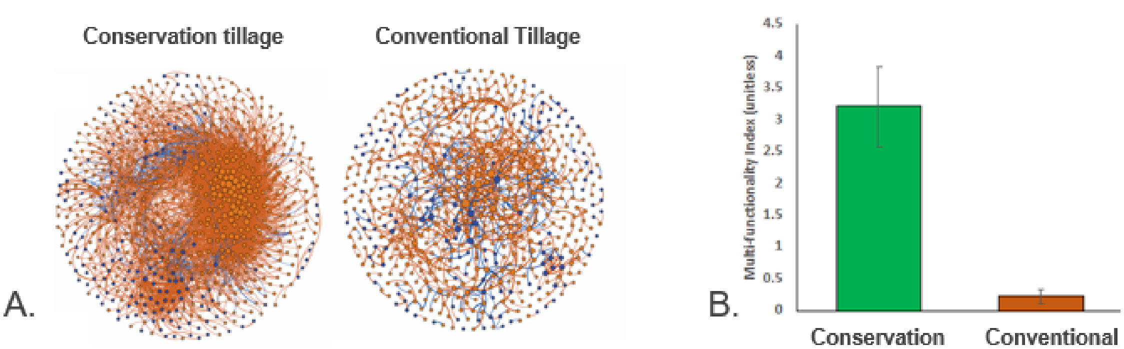

Figure 3. Soil samples collected and analyzed by Dr. Pankaj Trivedi (Colorado State University) to compare the soil microbiome under conventional and no tillage systems from across the cooperative. Greater diversity in bacteria (A, blue dot) and fungi (A, orange dot) under conservation tillage (A). Soil function was also measured by Dr. Trivedi by measuring nutrient cycling (B); greater diversity/quantity of soil microbes = 6-fold higher nutrient cycling (B). Western Sugar continues to financially support Dr. Trivedi ($30,000/annually) in the development of soil health bioindicators.

(Figure 4)

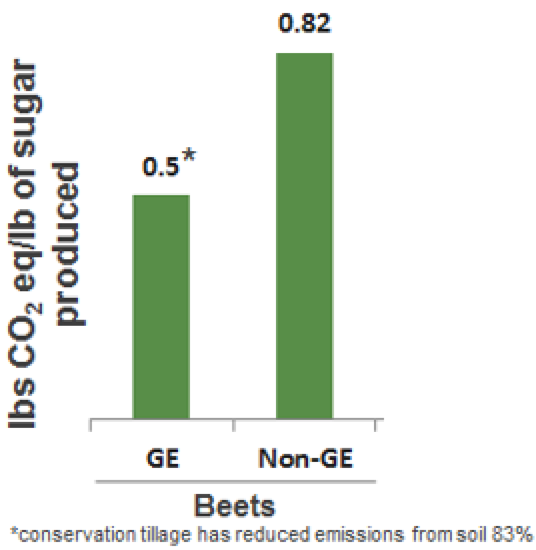

Figure 4. Western Sugar hired Dr. Douglas Warner and his team (University of Hertfordshire, U.K.) to conduct a lifecycle assessment of sugarbeet production in the cooperative before and after the introduction of genetically engineered (GE) sugarbeets. Emissions dropped 40% with GE sugarbeets primarily because of the adoption of conservation tillage. Note emissions are denoted in terms of units of production, this is a key component of sustainable intensification. Ignoring productivity can force the unintended consequence of land conversion and market leakage.

(Figure 5)

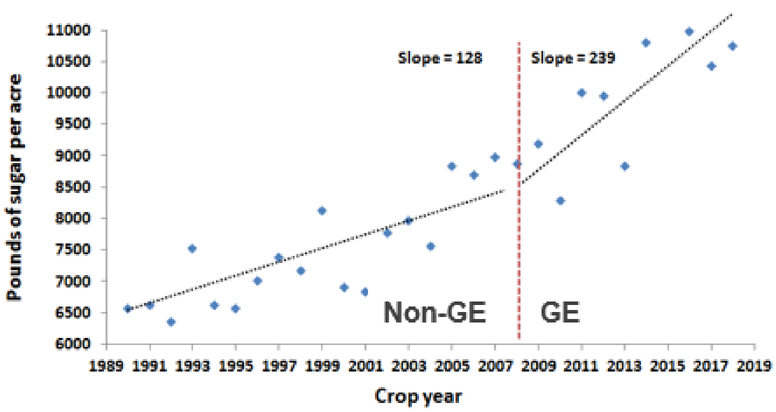

Figure 5. As Lancet Commission noted, environmental gains must be balanced against productivity to protect the global environment. Promoting environmental gains that reduce per unit productivity can lead to worsening climate change as additional acres are converted from native habitat to cropland to compensate for yield losses with a growing population. It is imperative Climate Smart agendas focus on sustainable intensification: improving environmental outcomes while promoting yield. Western Sugar has made significant advances in climate smart practices while also improving crop productivity 30% thanks to the adoption of genetically engineered (GE) sugarbeets.

(Figure 6)

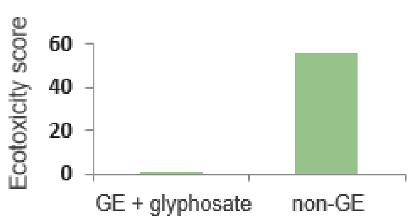

Figure 6. All beet sugar cooperatives operate as closed systems, approving what seed can or cannot be sold to our growers and enabling robust integrated pest management. Western Sugar requires the plant be ale to defend itself against seven prevalent pests and diseases. In addition, switching from non-genetically engineered (GE) and conventional herbicides to GE and glyphosate has reduced the environmental impact of sugarbeet production 92% as determined from pesticide fate and risk modeling conducted by Dr. Douglas Warner at the University of Hertfordshire in the UK.

(Figure 7)

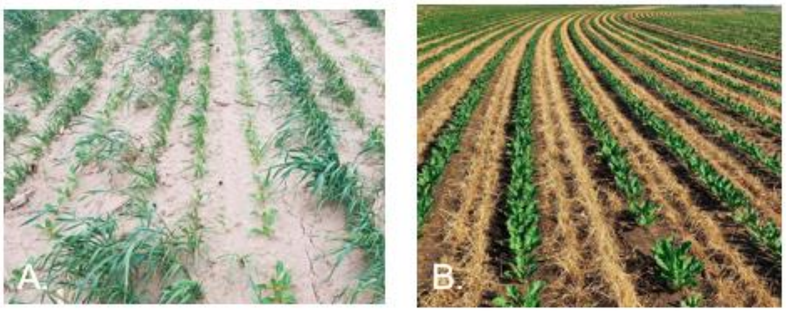

Figure 7. Western Sugar farmers who use cover crops tend to use wheat or rye (fast growing & cold tolerant). Some growers plant cover crops between rows (A), others seed the whole field to wheat then strip till prior to planting sugarbeets (B). Western Sugar is currently funding development of best management practices for spring planted rye cover crops for additional weed control and resistance management at the University of Wyoming (Dr. Andrew Kniss) and Montana State University (Dr. Lovreet Shergill).

(Figure 8)

Figure 8. Western Sugar pioneered the use of a factory waste stream for beneficial use in high carbon soil amendment. Using this product to regenerate soil health improves soil water holding capacity, reduces soilborne nitrous oxide emissions, increases long-term soil carbon sequestration potential and avoids methane emissions from landfilling the product [status quo (A); repurposing waste for beneficial use (B)]. The product has now been applied to nearly 6% of acres across the Rocky Mountain West with tangible improvements to soil health quantified by Dr. Bijesh Maharjan at the University of Nebraska. Growers readily adopted the practice because of the immediate benefit of improved crop productivity [visual impact on corn (C) and dry beans (D)].

(Figure 9)

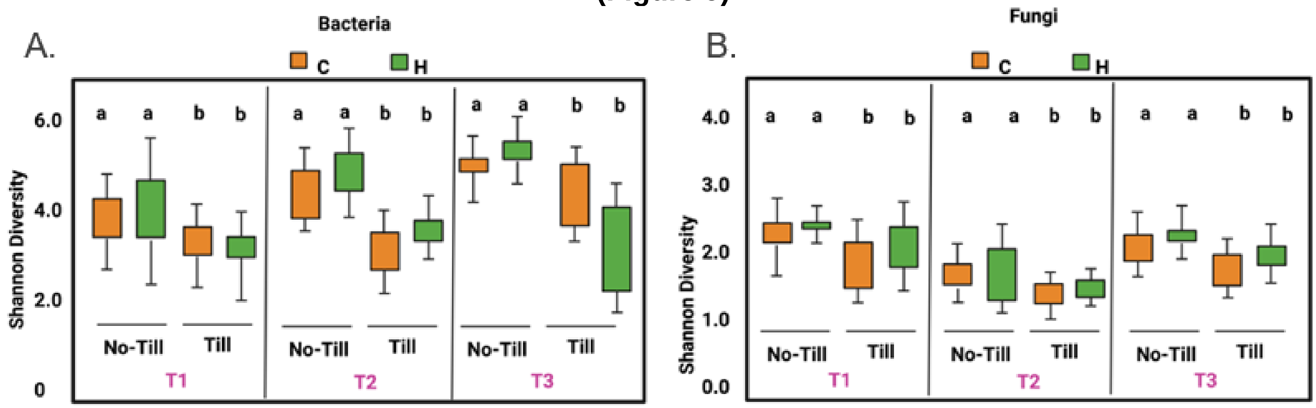

Figure 9. Dr. Pankaj Trivedi at Colorado State University analyzed population diversity of bacteria (A) and fungi (B) in different production systems (no-till or tillage) and with herbicide (H) and without herbicide (C) mimicking options for Western Sugar producers. Samples were collected at three different times (T1-T3). In all instances, tillage was the main driver of diversity loss; use of herbicides did not impact diversity (statistical significance denoted by letter above box plot, those with different letters are statistically different from one another).

Rebecca Lynn Larson (Bargabus)

EDUCATION

1999 B.S. (Ecology/Field Biology) St. Cloud State University, St. Cloud, MN

2003 Ph.D. (Plant Science) Montana State University, Bozeman, MT

PROFESSIONAL EXPERIENCE

The Western Sugar Cooperative, V.P./Chief Scientist and Governmental Affairs
Denver, Colorado 2016-Present

- Manages all internal research activities, including field yield trials and disease nurseries used for hybrid approval
- Represents all research functions on the Western Sugar Cooperative management team and responsible for all research reporting to the Western Sugar Cooperative grower board
- Steers Joint Research Committee, a board of Cooperative employees and farmers, in planning and investing in outside research in support of Cooperative activities
- Manages development, implementation, expansion, and reporting related to the Cooperative's on-farm sustainability program
- Manages all government relations activities
- Serve as primary public communicator for all on-farm technical matters

The Western Sugar Cooperative, Research Agronomist
Denver, Colorado 2015-2016

- Managed all internal research activities, including field yield trials and disease nurseries used for hybrid approval
- Collaborated with Joint Research Committee, a board of Cooperative employees and farmers, in planning and investing in outside research in support of Cooperative activities

Syngenta Crop Protection, Head of Product Evaluation for Diverse Field Crops, North America
Longmont, Colorado 2012-2015

- Managed a team of senior scientists focused on late stage hybrid and agrichemical evaluations for sugar beet, sunflower, canola, sorghum, alfalfa and pulse crops (known as Diverse Field Crops)
- Co-led the Seedcare Bioteam, overseeing and prioritizing seedcare protocols impacting Diverse Field Crops
- Guided product advancement through all major markets in North America, including designing, analyzing and interpreting all late-stage sugar beet hybrid trials and disease nurseries
- Led pre-commercial seed production/conditioning activities

- Member of the Biological Assessment leadership team, Product Evaluation leadership team, Diverse Field Crops management team and the Sugar Beet management team serving as the voice for end-to-end matters related to Research & Development in North America
- Accountable for end-to-end Research & Development activities for sugar beet and sunflower, including all trialing operations, seed productions, inventory management and budgets

Syngenta Seeds, Head of Product Evaluation & Regional Trialing Lead for Sugar Beets
Longmont, Colorado 2010-2012

- Managed the late-stage hybrid pipeline; planned seed productions, yield trials and disease tolerance evaluations
- Guided product advancement through all major markets in North America
- Member of the Biological Assessment Leadership Team which lead the reorganization of the North American Research & Development structure/operation
- Managed Research & Development activities at five sugar beet, three corn, one soy and one cereals research station housing 45 full time employees and greater than $10M in operating budgets
- Represented Sugar Beet Research & Development to external customers at seed committee meetings and official variety trial tours
- Managed all regulatory compliance and stewardship for genetically modified sugar beet, including regulated traits, in North America

Syngenta Seeds, Plant Scientist III Sugar Beets
Longmont, Colorado 2007-2010

- Planned and evaluated all late-stage yield trials, disease nurseries and seed productions
- Worked closely with sales and marketing team to understanding market gaps and determine how to fill them with existing Research & Development pipeline
- Managed Research & Development activities at the Longmont sugar beet station housing seven full time employees and $900K in operating budgets
- Managed all regulatory compliance and stewardship for the Longmont site

USDA-ARS, Research Plant Physiologist
Fort Collins, Colorado 2004-2007

- Developed proteomic tools (multidimensional liquid chromatography, tandem MALDI-TOF mass spectrometry, protein-protein interaction arrays) for understanding resistance and disease in sugar beet in response to *Beet necrotic yellow vein* virus and *Fusarium spp.*
- Discovered a role for phytohormone signaling in hairy root development and identified potential biomarkers for rapid resistance selection
- Actively and quickly published research findings in accredited peer-reviewed scientific journals

- Managed several assistant scientists, lab technicians, work study students and interns

USDA-ARS, Post Doctoral Research Associate
Fargo, North Dakota 2003-2004

- Developed *Barley stripe mosaic* virus vectors for silencing *Beet necrotic yellow vein* virus in sugar beet leaf assays

Montana State University, Research Assistant
Bozeman, Montana 1999-2003

- Characterized the mode of action of a biological control agent (BCA) as induction of systemic resistance. The BCA has been patented through Montana State University (U.S. patent application serial #: 11/361,283) and has been licensed to Montana Microbial Products. Knowledge gained in these studies provided the framework for developing a rapid screening method for identifying novel BCAs. Was inducted into the Montana State University Inventors Society in 2014.

PROFESSIONAL ENGAGEMENT

Board member, Beet Sugar Development Foundation, 2021-Present
Board member and Secretary/Treasurer, American Society of Sugar Beet Technologists, 2019-2021
Board member, Colorado Ag Commission (Hickenlooper Administration), 2018-2020

TOTAL CAREER SENIOR AND JUNIOR AUTHORED PUBLICATIONS

Refereed Journals-	10	Book Chapters-	2
Invited Presentations-	50+	Technical Reports-	30+
Abstracts-	16	Proceedings-	1

Truth in Testimony Disclosure Form

In accordance with Rule XI, clause 2(g)(5)* of the *Rules of the House of Representatives*, witnesses are asked to disclose the following information. Please complete this form electronically by filling in the provided blanks.

Committee: Agriculture

Subcommittee:

Hearing Date: 09/14/2022

Hearing Title:

"Soil Health Practices and Programs that Support Regenerative Agriculture"

Witness Name: Dr. Rebecca L. Larson

Position/Title: VP/Chief Scientist and Governmental Affairs

Witness Type: ◎ Governmental ○ Non-governmental

Are you representing yourself or an organization? ◎ Self ○ Organization

If you are representing an organization, please list what entity or entities you are representing:

Western Sugar Cooperative

<u>FOR WITNESSES APPEARING IN A NON-GOVERNMENTAL CAPACITY</u>

Please complete the following fields. If necessary, attach additional sheet(s) to provide more information.

Are you a fiduciary—including, but not limited to, a director, officer, advisor, or resident agent—of any organization or entity that has an interest in the subject matter of the hearing? If so, please list the name of the organization(s) or entities.

I work for Western Sugar Cooperative

Please list any federal grants or contracts (including subgrants or subcontracts) related to the hearing's subject matter that you, the organization(s) you represent, or entities for which you serve as a fiduciary have received in the past thirty-six months from the date of the hearing. Include the source and amount of each grant or contract.

NRCS-Sustainable Ag Research and Education Grant-Professional + Producer (subaward #G331-21-W8614; Western SARE Project #OW21-368) $75,000

Please list any contracts, grants, or payments originating with a foreign government and related to the hearing's subject that you, the organization(s) you represent, or entities for which you serve as a fiduciary have received in the past thirty-six months from the date of the hearing. Include the amount and country of origin of each contract or payment.

N.A.

Please complete the following fields. If necessary, attach additional sheet(s) to provide more information.

☑ I have attached a written statement of proposed testimony.

☑ I have attached my curriculum vitae or biography.

*Rule XI, clause 2(g)(5), of the U.S. House of Representatives provides:

(5)(A) Each committee shall, to the greatest extent practicable, require witnesses who appear before it to submit in advance written statements of proposed testimony and to limit their initial presentations to the committee to brief summaries thereof.

(B) In the case of a witness appearing in a non-governmental capacity, a written statement of proposed testimony shall include— (i) a curriculum vitae; (ii) a disclosure of any Federal grants or contracts, or contracts, grants, or payments originating with a foreign government, received during the past 36 months by the witness or by an entity represented by the witness and related to the subject matter of the hearing; and (iii) a disclosure of whether the witness is a fiduciary (including, but not limited to, a director, officer, advisor, or resident agent) of any organization or entity that has an interest in the subject matter of the hearing.

(C) The disclosure referred to in subdivision (B)(iii) shall include— (i) the amount and source of each Federal grant (or subgrant thereof) or contract (or subcontract thereof) related to the subject matter of the hearing; and (ii) the amount and country of origin of any payment or contract related to the subject matter of the hearing originating with a foreign government.

(D) Such statements, with appropriate redactions to protect the privacy or security of the witness, shall be made publicly available in electronic form 24 hours before the witness appears to the extent practicable, but not later than one day after the witness appears.