



# International Stewardship Symposium

## REPORT



## The Big Takeaways

The International Stewardship Symposium (14-16 July 2014) held in Saskatoon, Saskatchewan was organized by the Canadian Fertilizer Institute with funding from Agriculture and Agri-Food Canada's Agricultural Greenhouse Gases Program (AGGP). Organizing partners including, The Fertilizer Institute, the International Plant Nutrition Institute, the International Fertilizer Industry Association and the Global Institute for Food Security, came together to address current and future challenges surrounding sustainable agriculture for a growing global population. These challenges will require greater effort and more efficient use of plant nutrients, as well as special care of waterways and soils. With the overarching theme "Feeding Crops to Feed the World," the Symposium brought together key stakeholders in the national and international agricultural community to share and discuss solutions around responsible nutrient stewardship. Featured in the Symposium was the concept of 4R Nutrient Stewardship (Right Source @ Right Rate, Right Time, Right Place®) and its contribution in mitigating greenhouse gas (GHG) emissions, as climate change becomes top of mind on the global stage.

From the discussion generated over the two days at the International Stewardship Symposium, the following next steps should be considered as necessary actions for the path forward:

- **Establish Support for the Evidence-based Approach.** The 4R Nutrient Stewardship program is a science-based approach relying on evidence from research. In order for growers to make informed decisions about their plant nutrient Best Management Practices (BMPs) on the farm using the right source, at the right rate, at the right time and in the right place, those BMPs require support by scientific principles and science-based evidence. Soil and weather are both complex entities and understanding the relationship as they relate to agricultural practices is essential for the development and evolution of BMPs. Agricultural tools that may aid farming practices, including soil status measurements and weather modelling, also stem from principles learned from scientific studies. Therefore, it is important to maintain support to fund this research. Similarly, GHG emissions can be reduced but because they are region-specific and can be highly variable, a better understanding of how GHGs behave in different regions provides sustainable options for mitigation strategies.
- **Connect Research to Growers.** There is a lack of extension and technology transfer initiatives particularly in developing countries despite the vast number of opportunities that exist. They are also identified as key elements in moving forward as they bring essential information about nutrient stewardship programs to growers. Creating partnerships with various stakeholder groups and other stewardship related programs for clean air, water, and soil can aid in increasing awareness of BMPs for agriculture. Understanding the audience demographic and encouraging producers to share their experience can also serve as a powerful communication tool. The sharp focus on extension programs must be maintained. Extension programs serve as a link between research and growers — the benefits of nutrient stewardship practices cannot be communicated without these initiatives.
- **Communicate to Raise Awareness and Make Connections.** Achieving a global strategy for real environmental and economic performance will require a holistic approach. Bringing people together, both inside and outside of the agriculture sector, will be essential for success. Creating partnerships through common goals, developing metrics that demonstrate the success of the program, and pushing forward with outreach and extension initiatives will aid in increased adoption of the 4Rs on an international level.
- **Data Collection and Sharing.** Development of a 4R data collection system or network for research and the development of good-practice indicators may be of interest. Data is a powerful reflection on the benefits of nutrient stewardship programs and can help communicate the program on multiple levels inside and outside of the industry.



The 2014 International Stewardship Symposium was successful in achieving its objectives. It provided education and awareness among audiences on the sustainable aspects of 4R Nutrient Stewardship BMPs. It fostered systems-based research to increase agricultural productivity while stewarding land and natural resources in the best way possible. It created an international, multi-stakeholder network to implement the 4Rs on a national level. Lastly, it enabled 4R Nutrient Stewardship to be embedded into global agricultural extension programs. We look forward to learning more about the continuing collaborations that encourage global agricultural sustainability and feeding crops to feed the world in 2015 and beyond.

The following report documents discussion from this inaugural event and summarizes suggested next steps in moving forward with 4R Nutrient Stewardship adoption.

## International Stewardship Symposium — Prelude Activities

### 1. Research Plot Tour

The International Stewardship Symposium was preceded by tours of two research fields under study at the University of Saskatchewan, providing participants with an opportunity to view local examples of research on the ground utilizing 4R Nutrient Stewardship. In order for growers to make informed decisions about fertilizer BMPs on the farm; including implementation of the right fertilizer source at the right rate, at the right time and in the right place; there is a need for those BMPs to be supported by scientific principles and science-based evidence. This forms the fundamental basis of the 4Rs.

Dr. Richard Farrell's research site at Goodale Farm investigates fertilizer and pulse crop residue interactions. His team is trying to identify factors that contribute to a 'leaky nitrogen system.' Nitrogen (N) is an important GHG component in the form of nitrous oxide ( $N_2O$ ) which contributes to climate change, but plants cannot grow without it.

Using stable isotope labeling of Nitrogen and Carbon on a variety of major Prairie pulse crops including pea, lentils, chickpea and faba bean, Farrell's team can measure the fate of the carbon and nitrogen in soil organic matter pools, in greenhouse gas emissions and the availability and uptake of Nitrogen into a subsequent crop (in this study, wheat) in rotation. Gas samples are collected using chambers installed on the field to measure GHG emissions from plant decomposition, above-ground and below-ground residue and fertilizer additions. Studies are expected to provide new insight into the contribution of different pulse crops to soil organic matter dynamics — a key measure of soil health; cumulative amounts and temporal patterns of GHG emissions and below-ground benefits to subsequent crops in rotation. Such new insights will have implications on source, rate, time and place decisions for growers in the Prairies and help improve on-farm environmental sustainability.



*Darin Richman demonstrating a sample measurement for  $N_2O$  emissions from the gas chamber*

Dr. Jeff Schoenau's research site focused on a Short Soybean Fertility study. At the recently seeded site, Schoenau introduced his project, which evaluates nutrient requirements, N-fixation and release of available nutrients by short-season soybeans, in comparison to other pulse crops — lentils and peas. Short season soybean is of interest as an emerging profitable yield in Saskatchewan. Crop breeding efforts have led to the development of varieties of soybeans that can operate in the shorter growing season that exists in Saskatchewan.

In their soybean study, Nitrogen isotope labelling is used to determine how much nitrogen is being fixed by these three pulse crops (soybean, lentil and pea). Uptake of soil nitrogen is also done using the isotope labelling and resin membrane (Plant Root Simulator) probes used to measure the dynamics of nitrogen in the soil. Schoenau hopes to optimize the fertility of the crops — the nutrient management, the maximization of nitrogen fixation, and the recovery of nutrients by crops in the entire crop rotation system. This information would provide Saskatchewan growers with a better profile of short-season soybean and its interaction with other crops so that the right source, rate, time and place practices can be put to use.



*A demonstration of the gas chambers for N<sub>2</sub>O emissions sample collection on Richard Farrell's plot*

## 2. North American 4R Summit

The Fertilizer Institute hosted the annual North American 4R Summit, which brings industry groups together to discuss agricultural issues and provide feedback on 4R Nutrient Stewardship efforts. This year, the half-day summit provided participants with developments on the projects funded by the North American 4R Research Fund; state and provincial 4R Nutrient Stewardship efforts; and supply chain sustainability efforts. Examples of such developments include progress reporting on meta-analysis and research projects to support new and existing knowledge on 4R BMPs; regionally developed certification programs to count 4R acres and address emerging environmental issues for watershed conservation; and ongoing development on collaborations with various supply chain stakeholders involved in agricultural sustainability.

## International Stewardship Symposium — Day 1

Setting the tone for the International Stewardship Symposium, Sean McMahon (The Nature Conservancy) opened the meeting with his perspective on the conference theme: Feeding Crops to Feed the World. He acknowledged that the agricultural industry faces an incredible challenge of producing more food by 2050 than in the last 10,000 years. His impression of the 4Rs was that it continued to gain attention by those outside the fertilizer and agricultural industries, as a solution to addressing this complex global challenge. McMahon also emphasized the critical relationship required between nutrient stewardship and agricultural sustainability efforts. As an example of this connection, he spoke to Field to Market: The Alliance for Sustainable Agriculture. Field to Market is a 4R partner who is currently exploring ways to incorporate right source, right rate, right time and right place technology into their Fieldprint Calculator. McMahon identified the 4Rs as providing an opportunity for alignment with various key stakeholders outside of the agriculture industry.



*"The 4R Nutrient Stewardship program is a win-win for producers, agribusinesses, conservation organizations and the general public at large. Essentially, it's all about more efficient resource utilization. If we can increase the uptake of nutrients by the crop, then not only are we improving yields and farmers' profitability, but we are improving environmental performance."*

Sean McMahon — The Nature Conservancy



## Session 1: Feeding Crops to Feed the World — 4R Nutrient Stewardship Solution

Dr. Robert Tyler (Global Institute for Food Security) provided a global perspective on the issue of food security, identifying increased productivity as a priority for addressing increasing population demands. The 4Rs are identified as a way to contribute to increased productivity while addressing environmental concerns.

The first session provided delegates with an overview of 4R Nutrient Stewardship and showcased application of the 4Rs in smallholder farms to improve farm profitability while reducing losses of crop nutrients to the environment. 4R Agronomist, Dr. Dan Heaney (Random Cross Consulting) outlined 7 Essentials of 4R Nutrient Stewardship:



Dr. Adrian Johnston and Dr. Fernando Garcia (International Plant Nutrition Institute) showcased approaches to developing information and extension programs with smallholder farmers in other countries. Fertilizer recommendations based on soil testing forms the scientific background to nutrient management planning in most of the developed world. However, access to, cost and timeliness of soil testing services in the developing world has seriously limited access to this diagnostic tool. To address this challenge, IPNI helped develop a decision support system that encompasses science-based, 4R consistent fertilizer recommendations for wheat and maize in Asia and Africa. Using the 'QUEFTS' model (Quantitative Evaluation of the Fertility of Tropical Soils) showing the relationship between crop yield and nutrient uptake, an accessible on-line decision support system tool (Nutrient Expert™) was developed which incorporates the expert knowledge of regional agronomists and advisors in a set of questions asked to the farmer. In Latin America, delegates heard examples from the Southern Cone of how 4Rs are used in their wheat-soybean-maize cropping systems. Gaps between current and water-limited attainable yields are estimated at 31.7%, 41.5%, and 41.1% for soybeans, maize, and wheat, respectively. Thus, nutrient management would contribute to closing these yield gaps in several areas and crops. Developments in Latin America include exploration of nutrient deficiencies of different crops and in different areas, soil testing, calibration programs,



*Fernando Garcia explores a 4R Nutrient Stewardship research plot*

evaluation of right time for N application in wheat and maize, comparison of alternatives for Phosphorus (P) placement and time, and evaluation of long-term impacts of balanced fertilization in soil health and resource use efficiency. The goal is to see crop managers selecting practices to apply the right source at the right rate, at the right time, and in the right place, based on support provided by crop advisors, extensionists, agronomists, and research scientists through on-farm, station and laboratory research.

Discussions with this panel invoked interest on the role of technology in 4R practices, the impact and barriers of widespread adoption in the supply chain as a whole and improving crop quality as part of managing yields.

- As a site-specific, flexible concept, 4R focuses on how practices are adapted to the farm, rather than placing emphasis on technological methods that may not be as easily accessible
- Agronomists must continue to play a pivotal role in the progress and adoption of nutrient stewardship
- Quality is as important as quantity for food security
- Food security is a global challenge, but must be played out on a local scale as a proactive strategy



*Adrian Johnston discusses extension programs with smallholder farmers in his presentation*

## Session 2: Economics & Development

Barrie Bain (Fertecon Ltd) provided his perspectives on agriculture as a key driver of the country's economic prosperity. Low-income grower access to inputs required for operating a farm can help increase yields without threatening biodiversity and is a major part of increasing agricultural productivity. Some of the poorest people in the world are in fact farmers who grow barely enough food to feed their families. By using fertilizers in a sustainable way they could not only increase yields but also reap seemingly unfeasible social benefits (e.g. create a surplus of income that could go towards education for their children, and towards consumer goods and services). Through the workings of the economic multiplier effect, this provides a massive stimulus to the whole economy. Making the poor richer is an effective engine of economic growth. Increasing the income of the poorest in society can invigorate money into the economy, and generate other additional economic activity.

The panel for this session looked at various ways in which soil fertility, Nutrient Use Efficiency (NUE) and 4Rs contribute to global agriculture and economic development, particularly in the developing world. Dr. Kevin Tiessen (International Development Research Centre) outlined the role of government in supporting research that addresses economics and development challenges. He pointed out that most smallholders tend to be women who also account for over 60% of the world's undernourished. There is a need to find short, medium and long-term solutions to support these farmers in helping feed the millions of people at risk of hunger and malnutrition while also safeguarding the environment. He also acknowledged that in order for soil fertility, NUE and 4R Nutrient Stewardship to contribute to global agriculture and economics in the developing world, one would need to determine: how to sustainably produce food now and in the future; how to maintain a strong, clear connection between agriculture and nutrition; and gain a better understanding of gender and livelihood issues as it



*"I think what I am going to take back is that it is important that the scientists and the farmers come together so that the research results are taken back to the farmers. I think if that link is maintained, that is the best way the research can have value."*

Charles Ogang — Uganda National Farmers Federation



links to economics, value chains and policy. He drew from key examples of IDRC supported research contributing to these efforts, such as the study of BMPs for pulse crops in Ethiopia and fertilizer micro-dosing in Sahel. Ultimately, growers need to be involved in research and policy makers need to be engaged in what the study reveals. Tiessen suggested that in some cases, it was okay to “think inside the box” by looking to local experiences for improved nutrient stewardship implementation in the developing world. Rafael Flor spoke to the activities underway by the Earth Institute, based at Columbia University, surrounding economics and development. He recapped that the over 50 million smallholders in Sub-Saharan Africa need a different business model that allows them to contribute and benefit from soil fertility, NUE and 4R compared to other places. They face challenges of climate change, low fertilizer use, nutrient mining/soil degradation, and food waste. Sub-Saharan Africa’s 4R solution will require improved extension services; crop-specific fertilizer blends; small scale retail and business services; better promotion/extension of nutrient management knowledge and use of information technology for delivery of 4R knowledge.

Finally, Charles Ogang (Uganda National Farmers Federation) provided a snapshot of the Ugandan smallholder and the economic and operational limitations they face: 1.5 – 3 hectare farms, prominent family labor, and low input/low output (yields 20-30% of developed world farmers). Growers also face erratic rainfall from the impact of climate change that affects 90% of agricultural production in the third world. For nutrient stewardship to be applicable, farmers need access to affordable inputs; have the ability to improve their labour-intensive processes; new knowledge and information on practices; weather forecasting for better nutrient management planning; and credit programs. Ogang urged delegates in the research community to “take it to the farmer” to improve nutrient stewardship in the developing world.

The session stirred much interest on how economics and development of agriculture may be advanced overseas to incorporate soil fertility, NUE and 4R practices. In so doing, increasing knowledge and technology transfer to developing countries through extension work with growers and *grower-to-grower* training was identified. This objective could be achieved by having private extension services and government extension services working more collaboratively, which would also improve on-the-ground relationships between government and grower communities. Acquiring long-term models of common storm systems can help farmers better estimate their timing and placement practices. Maximizing revenue with a changing climate and family security was another challenge addressed for economic improvement in developing countries. Like any business, farming involves risks and rewards which must be a consideration. Profit is always a primary driver and objective for farmers. For their business to be sustainable, finding a balance between profit, livelihood and environmental conservation is key. Cooperatives for buying and selling crops and getting produce to market may provide a way of striking that balance.

### **Agriculture More Than Ever (Lunch Session)**

Lane Stockbrugger (Farm Credit Canada) described the perception and position of Canadian agriculture, stating that the success of agriculture is built on genetics, technology and strategy. Agriculture is important to the Canadian economy, contributing \$135 billion every year through agriculture and agribusiness. As the fifth largest exporter of food in the world, Canada will have a large role to play in meeting the growing demand for healthy, nutritious food. The world



*Economics and Development Panelists Rafael Flor, Kevin Tiessen, and Charles Ogang*

food demand is growing not only due to the increasing human population, but also as food consumption shifts towards improved diets. The future of Canadian agriculture is reliant on building trust. This can be achieved through maintaining a positive image by investing in sustainable practices, the environment, and production of safe, quality food; through creating positive connections with youth, the public, consumers, and taxpayers; and through building opportunities with partnerships.

### Session 3: Reducing Greenhouse Gas — 4R Keys to Success

Reducing GHG emissions continues to be a priority for confronting climate change and its multi-dimensional impacts. The session featured current projects that are seeking solutions to mitigate GHG emissions generated at the agricultural level. Setting the tone for this session, Dr. Dan Heaney spoke to the Nitrous Oxide Emission Reduction Protocol (NERP), which enables growers to obtain offset credits in a verifiable way. In a collaborative project with the George Morris Centre, an analysis was conducted to provide the sustainability effects of using NERP to increase crop production from the existing land base rather than bringing new land into production through improved nitrogen management in Alberta. As a part of this study, a GHG lifecycle model was constructed that included field operations and the upstream GHGs associated with the manufacturing of fertilizer and other agricultural chemicals to evaluate the situations. The results showed that overall GHG emissions per hectare increased substantially with cropping intensity. However, emissions per kilogram of crop produced were similar at different levels of intensity. When the GHG emissions from the land base required to produce the same amount of crops are compared, there is no substantial difference in the GHG emissions among intensification scenarios. Conversely, increasing production through an extension of the area farmed in lieu of intensification involves conversion of lands from grassland, wetland or forest, which will result in a significant release of GHGs and the loss of net sequestration capability as well as the other ecological goods and services provided by natural ecosystems. This illustrates that intensification of existing land base is more effective at mitigating GHG emissions than expansion of land base.

Keynote speaker Dr. Susan Wood-Bohm (Alberta Innovates Bio Solutions) opened the session with her outlook on the Canadian farm community's role in managing GHGs. According to the Intergovernmental Panel on Climate Change, it is predicted that the global non-CO<sub>2</sub> emissions



*Susan Wood-Bohm, Keynote Speaker, engages panelists of the International Stewardship Symposium*



*Clyde Graham of the Canadian Fertilizer Institute presents Charles Ogang with a gift of gratitude*



from agriculture may top 8000MtCO<sub>2</sub>e/yr by 2030, as the world seeks to feed a burgeoning population with high quality foods from a decreasing land base. Canada too is faced with the challenge of reversing the trend of growing emissions linked to agricultural production and has aggressively tackled this problem with impressive research, field trials and support for this initiative. Wood-Bohm took delegates through a roadmap of what contributes to GHGs, citing key agricultural sources such as livestock (through enteric fermentation and manure sources), crop production (via the soil) and on-farm fuel. She brought forward four key messages: Agriculture must account for its GHG footprint, agriculture sequesters carbon, we as an industry can do better and we as an industry can help others do better. She left delegates to consider whether the bio-sphere could support the 40% increase in global population projected for 2050 and beyond. Her impressions were that we need to balance environmental effectiveness with affordability, in the face of pressure to produce more and more.

*Can the bio-sphere support the **40%** increase in global population projected for 2050 and beyond?*

Contributing to the innovative GHG research underway in Canada, 4R Researchers Dr. Mario Tenuta (University of Manitoba) and Dr. Richard Farrell (University of Saskatchewan) shared results from their studies on nitrous oxide (N<sub>2</sub>O) in their respective regions. Both researchers are part of CFI's Science Cluster program, introduced to delegates at the start of the session with a video profile of the researchers. The objective of the Science Cluster program is to demonstrate the benefits of using 4R BMPs under NERP to mitigate N<sub>2</sub>O emissions.

Tenuta's work in Carman and Oak Bluff, MB investigates the impact on N<sub>2</sub>O emissions related to nitrification by looking at enhanced nutrient products, their banding placement and their timing of application. In brief, slowing nitrification using inhibitors, controlled release products and banding lowered emissions; Dicyandiamide nitrification inhibitors were more effective when banded, compared to broadcast incorporated; banded stabilized urea did not result in plant toxicity; very late fall N-addition emitted less N<sub>2</sub>O than spring, but yield risk especially in light of changing weather patterns; and more generally, 4R management of fertilizer in Manitoba can reduce N<sub>2</sub>O emissions by 10-40%, with the caveat of weather influences. Dr. Tenuta also emphasized the importance for ammonia volatilization and leaching to be combined with N<sub>2</sub>O measures, the need for model development to include 4R practices and more automated monitoring infrastructure in more areas in Canada.



*Richard Farrell addresses visitors to his research plot, which focuses on lowered N<sub>2</sub>O emissions*

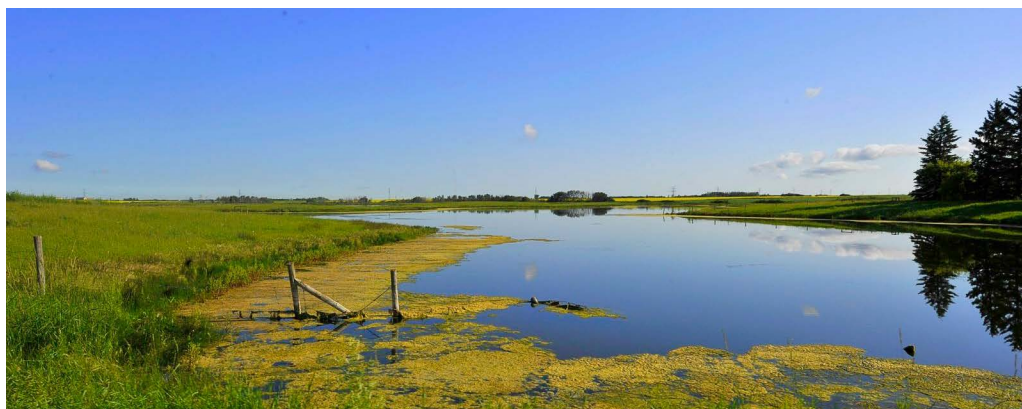
Farrell spoke to one of his companion projects in the Prairies (the Dixon Research Plot in Humbolt, SK) which aims to quantify and compare  $N_2O$  emissions from agricultural plots receiving long-term applications of liquid (swine) and solid (cattle) manure compared to obtaining equivalent rates of urea fertilizer. This would help to identify management practices that most effectively limit  $N_2O$  emissions. Using a randomized complete block design, they are assessing  $N_2O$  emissions as affected by N-source, rate, and sequence of application. They are also assessing the potential for long-term manure applications to “prime” the soil for increased  $N_2O$  production via enhanced microbial denitrification. What they have observed is that source, rate and timing of N application affects  $N_2O$  emissions such that liquid manure produced greater  $N_2O$  than urea, which produced about equal or greater  $N_2O$  than solid manure; emissions increase with increasing application rate; cumulative emissions tend to be greater when N is used in consecutive years and emissions during spring thaw were generally greater following fall N applications. Microbial denitrification enzyme activity was also found to be affected by N rate, regardless of source. The effect increases with increasing application rate; it is greater when N is applied annually, and under the right conditions can lead to higher  $N_2O$  emissions when the N rate is lowered.

Both researchers illustrated that 4R Nutrient Stewardship will be a decisive step to the design of new agroecosystems and that GHG emissions can be reduced but are indeed region-specific and can be highly variable.

An interesting concept that arose during discussions with this panel was the effectiveness of 4R Nutrient Stewardship when considering weather predictions. Growers look to forecasts as part of their planning on the farm. These predictions are growing much more difficult, in part due to the effects of climate change. There is a developing interest in studying the effects of microbes and their interactions with soil as they play a role in controlling soil moisture, which in turn influences climate variables such as temperature and precipitation. A better understanding of this effect can help inform source, rate, time and placement decisions for nutrients on the land.

#### **Session 4: Grower Perspectives — Putting Nutrient Stewardship to use on the farm**

The first day concluded with a panel of four farmers: Dean Hubbard from southern Alberta, Cedric MacLeod from New Brunswick, Steve Watts from Prince Edward Island and Charles Ogang from Uganda. Each shared personal experiences with 4R Nutrient Stewardship on the farm and addressed barriers to grower adoption of 4R BMPs. Dean Hubbard (Silverwood Ventures Ltd.) spoke to his experiences with CFI’s 4R Demonstration Farm program in 2013, sharing soil test results from the program and recommendations for practices from his farm including field-specific nutrient planning, harvest yield mapping and considering variable rate fertilizer as an application approach. Cedric MacLeod (MacLeod Agronomics) described his land at Hillview Farms under a 4R plan, which aims to restore soil biological health (pH, organic matter, reduced nutrient leaching) for crop rotation (potato/snow peas/barley), enhance



*The International Stewardship Symposium emphasized 4R Nutrient Stewardship as a means to minimize the environmental impact of fertilizer use*



crop yields, and better control of lime application to reduce phosphorus leaching. Steve Watts (Genesis Crop Systems Inc.) described the series of thirteen 4R demonstration farms in PEI. Promising results in PEI with Russet Burbank potatoes are supporting 4R Nutrient Stewardship as a sustainable solution for on-farm management. Meanwhile in Uganda, Charles Ogang spoke to the realities of Climate Change and product accessibility for growers on the ground and how it affects their fertilizer decisions, among other management decisions.

Moderating the session was Len Kryzanowski (Alberta Agriculture and Rural Development) who spoke briefly to extension and research activities that have helped enable growers in Alberta to put 4R BMPs to use on the farm. Two examples of note:

- A Research study that evaluates agronomic, economic and environmental performance of urea, coated urea (ESN) and blend, (crop growth, yield, quality,  $N_2O$ ) based on 4R nutrient management. The study was conducted on 12 sites: 9 Agronomic sites with a range of agro-ecological regions with various soil types and climatic regimes, and 3  $N_2O$  monitoring sites with different soil types (Dark Gray Luvisol, Black Chernozem, and irrigated Dark Brown Chernozem).
- The Alberta Farm Fertilizer Information and Recommendation Manager (AFFIRM), which was upgraded to incorporate 4R Nutrient Stewardship in AFFIRM's Decision Support System.

The panel received interest from delegates on how the activities of the supply chain affect them as growers, and moving forward what they expect from industries who work with them to help growers adopt 4R Nutrient Stewardship. There were differing approaches:

- Partly a communication struggle because growers have a difficult time relaying their message up the supply chain to bigger businesses on the significance of 4R Nutrient Stewardship.
- Partially a need for the economics to be prominent in messaging. Growers must remain competitive in the market.
- While growers are not afraid of change, they are uncomfortable when directly asked to change.

The panel highlighted that education and extension work should remain a focus moving forward. Growers could be implementing 4R practices without realizing it. In particular, smallholder farms and the young generation of growers who are more adaptable to innovative, sustainable practices may be more readily accepting of 4R Nutrient Stewardship.



Steve Watts, 4R Agronomist from Prince Edward Island



Delegates enjoy presentations at the International Stewardship Symposium

## International Stewardship Symposium — Day 2

### Connecting the 4R Concept to the Food Industry (Breakfast Session)

Lauren Stone (Cargill) and Dennis Rogoza (Canola Council of Canada) spoke on transparency across the supply chain. They touched on the challenge of measuring the results of our sustainability efforts to meet the demands of the market. This becomes complicated due to the diverse number of requirements that vary between market members and the associated cost of meeting them. In order to meet these needs, an industry-wide effort is needed to achieve an appropriate level of organization and to demonstrate performance to create consumer confidence. To address these challenges, the Canadian Roundtable for Sustainable Crops has emerged. This initiative is a national collaboration with the goal of creating an integrated metrics platform which will allow the agriculture industry to respond to market needs with respect to sustainability performance.

### Session 5: International Outreach & Development

The International Outreach & Development session looked at extension, research, policy, and agriculture on an international scale and in the developing world from the experiences and perspectives of the members of the panel. This session was moderated by Kristy Buckley (The Meridian Institute) who touched on food scarcity and the lessons learned by the fertilizer industry that can help us to work with smallholder farmers. From here, Debra Kerby (Canadian Feed The Children) spoke to a ground-up approach to moving from hunger to food security. Food security includes three elements — food availability, food access, and food utilization. All three must be considered if food security is the goal. Kerby focused on presenting a snapshot of smallholder farming in Africa, which is responsible for 90% of agricultural food production and is the principal supporter of the livelihoods of 65% of Africans. These farmers are buyers and sellers in addition to producers and therefore engaging the community from the ground up through farmer-focused extension is critical to achieving food security. Many of these smallholder farmers are women living in small villages and supporting families. They are unable to purchase or own land; they require control over the tools and resources necessary for the production and also lack access to markets and the ability to benefit from them which poses additional cultural challenges.

Jean-Paul Beens (Yara International) suggested that agricultural sustainability is a business. Agriculture has come a long way primarily due to mineral fertilizers which have aided in increasing the volume and nutritious value of crops; however there is still room for improvement. Beens described some of the avenues for solutions that Yara is currently exploring including deficiencies in Africa. He stressed that expertise and cooperation from



*Kristy Buckley moderates the International Outreach and Development panel*



*International Outreach and Development panelists take questions from the audience*



all levels of the supply chain — donors to development, finance institutions to government, and local/international private sectors to growers — is required for success. Agriculture must continue to be on the global agenda, and we must continue to engage in these discussions at an international level.

Paul Hagerman (Canadian Foodgrains Bank) emphasized that while fertilizer may indeed be the answer, it is not the only solution. Hagerman's perspective touched on African smallholder farms and how the Canadian Foodgrains Bank has played a role in helping achieve food security not through fertilizer, but with the help of knowledge-based approaches such as “train the farmer” techniques. He suggested that people may not have the money for fertilizer, but they have the brainpower to learn new agricultural techniques. They need more information to get more efficient inputs and as a result of techniques learned through these extension initiatives they can produce yield and income gains through the management of soil, rainfall, organic matter and time.

In the last presentation, Volker Andresen (International Fertilizer Industry Association) described nutrient stewardship strategies in a global context. The vital role of fertilizer in global food security and as a catalyst for agricultural development is widely acknowledged. However, due to the diversity of farming systems worldwide and the impacts of fertilizer “mis-/under-/over-use” on the environment, the call for nutrient stewardship to address significant imbalances in global nutrient use is critical. Andresen highlighted the important role the fertilizer industry plays in promoting nutrient stewardship — providing the right source of nutrients, at the right rate, at the right time, and in the right place — to improve economic, social and environmental performance of mineral and organic fertilizers through site and crop-specific implementation of scientific principles.

The sum of the topics discussed strongly emphasized the need to bring all stakeholders together to build the trust and commitment required to work towards nutrient stewardship and food security on a global scale. Several challenges were identified:

- Fake fertilizer products on the market continue to be an issue and threaten to weaken industry-customer relations.
- Industry stresses that ensuring good product quality and the continual development of customer relations is critical for maintaining a positive reputation and ensuring the needs of farmers are met.
- Cultural sensitivities surrounding women in agriculture requires attention. These issues are just a small part of the picture and working towards the empowerment of women will need to come as part of a larger cultural shift.
- Growing concern surrounding food waste — the idea that producing more food is not the solution the world needs, rather advancements in the production, quality, and usefulness of our current food system is where the focus should be.



*Achim Dobermann joins panelists via video-conference to discuss economic growth in current environmental conditions*

## Session 6: Planetary Boundaries & Nutrient Use Efficiency

The idea of planetary boundaries consists of the notion that the natural system of our world can only take so much human change. If we augment these systems too much, it reaches a point of instability and is more difficult (or impossible) to rebalance to its natural state. The focus of the Planetary Boundaries and Nutrient Use Efficiency session was to discuss the current and potential measures being taken to ensure the actions of the human population as a whole, stay within the stable zone and still meet sustainability goals. This panel was moderated by Dr. Derek Peak (University of Saskatchewan) who discussed fertilizer microdosing as a technology which could help improve economic gains and crop yields of smallholder farms in Sahel. Soils in this region are semi-arid and experience low nutrient content, high land degradation and frequent drought-related crop failure. Microdosing, which is the point source application of fertilizer shortly after seed germination, could help to improve crop yields without further depleting the soil of its nutrient reserves or accelerating the degradation of the land base. Field trials of microdosing analyzed using synchrotron technology have shown no negative impact on carbon content of Sahel soils.

As the keynote speaker of this panel, Dr. Achim Dobermann (Rothamsted Research) focused on the need to decouple future economic growth from our current unsustainable use of fossil fuels, land, water, oceans and other resources. In his presentation, Dobermann outlined sustainable development as a holistic concept with four interconnected dimensions: economic development, social inclusion, environmental sustainability, and good governance. Sustainable development goals addressing these four dimensions and their concrete targets for the post-2015 era are expected to be agreed upon by the global community in 2015. The priorities for these targets will vary between countries as each need to take into account their current positions and choose their own desired sustainable development path, with real, achievable goals at the national or local levels.

Robynne Anderson (Emerging Ag Inc.) suggested that the planet itself is a stakeholder. She outlined the nine planetary boundaries as a safe operating space for humankind, a topic currently being discussed by several high profile stakeholders including UN, World Wildlife Fund, and Oxfam. Improved nutrient management is one of ten identified mitigation opportunities to move towards a safe operating space for global agriculture. Anderson stressed that the human population needs to be aware of planetary boundaries and the operational reality that will result in the future.

Dr. Christine Negra (EcoAgriculture) spoke of the interconnected challenges in determining a safe operating space for climate and agriculture. Planetary boundaries provide a framework to work within for achieving sustainable intensification. However, the limits are dynamic and may not be defined. Therefore, no one-size-fits-all solution exists. Negra expressed the



Benny Chefetz addresses Planetary Boundaries and Nutrient Use Efficiency



*"Agriculture is at the top of the priority list for the new sustainable development goals that the UN will be implementing. It is really exciting to see the attention that agriculture is getting, because it is the foundation for all of the hunger challenges that the world faces and the quality of life. We need an agriculture system that is helping people be successful farmers, be successful economically, have a great quality of life socially, and to address the challenges in the environment."*

Robynne Anderson — Emerging Ag Inc.



need for greater investment in agricultural technologies to support food production growth. She acknowledged that the ideal combination of technologies however was not yet clear due to the lack of transparent, evidence-based information to support decisions on the potential of these alternative technologies. Therefore to move forward, spatially-explicit information in real time is required in combination with engaging farmers in research and the development of new technologies.

In the final presentation from Dr. Benny Chefetz (Hebrew University, Jerusalem) the use of treated wastewater for irrigation was put forward. Chefetz elaborated that with increases in the population, concerns with infrastructure and growing water demands have resulted in the need for new sources of water. There is a need to use low-quality treated waste-water, however he also cautioned against the risks of pursuing this course of action, particularly due to the introduction of pharmaceutical compounds into the agro-environment. Potential frameworks for the use of low-quality treated waste-water were outlined including the development of a grading system for use on particular types of crops such as non-edible or peeled crops.

In the conclusion of the session, there was a definite opinion that research — long-term studies in particular — is required to establish a scientific basis for planetary boundaries. However, the support for the research is lacking. Approaches that will engage agencies and politicians to the benefit of research will be critical for supporting long and short-term studies. Industry has to be proactive and work towards creating novel mechanisms and initiatives to meet these goals. On the other end of the spectrum, investing in agricultural extension through knowledge-based approaches is just as important to bring farmers onboard. Extension serves as a link between research and the farmer. The relevance of research to the farmer and how it can benefit them with respect to their agricultural practices cannot be communicated without this link. An understanding of the new system and its associated benefits will be difficult to develop, hindering progress.

### Cool Farm Tool (Lunch Session)

Christian Pallière (Fertilizers Europe) described a new initiative developed by The Cool Farm Alliance in his presentation *“INFINITY Toward Sustainable Intensification — The Cool Farm Tool”*. The Cool Farm Alliance is a collaborative, industry-led approach to enhancing sustainability in agriculture by providing options for measuring greenhouse gas emissions. Pallière introduced the Cool Farm Tool, which is a GHG emission calculator to assist farmers in calculating their carbon footprint over a variety of crops, inputs and conditions. User-friendly technologies, such as The Cool Farm Tool, can help farmers in making informed on-farm decisions that improve their environmental performance.



Robert Mullen discusses Extension and Implementation of Nutrient Stewardship

## Session 7: Extension and Implementation of Nutrient Stewardship

This session looked at program-focused efforts, perspectives on the outcomes achieved, and how these initiatives benefit nutrient stewardship. Moderator Robynne Anderson briefly outlined the role of soils in nutrient stewardship. Anderson brought to our attention that the United Nations has designated the year 2015 as the International Year of Soils. The Global Soil Partnership works to promote healthy soils for a healthy life with the goal to increase soil productivity in a sustainable manner to guarantee resilience.

In the first presentation Nicholas Nelson (Food and Agriculture Organization of the United Nations) shed light on the state of global soils. The understanding that there is an abundance of healthy fertile soil is a misconception — one-third of global soils are in a moderate to severe state of degradation. In order to eliminate food insecurity and malnutrition, members of the soil community and research circles must step up to establish new methods and initiatives for prevention and restoration of degraded soils. Nelson emphasized that fertilizers alone are not a solution — long-term management strategies supported by a solid information base are a critical component as well. Modern tools and methods for the measurement of accurate and informative soil data must be developed to achieve this goal.

Josie Van Lent-Staden (Lakeland College) highlighted work with the Soil Conservation Council of Canada, where the student-managed farm program provides an opportunity for students to learn the business of agriculture including 4R Nutrient Stewardship planning in a “hands-on” approach. She advocated education before legislation, stressing that education is the first step for progress towards improvement. The student managed farm plans and implements 4R Nutrient Stewardship best management practices for all aspects of the operation including the adoption of responsible and efficient nutrient management practices.

The concluding presentation by Dr. Robert Mullen (PotashCorp) touched on the importance of delivering well informed, science-based recommendations to farmers. Mullen stressed that part of the struggle is drawing attention to messaging. The message needs to be transparent and understandable but still based on sound scientific theory. This involves supporting the research contributing to the messaging and understanding the target audience and the challenges they face. Interaction should not be limited to one stakeholder; rather it should occur at all levels including consultants/retailers, watershed groups, policy makers, university extension personnel, commodity groups, and many others.



*Nicholas Nelson answers questions from delegates during the Extension and Implementation of Nutrient Stewardship panel*



*“When people know better they do better... education before legislation.”*

Josie Van Lent-Staden — Lakeland College, Vermillion Campus



### Session 8: The Science Behind the Economics

This session was moderated by Paul Thoroughgood (Ducks Unlimited Canada) and was initiated by keynote speaker Dr. Al Mussell (George Morris Centre). Mussell described how Canadian agriculture systems are increasing the intensity of their resource use. Despite the decreasing number of farms, agricultural output has increased with the same farm land base. This is possible due to improved agricultural practices and technological advances that allow for more efficient input and time usage. As the demand on agricultural resources increase, the need for further intensification of current land base will continue. Mussell emphasized that this will require a sector-wide initiative using fertility, pesticide, crop physiology management and 4R Nutrient Stewardship implementation principles to be safe and effective.

Dr. Claudia Wagner-Riddle (University of Guelph) presented outcomes of a series of studies which investigate the effect of rate and timing of urea-ammonium nitrate application on nitrous oxide ( $N_2O$ ) emissions under typical wet spring conditions in Ontario. Wagner-Riddle stated that as part of 4R Nutrient Stewardship, synchronizing the rate and timing of fertilizer application to plant uptake can aid in reducing nitrogen loss. While both corn yields and  $N_2O$  emissions increased with increasing rate of nitrogen application,  $N_2O$  emissions were increased significantly more (64%) than corn yields (6%) emphasizing the importance of employing an appropriate rate for good environmental performance. Timing also played a large role for mitigating  $N_2O$  emissions showing a 58% reduction of emissions for nitrogen applied as a side-dress at the 8<sup>th</sup>-leaf stage ( $0.88 \text{ kg N ha}^{-1}$ ) compared to at planting ( $2.12 \text{ kg N ha}^{-1}$ ) without impacting corn yields.

Dr. Miles Dyck (University of Alberta) spoke of the need for nutrient balance in soils, as the levels of one nutrient can affect the availability and uptake of other nutrients present. In particular, Dyck studied the effects of sulphur due to an abundance of sulphur-deficient soils in the Canadian prairies. Sulphur in fertilizer application was shown to increase crop yield and soil carbon over time. With liming of the soil to mitigate emissions as a result of soil pH, balanced fertilization including sulphur decreased cumulative  $N_2O$  emissions. Dyck suggested that this effect may be due to a preference for sulphur-denitrification within the soil over nitrogen-denitrification.

Dr. David Burton (Dalhousie University) stated that establishing the most appropriate set of best management practices requires in-depth knowledge of the nutrient status of the soil. This is a complex problem as soils are unique by location, dynamic and influenced by management.



*Panelists Bunyamin Tar'an and Claudia Wagner-Riddle discuss the Science Behind the Economics*

Burton spoke of a series of tools developed to assess nitrogen supply within the soil and estimate the potential for nitrogen loss. Climate plays a large role in nitrogen mineralization and, as a result, a strong focus has been placed in understanding its effects during both the growing and non-growing seasons. Tailoring these tools to help manage nitrogen in Atlantic Canada is currently in progress.

In the final presentation Dr. Bunyamin Tar'an (University of Saskatchewan) highlighted research focused on improving the productivity of crops and soil micronutrient management for nutritional improvement. Zinc deficiency among pregnant women in Ethiopia is a widespread problem contributing to stunting among children. Soils in these regions are also zinc deficient. Tar'an spoke to the development of zinc application strategies as an affordable technology to aid farmers in increasing the zinc content of chickpea varieties. Of the three placement strategies investigated, foliar application of zinc increased seed zinc concentration by 25% compared to soil application and seed priming.

From the topics discussed during this panel, it is apparent that the development of appropriate BMPs is a complex process requiring an intimate understanding of the relationships between soils, climate, plants, nutrients, and location. These relationships are in a constant state of flux and are influenced by the methods employed. The importance of continual development of tools to aid in determining nutrient status of the soil is clear. Similarly, the environment has been shown to have a tremendous impact on the success of a given BMP practice in terms of environmental performance and crop yield. Further research to understand these relationships is essential in developing and expanding best management practices to suit the dynamic environment in which they must perform.

### **Welcome to the West Reception — Water movement learning station demonstration**

Delegates closed out the Symposium by participating in festivities at Saskatoon's outdoor venue, Agar's Corner. Mitchell Timmerman of the Manitoba Agriculture, Food and Rural Development division at the government of Manitoba, brought a demonstration for delegates during the reception. The demonstration included both a rainfall and a snowmelt simulator to show the effect of runoff on different terrains, comparisons of tillage practices, samples of different fertilizers used in Manitoba and a unique exercise where participants portrayed different agricultural stakeholders to illustrate what best management practices they might encounter at their respective levels and how it affects the operations of a farm.



*Delegates of the International Stewardship Symposium are Welcomed to the West at the closing reception at Agar's Corner*



The Canadian Fertilizer Institute would like to thank the sponsors for making the International Stewardship Symposium a great success.



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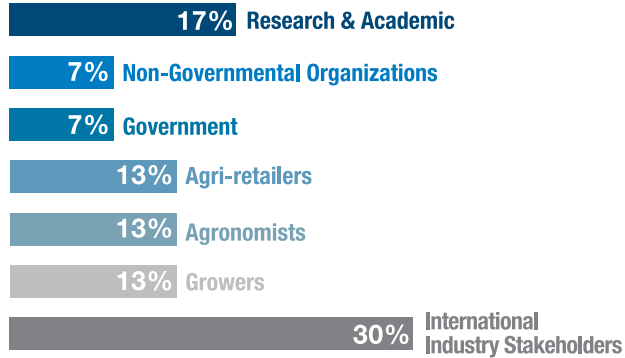
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## Symposium & 4R Statistics

The majority of participants were from the following sectors:



# 100 %

of post-conference survey respondents said they would promote 4R Nutrient Stewardship following the Conference



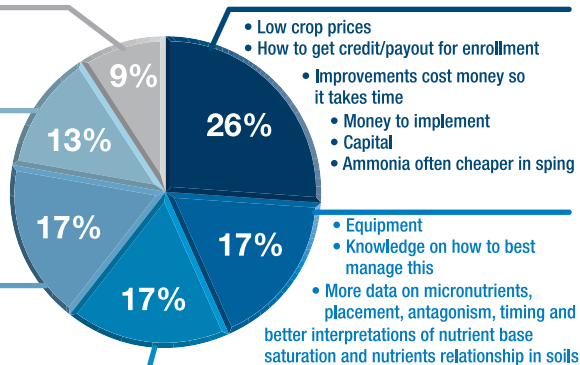
Canadian's have identified the biggest challenges and barriers faced when implementing 4R Nutrient Stewardship on the farm:

- Don't like change
- Close to retirement

- Building a plan
- Record keeping

- Excess water coming to farm from other places
- Weather sun and rain
- Variation in precipitation
- Acreage too large for micro-management

- Fall banding spreadout workload
- Time constraints
- Taking more time to apply it



- Low crop prices
- How to get credit/payout for enrollment
- Improvements cost money so it takes time
- Money to implement
- Capital
- Ammonia often cheaper in spring
- Equipment
- Knowledge on how to best manage this
- More data on micronutrients, placement, antagonism, timing and better interpretations of nutrient base saturation and nutrients relationship in soils

The implied net benefit of adoption of NERP practices was material, and ranged from \$9/acre to about \$87/acre



Implementation of 4R Nutrient Stewardship can result in a 15–25 per cent decrease in N<sub>2</sub>O Emissions



248 agricultural professionals are either training or trained in 4R Nutrient Stewardship and NERP







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- » Intensification of agriculture
- » Planetary boundaries



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