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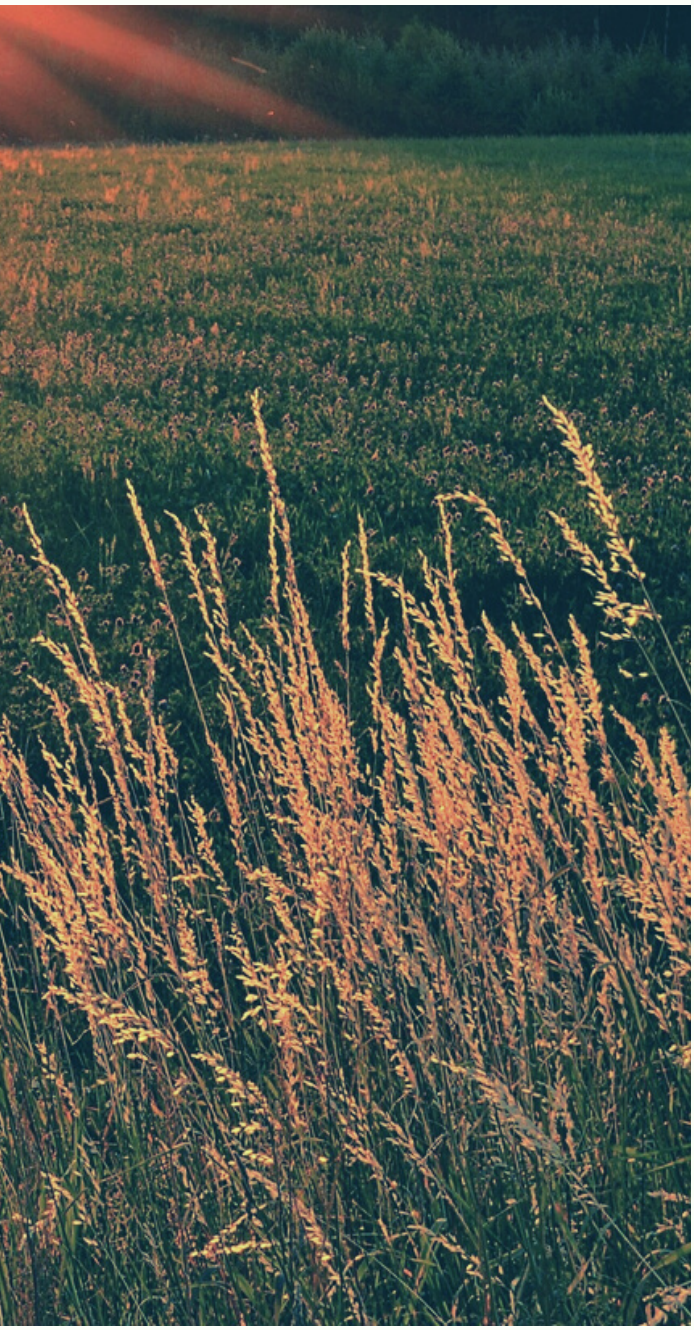
Connecting the Dots: Food-Water Nexus Workshop

SYNTHESIS REPORT

2021 | FEBRUARY

SASKATOON, CANADA

Contents



WORKSHOP NOTES, AND BIG QUESTIONS

GLOSSARY OF SYMBOLS

C COMMUNITY

N NATIONAL

G GLOBAL

L LOCAL

Thanks to Jay Famiglietti, Bing Si, Maryse Bourgault, Jeremy Rayner, Dave Schneider, Leon Kochian, Emil Hallin, Madhavi Daida, Chanchal Roy, Ian Stavness, Jeffrey McDonnell, Angela Bedard-Haughn, Steven Webb, Stephen Visscher, Hasan Ahmed, Palash Sanyal for their support in organizing the workshop.

Report written and designed by: Palash Ranjan Sanyal

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Organizers' Note

The United Nations Sustainable Development Goals strive to achieve zero hunger and cease all forms of malnutrition by 2030. If no action is taken, 890 million will be affected by hunger by 2030. COVID-19 made reaching this goal more challenging, as the World Food Programme estimates an additional 130 million people are affected by hunger due to the pandemic in 2020. This picture is complicated by changing patterns of freshwater availability since agriculture dominates global freshwater withdrawal and use. The impact of climate change is shifting how where water is available, and therefore how and where food is grown around the world. Note that this against a backdrop of a growing population that must be fed: we will have to feed 8.5 billion people by 2030.

The task at hand is daunting and requires long-term research, planning, and engagement. We believe the University of Saskatchewan (USask) is uniquely positioned to play a role in reducing global hunger. USask has been a leader in agricultural research in Canada since its establishment. This stature has been elevated and complemented by the establishment of the Canadian Light Source (CLS), the Global Institute for Water Security (GIWS), the Global Institute for Food Security (GIFS), and other institutions. The sheer body of expertise, knowledge, and tools at USask positions us to address some of the most significant and fundamental questions surrounding the challenges at the food-water nexus. Assessing the state of this knowledge on campus, including personnel, research strengths and interests, was the driving force behind organizing the Connecting the Dots workshop. Which faculty and researchers are engaged in, or would like to be engaged in coupled food-water research? Where are the opportunities for collaboration and what are strategic pathways towards large funding opportunities?

In an unconventional, virtual format, researchers from diverse fields shared their work and ideas related to the world of food-water on November 16-17, 2020. The workshop successfully brought together 50 researchers from 14 different units on campus and identified ideas worthy of further exploration. This report focuses on those ideas and many others that were discussed during the workshop. Next steps beyond the workshop will be to pursue smaller thematic group discussions where researchers will evolve themes into research questions, proposals, and into the research itself.

In 2021, we plan to pilot some of the ideas that have been shared we will explore opportunities for seed funding. We will be grateful to receive your input and suggestions. We thank everyone for their promotion and participation in the workshop and we are very excited about the next phase of food-water research at USask.

On Behalf of the organizing committee
Jay Famiglietti, Leon Kochian and Angela Bedard-Haughn

Background

Freshwater use for agriculture accounts for almost 80 percent of human consumption, which intimately links food and water security. The need for sustainable water resource management and sustainable food production, i.e. to produce more food with less water, including capacity building, enhanced institutional structure, and to contribute to better-informed decision-making, is more prevalent than ever.

The University of Saskatchewan (USask) is home to world-class researchers working on solutions to local-to-global scale problems that are enhancing both water and food security. On November 16-17, 2020, USask's Global Institute for Water Security (GIWS), Global Institute for Food Security (GIFS), and College of Agriculture and Bioresources co-convened a virtual workshop for USask researchers with interests in exploring research opportunities and collaborations on the food-water nexus.

Purpose

The purpose of the virtual workshop was to understand USask's existing food-water nexus research capabilities and to provide the opportunity to explore new and greater collaboration and synergies on campus.

80%
all freshwater withdrawals globally go to agriculture

40%
crops globally come from irrigated lands

FIFTH
largest agricultural exporter spot belongs to Canada

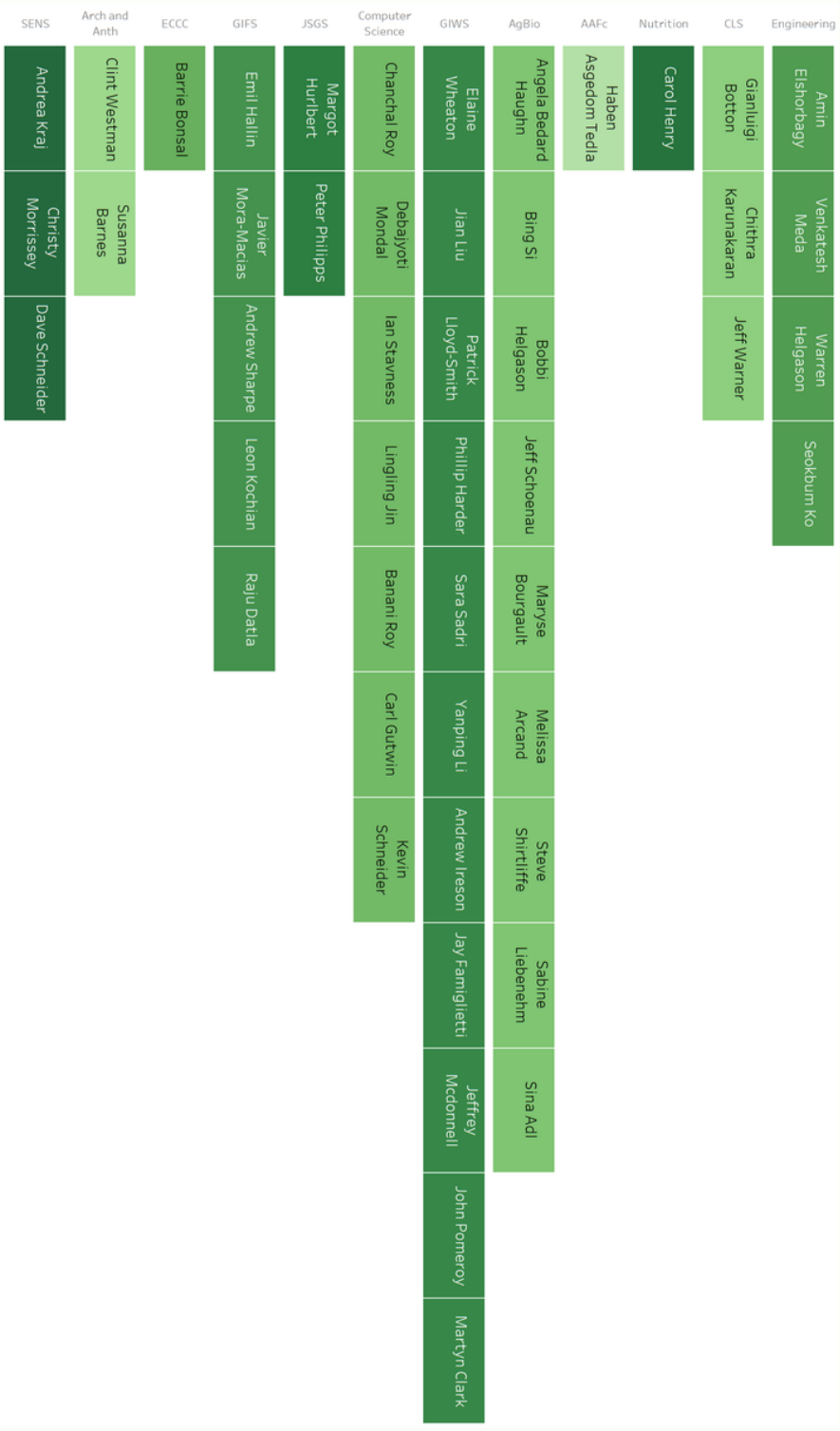
10M
tonnes more crops is planned to be produced by 2030 in SK

Organization of the workshop

The workshop targeted participants from all across the USask campus who are actively involved and interested in food-water nexus issues and research. A key goal of the workshop was for the participants to get to know each other, and in fact, many had never met. Furthermore, key goals were to understand the USask's current food-water research capacity and to begin to explore that community's joint interests. The following virtual meeting structure was adopted:

1. The two days were each divided into 4 1-hour sessions starting at 9 am and finishing at 4 pm.
2. An hour break was provided between sessions to encourage and allow participants to contact each other and to minimize screen time.
3. The first three sessions of the day included 45-50 minutes of 5-minute presentations, followed by a discussion. Every participant was given the chance to do a 5-minute presentation.
4. Each presentation focused on the following questions
    a. Who am I?
    b. What tools/methods do I use?
    c. What have I done in the past?
    d. What am I doing currently?
    e. What would I like to do (or see happen on campus) in the food-water area?
    f. One big question for the group to think
5. The last session of the day provided a broader platform for discussion

Participants



LIST OF PARTICIPANTS

Day 1
Session 1

Moderator: Jay Famiglietti

Presenters:

Jay Famiglietti, Global Institute for Water Security
Uses remote sensing to develop and communicate decision-support tools

Lingling Jin, Department of Computer Science
Working on computational modeling of biological and microbiological systems

Bobbi Helgason, College of Agriculture and Bioresources
Working on microbial aspects of soil and plant root-microbe interactions

Haben Asgedom-Tedla. Agriculture and Agri-Food Canada
Quantifying nutrient and moisture flows from hillslopes to the fields

Peter Philipps, Johnson Shoyama Graduate School of Public Policy
Focuses on global food security and bioscience innovation policy

Melissa Arcand, College of Agriculture and Bioresources
Working on root-microbe-soil interaction

Clint Westman, Department of Archaeology & Anthropology
Working on pollutant impacts and processed on indigenous community

Jian Liu, Global Institute for Water Security
Understanding nutrient cycling in agroecosystems

- There were numerous overlaps in the research conducted by the participants in the root zone of soils: water balance, plant water use, carbon, nitrogen, and nutrient cycling; complimentary use of tools like isotopes, imaging, etc.
- The presentations covered themes including mechanistic assessments of the water balance, space-time aspects of root zone water-balance and how that links to nutrients
- A recurring theme was how can we grow more food using the least amount of water and nutrients in ways that are environmentally friendly and culturally respectful
- Potential research and impact could be on planning for policy impact, for Indigenous engagement, focusing on lived experiences and connections and on oil sands impacts
- Broad interest in sustainable agriculture — water and nutrient efficiency, environmental efficiency were expressed
- Jian Liu has revealed an interest to talk more with Leon Kochian about the soil phosphorus research
- Jay Famiglietti expressed interest in doing new work with Peter Phillips and Clint Westman, and in a broader effort on root zone soil water, nutrient, carbon, GHG, root dynamics
- Clint Westman expressed his interest to connect with Melissa Arcand and Peter Phillips regarding research on lived experience

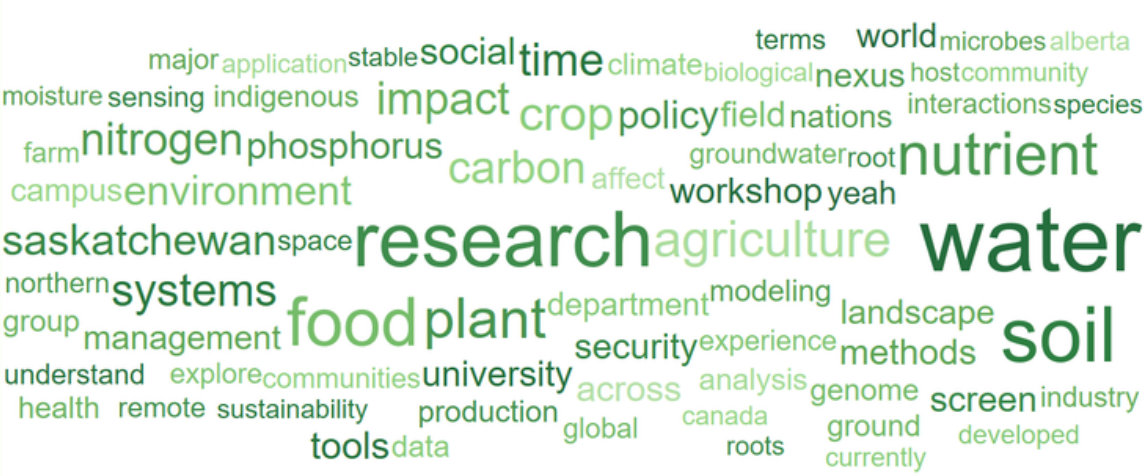


Figure: Word cloud from mining the recording of the first session

Big Questions

To produce more nutritious food with less water, innovative technologies are required...

-United Nations Decade for 'Water for life'

C How can natural scientists better engage with Indigenous community-based research to address issues of food and water security?

N Can we improve Canadian water quality while increasing or maintaining crop production?

G How can we integrate soil properties across different scales of space and time?

L How to measure the impact of the insights and innovations water-food scientists seek that will influence the choices we make about the water and soil's future for Saskatchewan?

G How can we measure and inform the impacts of environmental issues like mitigation of greenhouse gas emission on the food-water nexus?

Day 1
Session 2

Moderator: Andrew Ireson

Presenters:

Andrew Ireson, Global Institute for Water Security
Working on process-based hydrological modeling, e.g. soil moisture

Debajyoti Mondal, Department of Computer Science
Working on data visualization and machine learning

Dave Schneider, School of Environment and Sustainability
Modeling biological processes, root architecture/general computational work

Jeff Schoenau, College of Agriculture and Bioresources
Working on nutrient stewardship and soil management, SK farmer, the ground reality

Andrea Kraj, School of Environment and Sustainability
Working with indigenous communities and issues tied to the food-water-energy nexus

Seokbum Ko, College of Engineering
Using the Internet of Things (IoT), imaging to interpret food-water nexus data

Sara Sadri, Global Institute for Water Security
Working on soil moisture and app development relevant to irrigation

Chithra Karunakaran, Canadian Light Source
Working on high-resolution imaging

- Debajyoti Mondal's expertise in visualization can assist in large scale remote sensing/modeling work
- Dave Schneider suggested that we unite around a question and also raised the issue of scales (producer, northern community, the provincial government, national/international). The focus should be on uncertainty and on providing decision support tools when considering the scale
- Seokbum Ko raised the issue of internet access in rural areas given the increased use of technology in farming
- Sara Sadri expressed interest in doing research on vertical farming. She is also planning in developing an app that will help with the irrigation demand scheduling
- Jian Liu is interested in connecting with Andrew Ireson about frozen soil processes, with Jeff Schoenau about his nutrient research, and with Sara Sadri about her irrigation research
- Sara Sadri and Debajyoti Mondal might like to work together on an app for irrigation demand which will need input from farmers
- Leon Kochian inquired about root zone soil moisture - what is the state of the art. Andrew Ireson noted that there are ways to measure, but we have irreducible uncertainties due to heterogeneity
- Participants agreed that USask has good models and modeling capabilities
- During the discussion, some fundamental process gaps - e.g. root water uptake and preferential flow were observed. Chithra Karunakaran mentioned the use of imaging in pore network, scale models development
- Christy Morrissey suggested that we coalesce around a particular place, or places (e.g. network of farms) - there is scope to carry out a range of work
- The site-based approach was preferred by many participants during session 2. "***Get everyone working on different, interconnected problems at the same field sites...location-based nutrient and water-based science.***"

- Participants also suggested that nutrient management would be a good theme to unify around. Jay Famiglietti added Water Stewardship to the mix. "***Nutrient stewardship + water stewardship***"
- Overall the strongest themes to come out of the discussion were the suggestions of
  - placed-based research - something like Long Term Research or Critical Zone Observatory sites in the United States, where the researchers can all work together
  - a focus on water and nutrient management - or “stewardship” - cut across many of the interests and skill-sets of individuals that presented

Figure: Word cloud from mining the recording of the second session

Big Questions

Nutrient stewardship

+

Water stewardship

G	What are our capabilities when it comes to predicting crop productivity as a function of water availability and how can integrate crop models with hydrological models?
G	What would an ideal visualization look like for the food-water nexus available data?
M	What is needed to create a robust, data-driven decision support tools for multi-stakeholder groups?
L	How to ensure continued economic viability of ag producers and supporting industries while maintaining/improving water quantity and quality in Saskatchewan?
G	What are the integration points for energy in the food-water nexus?
G	How could we prepare for the changes that climate change is going to impose in our models and observations?
L	What would be the best ways to maximize expertise at USask on the Food-Water Nexus?

Day 1
Session 3

Moderator: Christy Morrissey

Presenters:

Carol Henry, College of Pharmacy and Nutrition
Linking agriculture and nutrition along the value chain

Banani Roy, Department of Computer Science
Working on workflow and data management

Javier Mora-Macias, Global Institute for Food Security
working on improving crop's access to nutrition under extreme condition

Susanna Barnes, Department of Archaeology & Anthropology
Engaged in community-based and ethnographically grounded research

Warren Helgason, College of Engineering
Working on crop-climate hydrology interaction

Christy Morrissey, School of Environment and Sustainability
focuses on understanding exposure and effects of environmental pollutants

Steve Shirtliffe, College of Agriculture and Bioresources
Working on optimization of managing crops

Jeffrey McDonnell, Global Institute for Water Security
Working on runoff source, flow path, and travel time

- The session discussion focused on the opportunities for collaboration or working together e.g. cross-disciplinary collaboration
- Participants expressed appreciation towards Vice-President of Research, Karen Chad for her notion and inspiration for being shovel ready for opportunities. That led Usask towards some big opportunities that have been successful, as a university. This workshop might usher a shovel ready project or such opportunities
- Jeffrey McDonnell was awed by the fact that the workshop brought in almost an entirely different constellation of people compared to conversations GIWS had initially during its establishment, a decade ago. He expressed appreciation for the young faculty that have been hired especially in recent years
- Open data and more sharing of ideas were supported, given the magnitude of human resources available at USask
- Tailoring crops for certain hydrologic or nutrient environments and managing water certain crops are two themes to see something long-term coming out of the workshop
- Finding overlapping aspects between GIWS and GIFS in the long term and not operating in isolation was a key discussion point
- Environmental sustainability and reducing the carbon footprint along with increasing yields is both connected to soil and water
- The carbon Sequestration zone is both for water and plant research
- Companies are working on their sustainability stewardship and they have a push to get information from researchers. Farmers or companies are asking for evidence on good practices
- A gap was identified in our ability to take practices the ground and relate them to what is being measured, and translating that into a meaningful tool/resource for decision-making that will shift agriculture not only here in Canada but around the world the need to do more
- The need to do more social research like credit for ecosystem services given that farmers are entrusted with the societal benefit of providing food to the society

- We should have a model that incorporates rewards for farmer's ecosystem services and also, identifying areas of the landscape where farmers actually lose money. If we can identify the locations where farmers don't make money at growing those locations can be utilized for ecosystem services even if there was a zero-sum game for the farmers
- How we can solve the problem of the different data set, format, or connecting different software tools to get a more robust output which is an important topic going forward particularly as we start using more complex interdisciplinary data

Figure: Word cloud from mining the recording of the third session

Big Questions

Overlap?
Global Institute for Water Security
+
Global Institute for Food Security

G How to efficiently effectively collaborate and analyze large-scale scientific data?

C In our engagement with food/water, do we seek to understand the role that these resources play in sustaining forms of socio-cultural life?

G How can we better incorporate participatory science into our research to improve the adoption of alternative agricultural practices?

G Can we forecast water availability for crops before planting? a) soil water availability b) precipitation

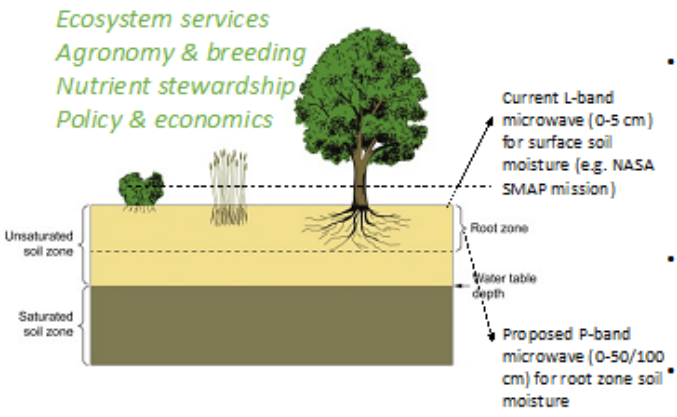
C How do you see community-engaged approach fitting into addressing food-water nexus research?

G Can we develop an age-based water balance?

Day 1
Discussion Session

Moderator: Jeffrey Mcdonnell
Dave Schiender

A Root Zone Water Balance project for understanding where and when roots access water
Implications for more efficient irrigation



- Measure water balance, especially profile of soil moisture in the root zone, for representative crops throughout the growing season.
- Simultaneously perform: isotopic analysis of soil, plant and transpired water to understand where in soil profile roots access water; canopy water balance; root distribution characterization; other measures of plant health, e.g. SIF
- Build conceptual model of frequency and depth of how crops access water, with implication for irrigation scheduling
- Test model in future growing seasons; estimate water savings, benefits, etc.
- Use field studies to understand how remote sensing of surface and root zone soil moisture can contribute to improving water use and irrigation efficiency

- For reference, the summary discussion began with a summary slide prepared by Jay Famiglietti and slightly modified by Dave Schneider
- Water use efficiency is a primary determinant of agricultural productivity in most prairie contexts. Note the presence of both human and biophysical factors and the critical role played by water and nutrients in the root zone. Long term success depends on finding solutions that improve productivity, economic value, and environmental sustainability
- The concept of establishing/connecting with a consortium of producers emerged who can give scientists access to real-life scenarios and scientists can provide the consortium with open source data and research. Also, the cohort can help describe/advise how they are using the research data/technology and the impact
- Creation of sites/network of sites that can help to have both extensive and field-level research, and also compliment multiple thematic areas of research was discussed
- Better management of physical and computational data so that they rub shoulders
- The idea of a common server that can provide a general idea of the data and expertise at USask came out of the discussion.
- Participants encouraged the organizers to create the environment for smaller group interaction and identify a few ideas to pursue food-water nexus
- The Pan-Canadian institutional collaboration was discussed, e.g. collaboration with Arrell Institute at Guelph, AAFc, etc.
- The University of Saskatchewan has land resources that could be utilized for collaborative research purposes
- Experts from the field of livestock were lacking in the conversation of Day 1

Discussion/Proposed Ideas

Inspire the world by achieving meaningful change with and for our communities.

-USask's University Plan 2025

- # Quarterly gathering of scientists interested in thematic areas. Collaborate with Pan-Canadian Institutes e.g. Arrell Food Institute, AAFc etc.
- # Development of thematic areas such as production, agronomy, socio-economics, biodiversity (wetland and waters) and soils. Identify scientists expertise and interest in thematic areas
- # Identify, classify, and communicate overlapping geography and transformational work (Spatial nesting). Collect the required metadata and build an interactive tool
- # measurement and indicators that can be used in small/large scales field research and which one can be used as proxy indicators?
- # Establish mechanisms to invest and encourage stakeholder engagement and social science research. Creation of a consortium of producers.
- # Establishment of a national network of long-term agricultural ecosystem network/living laboratory

Day 2
Session 1

Moderator: Andrew Sharpe

Presenters:

Leon Kochian, Global Institute for Food Security
Uses remote sensing to develop/ communicate decision-support tools

Elaine Wheaton, Global Institute for Water Security
Working on computational modeling of biological and microbiological systems

Sabine Liebenehm, College of Agriculture and Bioresources
Working on microbial aspects of soil and plant root-microbe interactions

Maryse Bourgault, College of Agriculture and Bioresources
Quantifying nutrient and moisture flows from hillslopes to the fields

Venkatesh Meda, College of Engineering
Focuses on global food security and bioscience innovation policy

Andrew Sharpe, Global Institute for Food Security
Working on root-microbe-soil interaction

Yanping Li, Global Institute for Water Security
Working on pollutant impacts and processed on indigenous community

Ian Stavness, Department of Computer Science
Understanding nutrient cycling in agroecosystems

Chanchal Roy, Department of Computer Science
Understanding nutrient cycling in agroecosystems

- The first day of the workshop made clear that agricultural research is a large and complex, multidisciplinary science field
- USask has researchers spanning a wide range, from the biological sciences, across the physical sciences, and into the social sciences
- A goal could be to train the agricultural researchers of the 21st century that can either work at the interface of biology and physical sciences or have the tools to work with the scientists from the other disciplines and start speaking the same language
- Based on technological and computational advances, GIFS is able to conduct digital mining/digital breeding of digital crop genomes and phenomena on the genomic side. These tools could be used for the crop improvement side of research at the food-water nexus
- Yanping Li works on land surface and hydrological modeling that can be used to conduct crop modeling and is helpful for climate adaptation study. There is scope to improve the parameterization of dynamic crop growth in our coupled model
- Maryse Bourgault invited the group to join in a cropping system comparison experiment where researchers explore intercropping, crop rotations, winter crops cover, crops bearing including livestock grazing

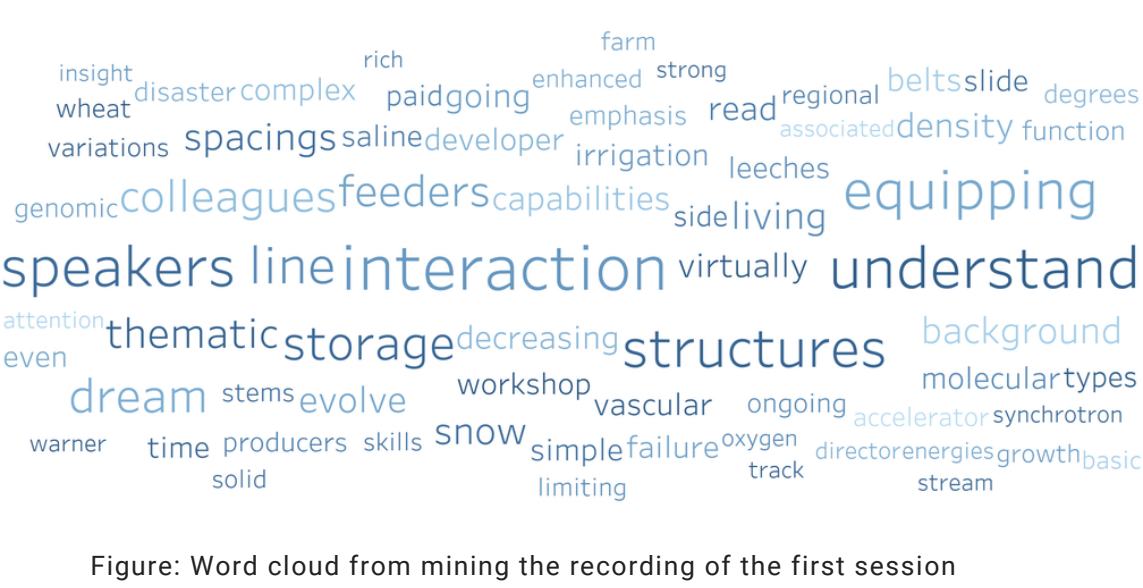


Figure: Word cloud from mining the recording of the first session

- Speakers discussed more strategic partnership and relations building across the campus
- Overall this was a vibrant session in which we learned a lot about GIFS and its CFREF, the P2IRC program. There is room to integrate water studies into plant breeding work at GIFS: amounts of water, quality, salinity, etc, in both rain-fed and irrigated plant breeding
- The network of field sites idea continues to bubble up with presentations
- Yangping Li opened the door to crop-hydro modeling Big data and data/food platforms emerged as an important idea

Big Questions

...Support the development of more productive, efficient, resilient, inclusive, and sustainable food and integrated water resources management systems

-G20 Agriculture and Water Ministers, 2020

G What are the impacts of climate variability and extremes on agriculture and water?

C Culturally accepted solutions for climate-resilient development pathways with equal opportunities for everyone?

G How can we address gaps in the awareness and use of climate information for adaptation and reduction of vulnerability

G How can we adapt agricultural production systems to climate change?

L With the Saskatchewan Irrigation Plan 2020 in mind, what research support we can provide to the Provincial agencies?

G Can we be the world leader in food-water data?

Day 2
Session 2

Moderator: Bing Si

Presenters:

John Pomeroy, Global Institute for Water Security
Working on process-based hydrological modeling

Emil Hallin, Global Institute for Food Security
Working with polarized penetrating radiation

Bing Si, College of Agriculture and Bioresources
Researching the deep soil and deep soil hydrology

Gianluigi Botton, Canadian Light Source
Uses electrons to study materials

Margot Hurlbert, Johnson Shoyama Graduate School of Public Policy
Working on social science methods related to climate change and water-food-energy

Sina Adl, College of Agriculture and Bioresources
Working on microcosms, stable isotopes, and soil biodiversity

Raju Datla, Global Institute for Food Security
Studies Arabidopsis and crop plants developmental biology

Jeff Warner, Canadian Light Source
Working on high-resolution imaging, spectroscopy, scattering

Carl Gutwin, Department of Computer Science
Working on human-computer interaction and visualization

- GIWS' CFREF, the Global Water Future program, is focusing on Cold Region Hydrological Modelling
- The Canadian Light Source (CLS) can be utilized for soil sciences speciation, food structure (crystalline), chemistry, plants (Structure, roots), seeds (chemistry, metrology, contaminants), water (soil contamination in mining operation), etc.
- CLS can also assist in understanding unique structure at the mesoscale: where are nutrients, water? The synchrotron is most powerful when it's well integrated with other techniques, e.g. analytical, modeling, or in situ
- From a contaminant perspective, timescales of stability are important. Is artificial aging a possibility in experiments?
- Margot Hulbert pointed out that GHGs in soil, water, nitrogen, cropping practices, and the accounting, verification, and reporting of GHGs- together with policies is a large but important goal to solve
- There is interest in the mechanistic insights into the inner working of water, nutrient, and CO2 utilization efficiencies in crop plants for improving seed/grain yields
- Through this session, the idea of sustainable food production-coupled with sustainable water management, in the face of climate change, as the overarching question, models, sites, transdisciplinary connections, all fit nicely underneath such an umbrella, which can lead to the development of future large projects

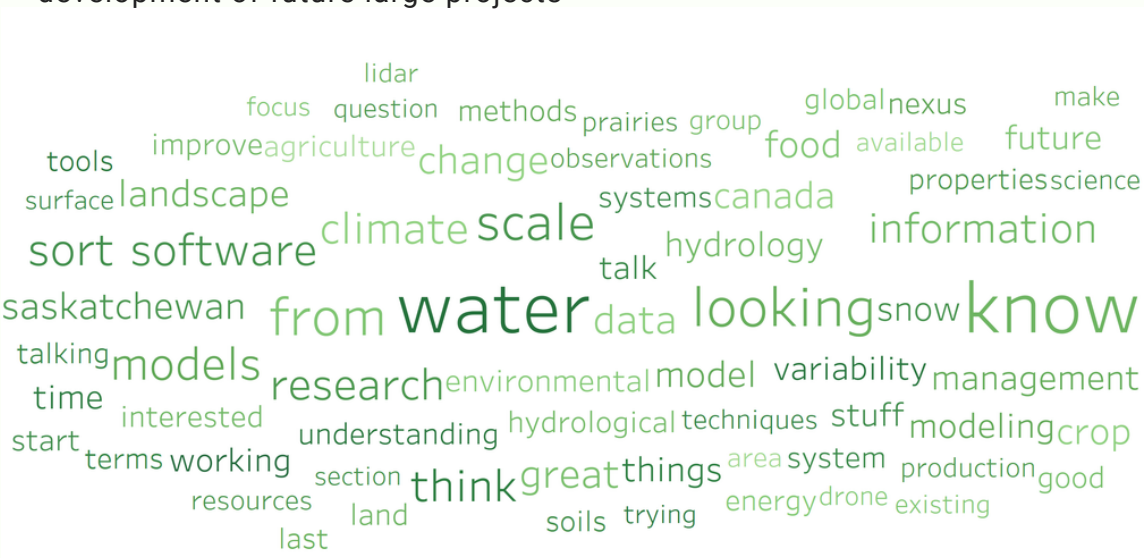


Figure: Word cloud from mining the recording of the second session

Big Questions

A New Model Development Program= Network of Research Basin + New Observational Technology

G How can we develop agrohydrological models driven by climate and crop futures that can predict effectiveness of future agricultural practices?

L Is there a good reason to do your research anywhere else in the world?

G How to manage deep soil water, so that our agrosystem can cope better with extreme weather events? Linking deep soil water with irrigation?

G Are deeper the roots better in semiarid environment?

L Can we predict and avoid cascading risk in multi-breadbasket failure?

G How can we better link regional hydrology to seasonal weather patterns, and soil biogeochemistry? Can we include a historical perspective?

G How can we better link regional hydrology to seasonal weather patterns, and to soil biogeochemistry? Can we include a historical perspective?

Day 2
Session 3

Moderator: Angela Bedard-Haughn

Presenters:

Phillip Harder, Global Institute for Water Security
Researching Ag-Water Interactions in a cold climate

Kevin Schneider, Department of Computer Science
Working on software and human-computer interaction

Martyn Clark, Global Institute for Water Security
Working on computational hydrology

Angela Bedard-Haughn, College of Agriculture and Bioresources
Engaged in community-based and ethnographically grounded research

Amin Elshorbagy, College of Engineering
Working on performance and sustainability assessment

Patrick Lloyd-Smith, Global Institute for Water Security
Researching human behaviour and values for environmental resources

Barrie Bonsal, Environment and Climate Change Canada
Focuses on hydro-climatic extremes such as droughts and floods

- Soil sampling can be a process where water scientists, soil scientists, and microbiologists can interact. Bobbi Helgason, Angela Bedard-Haughn, Bing Si, and others expressed interest to work together with Phillip Harder
- Digitizing the soil surveyor's conceptual model across the landscape and validating it a very important work. There is a need to collect data and conduct research that can be utilized at the management level scale. The existing legacy soil data of Saskatchewan does not help to research carbon distribution or nutrient movement
- The participants expressed interest to extend their research into the deeper root-zone. Using satellite data can help to digitize the soil maps but often does not include wetlands, which are important for management purposes. An integrated mapping approach that involves stakeholders that can help in the process
- There has been 30+ million dollar development around the Livestock and Forage Centre for Excellence at Clavet in the last 6 years. The involvement of the Centre will create synergy for the food-water nexus conversation at USask. The first step may be to formulate some appropriate common questions
- An ongoing disconnect is between the crude crop growth modeling in hydrology models with the detailed crop growth understanding from the plant physiology side. A formal working group to translate information between these two arms of science may become beneficial for future breeding programs

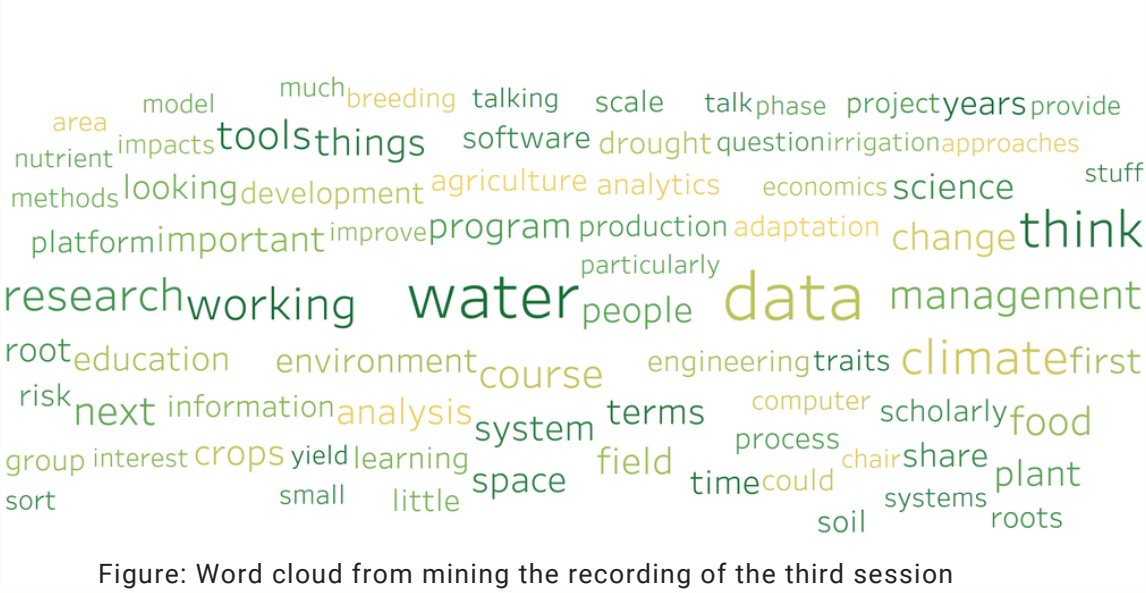


Figure: Word cloud from mining the recording of the third session

Big Questions

About 75% of all agricultural water withdrawals in Canada take place on the Prairies, mainly for irrigation

G How will advances in crop breeding and agronomy change the agricultural systems of the future?

L How is research software limiting/enhancing scientists' research?

G How can we better incorporate our understanding of soils variable nature into management, models and policies?

L Establishment of a strategic research unit focusing on water, energy and food

L How can we utilize the interdisciplinary expertise in the two global institutes to inform policies?

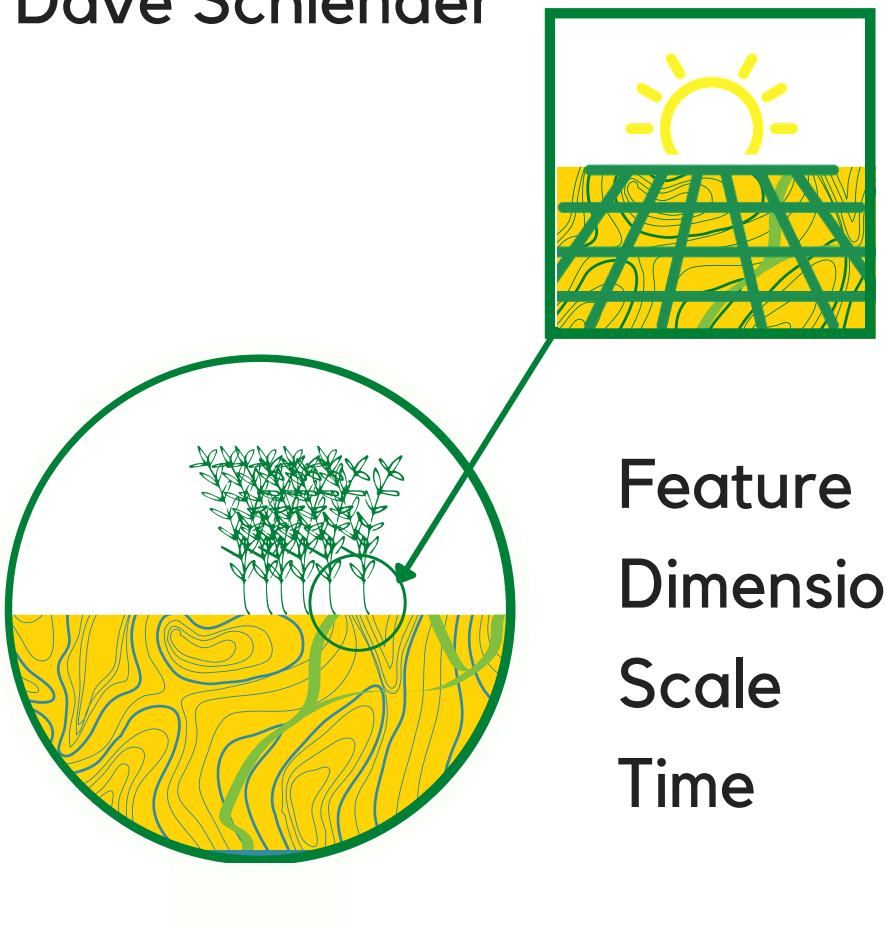
G Where, when (how) do we transfer water from areas of surplus to areas of deficit in the future?

Day 2
Discussion Session

Moderator:

Leon Kochian

Dave Schiender



Feature

Dimension

Scale

Time

- GIFS is leading an initiative with Bangladesh around sustainable food security and at the heart of that is sharing and exchanging technology and technology transfer as part of the overall goal. The initiative has successfully gathered several people from different parts of the campus, not just the university but also in the federal bodies and places like the Food Development Center
- The initiative has pinpointed four main research themes and an overarching technology center, which has reached the point of a high level of political support from both Canada and Bangladesh. This initiative and its themes relate very closely to the agenda of the food-water workshop
- The four themes are around genomics and phenomics, soil health and quality, the water soil water regime and adaptation to climate change, and the post-harvest handling, and processing
- There is much science to be done in the scope of large-scale irrigation in both developing (Bangladesh) and developed (Canada) countries. At the heart of Saskatchewan, Saskatoon, the two institutes (GIWS and GIFS) existence should provide the best available science to the policy-makers to assist in their decision-making
- Mapping water in the root zone is a significant technical issue because of the water use efficiency limitation of production in typical prairie environments. The spatial distribution really requires producers to be useful. There is a need to get fine-scale information about variation in soil type and water availability but what is available currently from satellites is minimal depth for microwave measurements
- There has been a proposal to put up a P-band microwave system to get deeper information about deeper layers and get finer scale information that's gridded at a scale relevant to producers. Given that the unsaturated soil zone really is the food-water nexus, physically, workshop participants realized it makes sense to focus on the characteristics from soil science and nutrition management perspective

- Speakers commented that, from a food-water nexus perspective, the CLS/imaging has been underutilized
- There has not been much emphasis on the human and socio-economic dimension of the food-water nexus work which requires further attention from an interdisciplinarity prospect

Discussion/Proposed Ideas

Foster, expand, and diversify local, national, and global partnerships—rooted in reciprocal learning and the co-creation of knowledge.

-USask's University Plan 2025

- # Development of computer science as a research pillar and a technology platform for agriculture at USask
- # Development of academic programming, professional certificate and training programs that established USask as an **Food-Water Nexus Education Hub**
- # Develop world's first functional visualization of an intact and stationary rhizosphere in natural soil medium, with visualization of the biotic and abiotic participants
- # Improving representations of agriculture in hydrological models, representations of hydrology in crop models, and crop-water models in precision agriculture
- # Creation of a site, that is right next door, that can be utilized collectively by the scientists to better understand water-plant-soil relationship
- # Utilize the Synchrotron to it's full potential for food-water nexus research

Moving Forward

We have the necessary tools at our disposal at USask and also, the minds. We need to make collaborations happen.

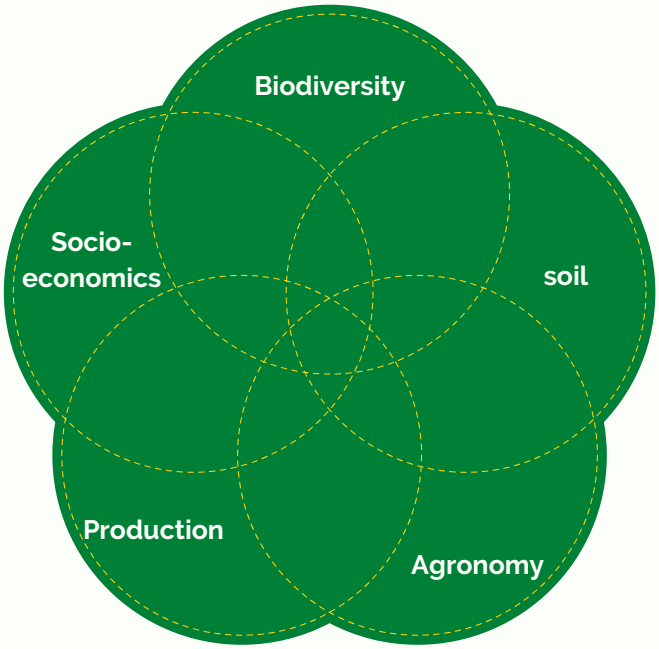


Figure: Tentative thematic areas

Development of Thematic Areas

To build on the success of the first ***Connecting the Dots: Food-Water Nexus workshop,*** we will now begin to organize more focused meetings of thematic areas. These smaller group interactions will help build interpersonal relationships and also will help focus on goal identification, process, and accomplishment.

A systems approach to the plant-soil-water continuum in the root zone

The physiological response of plants to abiotic stresses such as heat and drought is extremely complex and difficult to study in field settings due to the spatial variability of factors such as soil quality and drainage patterns. Proper stewardship of nutrients and water are fundamental to both sustainability and productivity. Management decisions and environmental events may have lasting impacts through hysteresis – the state of the system depends on the past through the availability and spatial variation

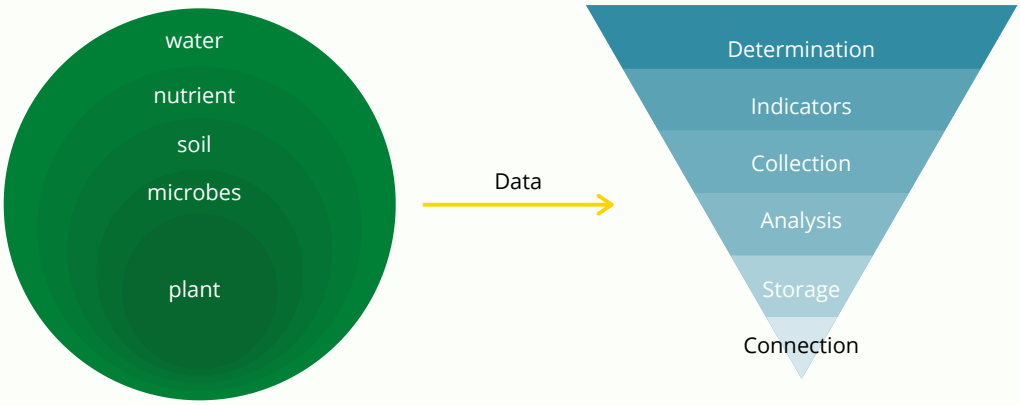


Figure: schematic diagram of connecting multiple levels of plant-soil-water continuum and data issues in the root zone. Integrating and visualizing data across the continuum remains a very difficult and important conceptual, computational, and practical problem.

of water, nutrients, organic carbon, soil microbiota, etc. Water use efficiency is critical in the Canadian prairie provinces. Root-zone measurement, modeling, imaging, and visualization capabilities must cope with dramatic variations of spatial and temporal scales.

Collaboration Grounds

The long Term Ecological Research Network (LTER) model in the United States encourages sustainable use of study areas allowing researchers to benefit from prior work in the same location. On the other hand, the spatial heterogeneity of the prairie agroecosystem makes it very difficult to select a small number of sites that would faithfully represent that variation. These

considerations suggest the importance of having a diversity of sites that would support both fundamental and applied research programs. The proximity of research sites to the university would be very helpful. Several such sites were discussed including the Livestock Forage Center of Excellence and a nearby farm that is being decommissioned, the St. Denis National Research Area, university-owned research plots, and various privately owned farms. It may be possible to promote cross-campus collaboration, simplify logistics, and leverage prior work by other groups by developing a mapped inventory to facilitate research on place-based research programs. Sites with ongoing commercial production would be extremely valuable because they would serve as living laboratories for translational research.

Food-Water Data Hub

Data science especially analyzing big data in different fields is becoming more and more popular and, while crucial for breakthrough research. The introduction of big data and machine learning methods has extensively increased the ability to understand agricultural processes at multiple scales. USask's strength in computer science, water, and food offers the possibility to build a data hub that can support the collection, organization, and analysis of big data.

More involvement with CLS

Canada's only Synchrotron is located at the heart of the USask. For the last 20 years, it's been working with national and international agencies and researchers on multiple intricacies. There is a growing interest for researchers on campus to use this facility and also, there is an interest from the CLS side to assist in food-water nexus research. This was highlighted multiple times during the workshop.

Training Hub for Next-Generation Researchers

There is a growing need for specialized training in the food-water research arena, especially in the food-basket regions of the Global South. Researchers expressed interest to create pragmatic professional and academic programs that can bring in talents and revenue to USask.

The Bottom Line

Economic factors such as the need to maximize yield often dominate producer decisions. Developing a more robust, productive, and sustainable agroecosystem may require agricultural policy initiatives to incentivize progressive decision-making by producers. For example, currently, the crop insurance system does not reward producers for planting drought-tolerant varieties. Other socio-economic considerations include the valuation of biodiversity and ecosystem services outside of the transactional nature of the traditional agribusiness model. Thoughtful, deliberate, and sensitive engagement is critical to the success of collaborations with Indigenous communities in remote settings where food, water, and energy insecurity must be addressed simultaneously. Developing innovative solutions that maintain or enhance economic productivity and environmental sustainability in a broad sense should be viewed as building a critical national and provincial capability.

Beyond the Circle

The workshop hosted participants from more than ten USask departments. But there is still expertise within USask that can be tapped into in our future conversations. For example, future meetings will seek to engage participants from the Edward Business School, Livestock and Forage Centre of Excellence and the School of Public Health.

Planned Next Steps

- Broad dissemination of the report across campus A call for more focused follow-up meetings to discuss new collaborations, proposals ideas and related activities

- An expression of interest for a CREATE proposal has already been submitted. Open discussion on how to best formulate the proposal will be announced

- A map database of field sites where USask researchers have and are working has been initiated. This will ensure the exchange of ideas and data on multiple levels.

- Discussion of potential a CFI submission will be announced The possibility of seed funding for workshop-related pilot projects will be explored.

- A survey to gauge the interest among researchers to produce specific academic and professional training modules on food-water security by March 2021.