Asia-Pacific
Economic Cooperation

Field Guide: Approaches to Decreasing Agriculturally Generated Greenhouse Gas Emissions in APEC

APEC Policy Partnership on Food Security &

APEC Agricultural Technical Cooperation Working Group

SOM 1 Workshop

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APEC Project: *APEC Workshop on Approaches to Decreasing Agriculturally Generated Greenhouse Gas Emissions in APEC*

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Acronyms

AAFC	Agriculture and Agri-Food Canada
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Nations
AWD	Alternative Wetting and Drying
EBB	Eco-Bio Businesses
EEF	Enhanced Efficiency Fertilizer
GHG	Greenhouse Gas
GCF	Green Climate Fund
IRN	Indigenous Research Network
NEPA	National Environmental Policy Act
NUE	Nitrogen Use Efficiency
USDA	United States Department of Agriculture
1M5R	One Must Five Reductions

Foreword

Purpose of the Project

The APEC PPFS workshop “Approaches to Decreasing Agriculturally Generated Greenhouse Gas Emissions in APEC”, took place on February 18th, as part of the Senior Officials Meeting (SOM) 1 events. The workshop provided economy representatives with the opportunity to engage on a number of climate-related issues related to greenhouse gas emissions and resilience.

Agri-food systems account for over one third of global greenhouse gas emissions, totaling 18 billion tons. Food production processes, including fertilizer use, and land usage encompass the majority of that amount.[1] To achieve ambitious commitments in the 2015 Paris Agreement to limit the global temperature rise to no more than 1.5 degrees above pre-industrial levels, economies must forge a collaborative, innovative, and united approach to further climate-smart agriculture.

For the SOM 1 workshop, economies and private sector players united to discuss learnings and best practices to reduce agricultural greenhouse gas emissions in four focus areas; 1) innovations in methane reduction and fertilizer use: manure management, enteric fermentation, rice cultivation, and enhanced efficiency fertilizers, 2) diversity and inclusivity: examples and best practices for inclusive decision making in climate change mitigation and adaptation (indigenous peoples, women, youth, other underrepresented communities, local representation), 3) best practices and solutions for increasing and utilizing investments for adaptation and resilience and
4) resilience and adaptation to climate shocks, extreme weather events, and long-term adaptation planning.

About the APEC Policy Partnership for Food Security

Food security has been a concern in the APEC region for many years, given the volatility of food prices, supply chain disruptions, and issues with supply and demand for food. These issues are exacerbated by climate change challenges and inequity in food security across populations. Food security has been an issue of particular concern for developing economies and for women, indigenous, and rural populations within those economies, who are most adversely affected by changes in the global food system.

In response to the growing concerns related to food security in APEC, the PPFS was launched in 2011 to strengthen public-private cooperation to address these issues.2 The current work of PPFS was built upon the Niigata Declaration on APEC Food Security, the first APEC plan for promoting food security in the region; and the Kazan Declaration, the Beijing Declaration, and Piura Declaration, which furthered APEC plan of action on food security.

In 2021, the PPFS forum, in collaboration with the APEC Food Security Ministers, developed the “Food Security Roadmap Towards 2030”. The Roadmap is focused on setting out a path to ensure access to access to sufficient, safe, affordable, and nutritious food to meet the dietary needs and food preferences for an active and healthy life.3 In 2022, the PPFS developed an implementation plan to carry out the Roadmap. In 2023, the PPFS, chaired by the United States during the U.S. APEC host year, focused on APEC 2023 theme “*Creating a Resilient and Sustainable Future for All*, with specific focus on *interconnectedness, innovation* and *inclusivity*, and the agriculture sub- theme of *Together Achieving Sustainable, Equitable and Resilient Agri-Food Systems.”*

Foreword

[1] Food systems account for over one-third of global greenhouse gas emissions | UN News
[2] Policy Partnership on Food Security | APEC
[3] Policy Partnership on Food Security | APEC

Introduction

How to Use This Guide

This guide is designed to serve as a technical reference for PPFS member economies and their respective stakeholders to consider in their development, implementation, and monitoring of evidenced-based policies for reducing agricultural greenhouse gas emissions and promoting agricultural resilience. The information presented in the guide is derived from a PPFS workshop on February 18, 2023, in Palm Springs, California where experts from across the PPFS economies convened, in-person and virtually, to network and exchange evidence about best practices and successful innovations in policymaking for sustainable and resilient agriculture. This guide aligns with the workshop objectives and agenda; however, it is not an exhaustive report of all the information and evidence generated at the workshop.

The chapters of this guide follow the SOM 1 workshop agenda (Annex 1), by session.

Chapter 1. Opening Remarks

Allison Thomas, the Managing Director of Trade Policy, and Geographic Affairs at the Foreign Agricultural Service at the United Stated Department of Agriculture (USDA), delivered opening remarks. She shared the goal of the workshop, for participants to gain knowledge, build strategies, and form new partnerships to reduce greenhouse gas (GHG) emissions. She outlined the multitude of issues covered in the workshop, including methane reduction, efficient uses of fertilizer, agricultural productivity as it relates to climate change, and climate hubs across APEC. Thomas emphasized the relevance of addressing GHG emissions in the face of new challenges to food security—such as the COVID-19 pandemic, climate change, and the conflict in Ukraine. Therefore, it is critical to share resources and practical strategies to reduce GHG emissions, adapt to climate change, increase sustainable production, processing, and consumption, and to reduce food loss and waste as noted in the APEC Food Security Road Map. Thomas also noted farmers and producers' interest in being a part of climate change solutions, and the necessity to give them tools to be active participants in such conversations.

Thomas shared perspectives as a representative of the United States. At the forefront of the U.S. strategy is voluntary incentive-based and market-based approaches to transform frameworks for food production. Transforming food production frameworks requires creating new markets, ideating supportive methods to aid companies in reduction their GHG footprint, and establishing strong partnerships.

Thomas ended her remarks by introducing the workshop's moderator, William Gould, the National Lead of USDA Climate Hubs for the United States Department of Agriculture. Climate Change impacts every aspect of agri-food systems, from production to processing, and distribution.

Chapter 2. Session 1 - Innovations in Methane Reduction and in Fertilizer Use: Manure Management, Enteric Fermentation, Rice Cultivation, and Enhanced Efficiency Fertilizers

The first panel session "Innovations in Methane Reduction and in Fertilizer Use: Manure Management, Enteric Fermentation, Rice Cultivation, and Enhanced Efficiency Fertilizers," featured four panelists with expertise in each of the panel's sub-topics. Presenters gave global and APEC economy-specific insights on the opportunities to reduce methane emissions in fertilizer use regarding manure management, enteric fermentation, rice cultivation, and enhance efficiency fertilizers.

Hayden Montgomery

Hayden Montgomery, Agriculture Program Director of the Global Methane Hub, presented an "Introduction to the Global Methane Hub". The Global Methane Hub is an organization established on the margins of COP 26 to support the Global Methane Pledge signatories and potential signatories in the agriculture, energy, and waste sectors. The Global Methane Hub collaborates with governmental and non-governmental bodies to scale cost-effective and innovative solutions to mitigate methane emissions.

The presentation centered around agricultural methane emissions through the Global Methane Hub's Enteric Fermentation R+D Accelerator. To expand the gap that the Enteric Fermentation R+D Accelerator fills, Montgomery first addressed the high need for low-cost technological development for absolute reductions in agricultural methane, and specifically in enteric fermentation. 40% of global methane emissions stem from agriculture, with enteric fermentation comprising 70% of agricultural methane emissions. The presentation is pertinent to many APEC economies since at

least 80% of agricultural methane emissions are released by developing economies due to the correlation between land mass, agricultural productivity, and methane emissions. For rice cultivation, at least 95% of agricultural methane emissions are released by developing economies. This means that the Global Methane Hub must closely attend to the needs of developing economies. A further challenge the Global Methane Hub faces in reducing agricultural methane emissions is scaling. 570 million farms exist globally, 85% of which are smallholders comprising 2 hectares of land. This enormous number of small-scale farmers complicates scaling interventions.

The Enteric Fermentation R+D Accelerator is operating at a critical juncture in agricultural methane emissions. Due to population growth, increased global wealth, and changing consumption patterns, experts predict almost a 40% increase in agricultural methane emissions between 2010 and 2050. This rise can be further compacted by the effects of climate change. In the context of the goal to maintain a maximum global temperature rise of no more than 1.5 degrees above pre-industrial levels, an IPCC report demonstrates that agricultural methane emission levels must decrease by 10% below current levels by 2030, and up to 50% by 2050. The predicted rise of agricultural methane emissions conflicts with the reduction necessary to keep warming below 1.5 degrees above pre-industrial levels.

The Enteric Fermentation R+D Accelerator, which is close to launch as of February 2023, is a globally coordinated and accelerated initiative that brings close-to-commercial methane reduction interventions across the finish line, develops technologies that benefit the farmer in methane reduction, and disseminates scientific research to the public domain to ensure knowledge is widely available. The Accelerator focuses largely on feed additives but also on overall livestock development systems including breeding, methane vaccine, and information on rumen microbiome ecosystem. Regarding the rumen microbiome ecosystem, the Accelerator is researching the function of present microbiomes and working to share microbiome cultures and information to the science community. The Accelerator builds consumer confidence by progressing this mission solely in the public domain. Through live large-scale, real-world trials with farmer participation, the Accelerator seeks safety, scale, speed, and consumer confidence in the technological solutions developed.

Dr. Nguyen Anh Phong

Dr. Nguyen Anh Phong is the Director of Information at the Center for Agriculture and Rural Development in Viet Nam. His presentation, “Low-Carbon Rice Production: Moving toward a Green Agriculture Transformation in Viet Nam”, shared the economy’s work in reducing GHG emissions from rice production. Rice production encompasses an enormous share of Viet Nam’s economic activity, while simultaneously comprising a large share of GHG emissions. Viet Nam produces over 43 million tons of paddy and exports over 6 million tons of rice, culminating about over USD $3 billion in export revenue. In its effort to increase environmental sustainability, the government is concerned about maintaining food security and protecting farmers’ livelihoods while simultaneously reducing GHG emissions from rice.

Dr. Phong noted the key drivers of GHG emissions in rice production as inefficient water usage to irrigate, high seeding density, inefficient and excess fertilizer application rates, poor management of rice residues, and inefficient energy use. Inefficient energy use often stems from poor infrastructure, requiring higher inputs to produce, store, and transport rice. Solutions must acknowledge the low profit margin for rice as opposed to cash crops, meaning that farmers are often discouraged from paying premiums for “green” rice. Further, in line with Montgomery’s observation about the high proportion of small hold farmers, small scale farmers comprise a large proportion of rice producers in Viet Nam, presenting challenges to disseminating and scaling any intervention.

Dr. Phong noted three applicable solutions: alternative wetting and drying (AWD), One Must Five

Reductions (1M5R), and digitization. AWD is a water management technique that can increase profit margins while reducing GHG emissions. In 1M5R, farmers use certified seeds and reduce five elements: seed rates, pesticide use, fertilizer use, water use, and postharvest losses. Lastly, the application of digital technologies in tandem with AWD and/or 1M5R, such as water sensors in irrigation systems further optimizes input levels. Cost, however, is a barrier to transitioning to low carbon rice and varies significantly depending on irrigation infrastructure conditions. Other costs that farmers and local government would bear in these solutions are to improve irrigation system operations and maintenance; to train farmers' adoption of sustainable practices; to establish a system for measuring, reporting, and verifying carbon credits; and to link farmers to carbon markets to maximize the benefits.

Dr. Phong presented some key recommendations. First, prioritizing strategic use of economic instruments to reduce GHG emissions from rice such as charging irrigation fees to improve water productivity and incentivize efficient water use; revising the support policies to limit fertilizer overuse and promote sustainable practices; pilot programs on fees/taxes on environmentally damaging inputs; and mechanisms for payment for environmental services and carbon emission trading. Second, given that about 90% of farmers in Viet Nam have smartphones, it is crucial to support IOT platforms to connect farmers and service providers. Finally, the importance of carbon tax as a policy lever to reduce GHG emissions.

Dr. Phong closed the presentation with an exciting economy-wide program. Starting in 2023, the Ministry of Agriculture and Rural Development has been drafting the program on 1 million hectares of high-quality and low carbon rice production in the Mekong Delta. The program works to support low-carbon rice production through credits to farmers for certified rice seeds and access to agricultural insurance policies for rice, as well as short-term bank loans to support enterprises in purchasing the necessary equipment and improving infrastructure.

Dr. Josh McGrath

Dr. Josh McGrath is the Lead of Technology Development at OCP North America. Dr. McGrath's presentation, "Innovation to Improve Nitrogen Fertilizer Efficiency" drew on his 16 years in academia at the University of Kentucky and the University of Maryland. His technical overview of the global nitrogen cycle pinpointed nitrogen leaks, particularly regarding the soil nitrogen cycle, and highlighted the need for including local context in solutions.

Ammonia production to make fertilizer through the Haber-Bosch process accounts for about 2% of global energy consumption. However, the system is leaky from manufacturing to usage in the field. Dr. McGrath shared statistics that stressed the need to increase fertilizer efficiency. Fertilizer Nitrogen Use Efficiency (NUE) globally, calculated by comparing units of feed produced per units of fertilizer, is under 50%. Further, fertilizer application inefficiency and wasted food product causes 43% of the nitrogen in the food cycle to be lost in the food system between production and consumption.

Before turning to the presentation's main focus on the use of nitrogen fertilizer post-production, Dr. McGrath noted the multiple avenues that exist to increase fertilizer efficiency in production. The Haber-Bosch process to make nitrogen fertilizer contains two main parts, hydrogen production and ammonia synthesis, which both impact GHG emissions. It is possible to obtain net zero ammonia production, however tradeoffs exist. One option is Electrolysis, the use of carbon neutral electricity to produce nitrogen fertilizer from water. Another option is Biomass gasification.

In the soil nitrogen cycle, fertilizer nitrogen emissions, both direct and indirect, account for about 1010 megatons of carbon dioxide per year. Almost half of these emissions come from the cropland per a 2019 study. GHG reduction requires innovation in fertilizer design and, most importantly to

Dr. McGrath, innovations in fertilizer management. NUE could be increased by 67% by 2050, significantly reducing total nitrogen demand by 48%, through combining technologies to reduce nitrogen-related fertilizer emissions at specific points in the soil nitrogen cycle. These technologies include green production, nitrification inhibitors, and demand reduction.

The nitrogen cycle involves biological and chemical processes, meaning that climate interactions with the nitrogen cycle make the process difficult to manage. Referencing Dr. Phong's exemplification of local solutions, Dr. McGrath stressed the need for solutions that account for the "field-by-field" climate. The objective should be to manage the nitrogen cycle in the field to maximize plant available nitrogen during the period of plant uptake, then store the excess nitrogen in the soil as organic matter for the future.

Enhanced efficiency fertilizers (EEFs) are often a point of discussion, with a focus on the source. However, Dr. McGrath observes that timing in management is a pivotal factor to reduce nitrogen emissions. Thermal and biological nitrogen fixation are the ultimate source of the changes between various nitrogen forms. Thermal nitrogen fixation is a large source of nitrogen emissions in the field. Changing the nitrogen source away from urea-based fertilizers or changing the management of the urea-based fertilizer is proven to be more effective in addressing thermal nitrogen fixation than adding a urease inhibitor to the fertilizer because the effectiveness of urease inhibitors is based on the probability of a weather event that drives nitrogen loss. In some regions, therefore, urease inhibitors are unhelpful because the probability of such weather events is low. Dr. McGrath compared universal use of urease inhibitors to using a sum -pump in Palm Springs, California. The sump pump will work but it will rarely, if ever, be active because it is in a desert.

Dr. McGrath then focused on the next step of the nitrogen cycle involving nitrate. Nitrate readily leaches and denitrifies, causing it to go off as a gas. Nitrification inhibitors can be extremely effective, but similar to urease inhibitors, they are practically ineffective in certain environmental conditions. Therefore, management in timing is a more reliable lever to reduce nitrification. Further, biological nitrogen fixation conversations explore the possibility of moving to microbial based fertilizers. However, limited literature exists on microbial based fertilizers for non-legume crops.

Given the numerous access points along the nitrogen cycle to reduce emissions, an integrated approach that leverages timing is required. Successful interventions must also be varied by the climate variability of each region. In implementing interventions, one cannot assume that markets will drive farmers to use EEFs because their performance is uncertain. Successful nitrogen management in fertilizers requires the examination of the nature of recommendations themselves. We cannot assume that good recommendations exist, and farmers simply do not follow them. In contrast, unfollowed recommendations are too imprecise to meet existing performance objectives (economic, yield, environmental loss). Historically, nitrogen management in fertilizer focused on economics and yield, and while they are highly accurate these recommendations on fertilizer usage amounts are not precise. To be precise, recommendations must be site, time, and crop specific. To this point, Dr. McGrath used an example from a cornfield in Kentucky where researchers utilize data from over 3,000 plots to propose more site-specific nitrogen recommendations that adjust the nitrogen rate needed to grow corn between years, between fields, and even within fields. By contrast, averaging the 7,000 datapoints across the 64 years at this field results in nitrogen use recommendations that are highly accurate yet imprecise to specific field area and year.

An area of further research is learning how to balance nitrogen supply with nitrogen requirements. This information can be learned from mechanistic models that determine the nitrogen needed through the amount of nitrogen lost from a specific plot in the field and the space crop takes up.

As a key takeaway, future fertilizer design will be a vital tool to decrease agricultural GHG emissions and increase NUE. Implementers must work and improve internal confidence among farmers given the imbalance between internal and external benefits in EEFs. Further, larger gains can be made with better management and yield gains. However, one must note that farm nitrogen economics will not drive nitrogen use efficiency alone. Dr. McGrath also notes that NUE should be normalized to calorie and protein use production. Finally, yield is a crucial component since yield gains have driven NUE in the United States to date.

Dr. Douglas Smith

The session's fourth panelist, Dr. Douglass Smith, Soil Scientist of the Agricultural Research Service at the United States Department of Agriculture, spoke on "Mitigating Greenhouse Gases from Agricultural Sources: Recent Trends, Unrecognized Sources, and Tradeoffs". Dr. Smith shared recent trends in EEFs in the United States and the variables in which EEFs reduce nitrogen emissions. He relayed how to avoid nutrient applications to minimize environmental risks, such as moving to precision fertilizer management. Dr. Smith also noted how phosphorous fertilizer can increase methane emissions in systems such as rice, but with sulfate can decrease methane emissions. He shared, however, that phosphorous inputs to lakes can increase eutrophication, which can increase methane emissions. Dr. Smith's technical information and science-based recommendations informed the audience of the potential of EEFs.

Chapter 3. Session 2 - Diversity and Inclusivity: Examples and Best Practices for Inclusive Decision Making (Indigenous Peoples, Women, Youth, Other Underrepresented Communities, and Local Representation)

The second panel session "Diversity and Inclusivity: Examples and Best Practices for Inclusive Decision Making (Indigenous Peoples, Women, Youth, other underrepresented communities, and local representation)" explored the necessity and the benefit in including diverse populations—indigenous peoples, women, youth, underrepresented communities, and local populations—in environmental decision making. The session included themes applicable to all APEC economies, as well as presentations on best practices from New Zealand and the United States.

Gideon Kruseman

The session opened with a presentation titled "Why does Equity Matter and Why is it Challenging?" from Gideon Kruseman, Coordinator Community of Practice Socio-Economic Data at the CGIAR Platform for Big Data in Agriculture, the Netherlands. Climate change disproportionately affects disadvantaged and minority groups because these communities often have limited access to resources to adapt to climate change. For example, women and children who are often responsible for collecting water and firewood are often the first to suffer the consequences of droughts and natural disasters. Indigenous peoples, who often rely on traditional land use practices, experience outsized impacts from environmental degradation. Youth, who will inherit the consequences of current emissions and environmental issues, face an increasingly uncertain future. The elderly exhibit increased vulnerability in adapting and reacting to climate change and weather events such as floods, heat waves, and sea level rise. Successful actions against climate change require input from diverse communities.

CGIAR is a coalition of international agricultural research and development groups working in five impact areas: climate change, adaptation, & mitigation; environmental health and biodiversity; nutrition, health, & food security; poverty reduction, livelihoods, & jobs; and gender equity, youth, and social inclusion. These impact areas closely link to inclusive decision making which through

CGIAR can fully address the complex challenges of climate change, environmental health, and social inequality.

The CGIAR Foresight Initiative uses innovative analytics, stakeholder engagement, and close partnerships to offer better insights into alternative transformation pathways to inform choices in food, land, and water systems. The aim is to provide actionable recommendations through a forward-looking and systematic approach that supports the United Nations Sustainable Development Goals. The Initiative includes explorations of future scenarios, identifying and assessing future risks and opportunities, and providing evidence-based insights. Identifying macro-trends in the food, land, and water systems helps inform the drivers of change. Kruseman notes that one must identify these trends and the interaction between them. Equally crucial is a localized focus. By exploring data on specific regions and economies, the Initiative can provide more tailored foresight, analysis, and policy recommendations to decision-makers. The Foresight Initiative works with local partners to co-design scenarios and analyze policy options, incorporating local foresight expertise and accounting for the unique challenges and priorities of each region. Through systems-level metrics, models, and databases, the Foresight Initiative is reducing barriers to foresight data as data systems and the ecological systems they analyze increase in complexity.

Dr. Elisabeth Grinspoon

Dr. Elisabeth Grinspoon of the United States Forest Service ("Forest Service") presented on "Environmental Justice and Climate Adaptation in the USDA Forest Service." Dr. Grinspoon traced the lineage of the environmental justice movement and the role of environmental justice in the Forest Service through key policy initiatives, success stories, and current frameworks.

The Forest Service manages about 193,000 million acres of land across the United States. The American Civil Rights Movement in the 1960s inspired the environmental justice movement. Environmental justice made its first large federal debut in Executive Order 12898 of 1994 signed by President Clinton. The order directed federal agencies to "identify and address" the negative environmental impacts of federal actions on low-income and minority communities to better achieve environmental protection for all communities.

The Forest Service formally included environmental justice into activities through the National Environmental Policy Act (NEPA) and the forest planning process. The two main components of NEPA and of Forest Service environmental justice are fair treatment and meaningful involvement. One case study, The BLT Vegetation project, demonstrates the facets of a successful environmental justice project in line with NEPA. Initiated in 2005, the BLT Vegetation Project addressed forest health and hazardous fuel concerns within a 14,000-acre area in the Cascade Mountain Range. The project needed to create measures to better protect forest life while accommodating the population of migrant Matsutake mushroom pickers, who camped around the edge of the national forest in tents, RVs, and tarps. Most mushroom pickers were of Asian descent. The Forest Service had to ensure fair treatment so that the management activities to better protect this environment did not put a greater burden of environmental harms and risks on underserved communities than on the general population. Further, meaningful involvement requires underserved populations to be involved in the decision-making process. The government engaged in meaningful involvement through collaboration with the mushroom pickers and trusted local organizations, bringing on translators and trusted local organizations, to ensure a solution that protected the pickers' economic livelihoods and the health of the forest.

Dr. Grinspoon then turned to the environmental justice efforts of the current administration, which built off the success of Executive Order 12898 of 1994 and resulting successful projects such as the BLT Vegetation Project. Executive Order 13985 in 2021, the first Executive order of the Biden Administration, aimed to advance racial equity and support for underserved communities. In

calling on equal opportunity as a cornerstone of American democracy, the order works to mitigate entrenched disparities in laws and practices that prevent equal opportunity. The Order requires each federal agency to prepare an Equity Action Plan outlining how the agency will address barriers to full and equal participation in programs, services, procurement, contracting, and other funding opportunities. The Forest Service Equity Action Plan contains ten actions to support underserved communities: to (i) increase tribal trust responsibilities and participation in Forest Service activities that honor tribal rights and interests; (ii) increase tribal and stakeholder engagement and relationship-building and equity-centered communications, (iii) achieve a representative and inclusive workforce, (iv) embed equity in employee onboarding processes; (v) providing economic opportunities through contracting and procurements; (vi) provide economic opportunity through grants and agreements; (vii) reduce wildfire risk to tribes and underserved communities; (viii) expand cooperatives and state forestry assistance programs to underserved communities; (ix) expand urban forestry benefits to underserved communities; and (x) increase access to recreation and outdoor experiences for underserved communities.

The Biden Administration released Executive Order 14008 one week later, which established an interagency council on environmental justice to “develop a strategy to address current and environmental injustice” through consultation with the White House Environmental Justice Advisory Council and local environmental justice leaders. The order also instructs the council to develop clear performance metrics and publish annual performance scorecards on its implementation. In addition, agencies must develop Climate Action Plans and data products to improve adaptation and resilience. The Forest Service’s Climate Action Plan was published in 2022 and identifies key risks of climate change on minority and tribal communities to co-create solutions. The Climate Action Plan also promotes formal government-to-government relations with tribes to build trust and partnerships. For example, the Tribal Climate Adaptation Menu is a collaborative initiative that provides a framework to integrate indigenous traditional knowledge, culture, language, and history into the climate adaptation process. In February 2023, the Forest Service finalized the National Tribal Relations Action Plan to expand tribal consultation and build nation-to-nation relationships.

Shiloh Babbington

Shiloh Babbington is a Policy Analyst at the Indigenous Research Network of the Global Research Alliance of the Ministry for Primary Industries, New Zealand. Babbington closed the session with the presentation, “The Power of Indigenous Inclusivity”. Under the Global Research Alliance, New Zealand and Samoa established the Indigenous Research Network (IRN) in recognition of the valuable and ingrained indigenous traditional knowledge systems and indigenous people’s strong relationship with the land. The IRN identifies leadership opportunities for Māori and indigenous groups, increasing the career pipeline and providing experience and upskilling opportunities their professional abilities. Further, the IRN provides access to collaborative research that promotes both traditional knowledge and New Zealand’s priorities. Organizations and initiatives of note include the Tāngata Whenua Alliance and the Kohimarama Aotearoa. Through case studies and initiative overviews, Babbington pinpointed the need areas to foster indigenous inclusion in the environmental sector and the value-add of indigenous inclusion.

Chapter 4. Session 3 - Resilience and Adaptation to Climate Shocks, Extreme Weather Events and Long-Term Adaptation Planning: Focus on Hubs and Innovation Centers

The third panel session, “Resilience and Adaptation to Climate Shocks, Extreme Weather Events and Long-Term Adaptation Planning: Focus on Hubs and Innovation Centers” featured perspectives from Australia, the United States, and Canada. These economies spoke on their

innovative “Hub model” network to connect science research with agricultural stakeholders to share information and interventions in response stakeholders’ needs to combat to climate change. Exploration of these economy-level Hub models demonstrates the collaboration opportunities between government, scientists, and end-users to respond to pressing environmental issues.

Katrina Baxendell

Katrina Baxendell is the Director at the R&A Strategy and Hub Management at the Department of Agriculture, Fisheries, and Forestry, Australia. Baxendell commenced session three with the presentation, “Future Drought Fund: Drought Resilience Adoption and Innovation Hub.” The Australian Drought Resilience Adoption and Innovation Hubs is a foundational program of the Future Drought Fund. The Fund, established in 2020, is an investment to build drought resilience in Australia’s agriculture sector, landscapes, and communities. As of February 2023, $5 billion AUD has been invested, with $100 million AUD available yearly to build drought resilience. The Fund envisions an innovative and profitable farm sector, sustainable use of natural resources, and adaptable rural, regional and remote communities. The Fund works around four key investment themes to reach economic, social, and environmental resilience to droughts: better climate information, better planning, better practices, and better prepared communities. Baxendell highlighted programs under each theme such as the Farm Business Resilience program to promote better planning and the Grant Programs to support better practices.

Under the better practices theme, eight regional Drought Resilience Adoption and Innovation Hubs were launched in 2021 to co-design activities, work on outreach, and manage projects relevant to that region. Further member “nodes” across each Hub region bring the work to over 40 locations involving over 250 members and network partners. The hubs are a consortium between researchers, farmers, entrepreneurs, resource managers, and producer and commodities group to manage over 30 projects that focus on end-user needs. Embedded knowledge brokers in each Hub translate scientific findings into practices relevant to farmers. Further, adoption officers facilitate the on-ground extension and adoption activities; drive uptake of new farms, current farms, and local innovations for improved drought resilience; and help identify potential Hub beneficiaries. Since the Hub borders are based on the major Australian agricultural regions, one challenge they face is coordinating with multiple regional governments when the Hub region crosses multiple domestic government entities. Still, the Hubs work with a variety of stakeholders to implement pivotal projects including Climate Smart Agriculture Adoption, a Northern Hub project that focuses on increasing these practices that build soil organic matter and water use efficiency, and Landscape-Scale Change, through the Southern New South Wales Hub in partnership with eight regional organizations to demonstrate modern pasture space use combinations and management practices known to build drought resilience that could potentially be applied across 82% of the New South Wales land area.

In addition to localized projects, the Hubs collaborate in economy-wide interventions for issues with wider applicability. The Hubs identified five collaborative cross-Hub projects in 2021-22, each involving at least two Hubs and their regions. Baxendell shared project examples such as the Managing Rangelands Project, which showcases technologies and techniques for digital precision mapping to improve rangeland management and forecasting. Another example is Nutritional Feed Based Mapping Technology. which addresses research gaps by defining the suitable system to manage pastoral grazing pressure and better prepare properties for changing conditions.

Baxendell concluded with a case study from the South Australian Drought Hub in collaboration with Murray Plains Farmers called Improving Canola Establishment in Dry Conditions, trialed starting in 2022. Legumes and oilseeds such as canola, known as ‘break crops’, are grown between cereal crops. Break crops can earn extra income for farmers and support integrated

disease and weed management. Since farmers often wait until season-opening rains to sow canola, delayed rain arrival minimizes the full crop potential for growers. Waiting until the rains to sow canola is based on the perception that planting during dry season presents unacceptable risks. Thus, growers need strategies for successful dry planting. The project is designed for the specific needs of Murray Plains Farmers grower members, who often experience dry starts of the growing season. The project supports the development of better approaches to manage canola in dry conditions through a focus on dry seeding and agronomic practices that maximize investment returns on canola crops. In addition, the trial compares canola varieties to pinpoint the best return on investment and will share collected knowledge at local community forums. The presentation emphasized how together, the Hubs act as a consortium between multiple stakeholders for successful project implementation.

Dr. Julian Reyes

Dr. Julian Reyes, the National Coordinator for the USDA Hubs, gave the presentation, “Building Climate & Community Resilience with the USDA Climate Hubs”. The USDA Climate Hubs are a network of ten regional Hubs, hosted by USDA research facilities in the Agricultural Research Service and the US Forest Service Research and Development Deputy Area, and an International Climate Hub hosted by the departments Foreign Agricultural Service. The Climate Hubs develop and deliver science-based regional information and technology to agricultural and natural resource decision-makers in response to learnings from stakeholders and partners. The Hubs function with input from a variety of government agencies, research institutions, and private sector groups to package and develop climate change science that is useful, usable, and used. Through collaboration and coproduction, the Hubs hold a two-way goal to improve information flow to stakeholders by translating climate science into action, and the information flow from stakeholders for feedback. This coproduction cycle is a process of knowledge exchange, monitoring, and learning among the Hubs and partner groups. The Hubs then take those lessons learned back to USDA agencies to improve product delivery to stakeholders.

The Hubs function through three main streams: science and data synthesis; tools and technology development and support; and outreach, convening, and training. In science and data synthesis, the Hubs assess and synthesize climate vulnerabilities and risks to provide partners with relevant mitigation and adaptation responses. For example, the Northwest Hub Biofuel Sources Overview stems from science and data synthesis. Further, the vulnerability assessments produced for each of the ten climate hubs provided input into the USDA’s congressionally mandated climate assessment. In addition, the Northeast Climate Hub led a study into the economic dimensions of soil health by using data from the Long-Term Agro-Ecosystem Research Network to evaluate the economics of no-till and cover crops to determine potential incentives for farmers. Dr. Reyes’ last example came from the Southwest Climate Hub’s assessment series using long-term crop insurance data to identify regional climate risks. By using this data, the project removed data silos to better understand agricultural risk management with risks such as drought and hail.

The technology and tool development and support stream emphasizes the development of useful tools as well as training and implementation. As of February 2023, the Hubs have developed over 25 tools to track and respond to climate change. Developed in consultation with ranchers and farmers, the Grass-Cast tool uses over 30 years of historical data on weather and vegetation, combined with seasonal precipitation predictions, to forecast the amount of grassland vegetation that will be available in the upcoming growing season. The Grass-Cast Tool can predict if rangelands are likely to produce above-normal, near-normal, or below-normal grazing vegetation on the county-level. This tool was primarily for the Great Lakes Region, but success led to adoption in Arizonia, New Mexico, and California, with plans to expand further. The AgRisk Viewer, connected to the Southwest Climate Hub’s insurance data analysis, provides over 30 years of county- and state-level visually accessible crop insurance loss data. To disseminate

information from the AgRisk Viewer, the USDA created Climate Quick Reference Guides. Additionally, the Freeze Date Tool from the Midwest Climate Hub helps producers manage growing season shifts for frosts and freezing. Lastly, the Seedlot Selection Tool from the Northwest Climate Hub helps foresters, landowners, and land managers consider climate change in reforestation and afforestation projects by giving insight to where seeds should be planted given that area's conditions.

The Hubs' outreach, convening, and training stream involves building educational modules and listening and learning from stakeholders. The Adaptation Workbook, also mentioned by Dr. Grinspoon in reference to the Tribal Adaptation Workbook, provides options for management scenarios in response to various climate risks. Specifically, the *Adaptation Resources for Agriculture Workbook* brings awareness to producers on short-term adaptive management options and long-term strategic plans. The Climate Hubs also prepare outreach on disaster preparedness, including community guides and factsheets to best prepare communities to react to climate events. In addition, the 23+ commodity guides developed by the Southeast Hub assist producers in hurricane preparation and recovery. The guides split information by state to cover a range of commodities including cotton, poultry, and pine trees. The Climate Hubs also lead in providing learnings from disasters. The Caribbean Climate Hub conducted an analysis and synthesis to identify gaps and challenges in future hurricane preparedness and recovery. Educational resources under the outreach, convening, and training workstream involves multimedia and education modules for youth and students to improve climate literacy. In addition, peer-to-peer learning initiatives including the Drought Learning Network and the Climate Learning Forum, support the cross-pollination of ideas.

Dr. Reyes expanded on the USDA Climate Hub work to reach diverse communities, connecting to themes from session two. The Justice 40 initiative works to ensure that 40% of clean energy and climate benefits disenfranchised communities. Looking forward, Climate Hubs will further expand engagement in underserved areas through a recent $9 million dollar grant from the National Institute of Food and Agriculture.

François Chrétien

François Chrétien, Acting Director of Research, Development and Technology at Agriculture and Agri-Food Canada (AAFC), concluded with the presentation, "Living Labs to Tackle Climate Change". In response to the pressing action required to combat climate change and related agri-environmental challenges and the Canadian government's ambitious climate action plan, AAFC launched the Living Labs network in 2018 to expedite development and adoption of sustainable practices and technologies for Canadian farmers. One pertinent goal outlined in Canada's climate action plan is to reduce agricultural GHG emissions from fertilizer by 30%. Living Labs also stems from the need to break down information silos between organizations and between social and natural scientists, as well as the need for a more integrated approach at the systems level to co-develop solutions. Further, AAFC noticed the need to reconnect scientists with the end-user, and for the end-user to be a key participant throughout the innovation process. Therefore, Living Labs works directly with farmers, scientists, and other stakeholders, to develop and refine solutions meaningful for producers.

Living Labs works on three core principles: user-centric innovation, working in partnership to address agri-environmental issues, and integration of real-life context through the usage of functional farms as opposed to research farms. Living Labs takes an iterative approach in co-developing a beneficial management practice or a new technology, testing, then evaluating it to adjust the development so that it can be broadly adopted in a much faster way by the wider agricultural community.

In 2018, Living Labs initiated two Labs to provide proof of concept and solidify operations before scaling. Two more Labs were founded in 2019. The projects focused on adjusting to climate change, reducing water contamination, improving soil and water conservation, and maximizing habitat capacity and biodiversity. As of 2022, the network features 13 Labs, each with about 15-20 organizational partners, 20-30 scientific teams, 80+ active participants, and hundreds of farmers. Chrétien presented a case study from the Ontario Living Lab on soil health in response to the increased frequency of algae blooms in Lake Erie from human activity. The Lab investigated whether changes on farms translate to changes at the watershed level to mitigate impact on the Lake Erie water quality. Healthy soil acts as a sponge, keeping nutrients in the fields rather than seeping into runoff. The Ontario Lab partnered with local producers to maintain farms with full year living root systems that better hold nutrients. Farmers involved express excitement to examine soil health with others who bring an academic interest.

The Living Labs approach and its network of farmers and scientists also allows communities to be more responsive when unexpected production problems occur, such as the recent potato warts issue.

Their newest solution is through the Canadian Government Natural Climate Solutions Fund to reduce carbon emissions by storing more carbon in soils. Specifically, the Agricultural Climate Solutions Fund component contains two relevant streams. The Living Labs stream gives $185 million CAD to Living Lab Projects between 2021-2031. The On-Farm Climate Action Fund stream invests $670 million CAD between 2021-2024 for direct support to farmers to adopt agricultural best management practices and reduce GHG emissions through cover cropping, nitrogen management, and rotational grazing practices. Looking forward, AAFC will co-host the International Forum on Agroecosystem Living Labs in Fall 2023.

Chapter 5. Session 4 - Best Practices and Solutions for Increasing Agriculture and Climate Investments, and Utilizing Investments for Adaptation and Resilience

The fourth panel session, “Best Practices and Solutions for Increasing Agriculture and Climate Investments and Utilizing Investments for Adaptation and Resilience” highlighted funds and initiatives from private sector and international organization actors from APEC economies including Peru, Indonesia, and the United States. Speakers demonstrated how capital can be structured to maximize impact for economy-level, regional, and local environmental initiatives to achieve maximum impact.

Claudia Godfrey

Claudia Godfrey, the Director of Innovation and Strategic Management at Profonanpe, Peru, began the session with the presentation, “Peruvian Private Facility to Boost Climate Investments for Adaptation & GHG Mitigation in Amazonian Bio Businesses”. Profonanpe is a Peruvian environmental fund that specializes in building and managing capital for programs that conserve biodiversity and promote climate change mitigation and adaptation. Eco bio-businesses (EBBs) help mitigate climate change and reduce deforestation, enhance resilience and environmental sustainability, and promote social integrity, sustainability, and gender equity. Profonanpe employs various financial modalities, such as technical assistance to strengthen eco bio- businesses in the Peruvian innovation ecosystem, reimbursable grants to scale and support investment leverage for eco bio-businesses, and a Round Table of Investors to connect eco bio-businesses and investors. A crucial operation of Profonanpe is the Amazon Eco Bio Business Facility, which leverages Green Climate Fund Grants to support EBBS either through technical assistance under Peru’s REDD+ framework and through repayable grants.

Imelda “Dada” Bacudo

Imelda “Dada” Bacudo, Advisor to the Associate of Southeast Asian Nations (ASEAN), presented on “Agriculture Sector Readiness for Enhanced Climate Finance and Implementation of Koronivia Joint Work on Agriculture in Southeast Asia”. The Koronivia Joint Work on Agriculture (KJWA) is a vehicle for the ASEAN CRN and ANGA to help Southeast Asian economies plan clear, regional “Common Positions” to further climate action in agriculture including scaled-up finance for climate healthy agriculture implementation, better technology access, better implementation and monitoring capacity of national and regional actions, and further support for action at multiple levels. Before turning to challenges the region faces in agriculture and climate action, Bacudo shared successes of the ASEAN CRN, such as the Laos-Thailand Mazie Seed Village Exchange, and ASEAN documents and guidelines to promote smart agriculture. Challenges, however, include sector scale and farmer burden in adopting climate change interventions, fragmented planning and monitoring, and difficulties accessing private sector finance. Bacudo then spoke on the SEA GCF Readiness Grant for Agriculture, a multi-year strategic readiness grant for Southeast Asian economies with agricultural development plans that reflect KJWA regional priorities and follow their economies climate change policy frameworks. Bacudo then review the program’s logical framework, implementation arrangement then turned to their future goals to increase partnerships in the endeavor.

Michael Chorske

Michael Chorske, Operating Partner at Pegasus Capital Advisors¸ closed Session 4 with the presentation “The Global Subnational Climate Fund, Scalable Impact Through Investments in Mid-size Emerging Markets Climate Infrastructure”. Pegasus Capital advisors is a global private markets impact investment manager that is the first and the only Green Climate Fund accredited U.S. private equity fund. Pegasus manages the Global Sub-Economy Climate Fund (SCF), which uses a blended-finance fund structure to advance four impact outcomes: building low-carbon nature-based and climate resilient infrastructure; mitigating climate change and strengthening adaptive capacities; improving livelihoods and enhancing prosperity; and transforming lives local economies and promoting inclusion. THE SCF currently hosts 20-25 projects in their portfolio, ranging from 5 – 75 million USD each. The SCF investment strategy is to follow scalable greenfield investments in high-growth arenas, united in a geographical and sector-diversified portfolio. Chorske presented the impacts of three examples, the Scaled Agroforestry Model in Jamaica, the African Foods Company Supporting Climate-Resilient Agriculture in Mali and Senegal, and the Temperature Controlled Logistics Platform in Morocco and Senegal.

Annex 1. Workshop Agenda

AGENDA

APEC Policy Partnership on Food Security (PPFS) and the Agricultural Technical Cooperation Working Group (ATCWG)

Workshop: Approaches to Decreasing Agriculturally Generated Greenhouse Gas Emissions in APEC

February 18, 2023: 9:00 am - 5:00 pm Pacific Standard Time

Location: ***Renaissance Palm Springs Hotel- San Jacinto*** *Room,* ***Palm Springs, California***

8:30 - 9:00 a.m.	Arrival and Check-ins • Arrival and check-in of Delegates, APEC Observers, and guests. • Virtual waiting room opens for online participants. NOTE: Virtual participants should use their Zoom meeting link sent to them after pre-registration to access the meeting. Virtual participants may check-in as early as 8:30 to verify audio and visual connections.
9:00 - 9:10 a.m.	Welcome and Opening Remarks **Allison Thomas,** Managing Director, Trade Policy and Geographic Affairs, Foreign Agricultural Service, United States Department of Agriculture

9:10 - 10:30 a.m.	**SESSION 1 - Innovations in Methane Reduction and in Fertilizer Use: Manure Management, Enteric Fermentation, Rice Cultivation, and Enhanced Efficiency Fertilizers** **Moderator:** Bill Gould, National Lead, USDA Climate Hubs, United States Department of Agriculture • *Accelerating R+D for Breakthroughs in Mitigation of Enteric Fermentation –* Hayden Montgomery, Programme Director, The Global Methane Hub, Uruguay (virtual) • *Low-Carbon Rice Production: Moving toward a Green Agriculture Transformation in Viet Nam –* Nguyen Anh Phong, Director of Information, Center for Agriculture and Rural Development, Viet Nam (in person) • *Innovation to Improve Nitrogen Fertilizer Efficiency–* Josh McGrath, Lead-Technology Development, OCP North America, United States (in person) • *Mitigating Greenhouse Gases from Agricultural Sources: Recent Trends, Unrecognized Sources, and Tradeoffs –* Douglas Smith, Soil Scientist, Agricultural Research Service, United States Department of Agriculture, United States (in person) *15-minute panel presentations followed by 20 minutes discussion and Q&A*
10:30 – 10:50 a.m.	Break

10:50 – 12:10 p.m.	**SESSION 2 - Diversity and Inclusivity: Examples and Best Practices for Inclusive Decision Making (Indigenous Peoples, Women, Youth, other underrepresented communities, and local representation)** **Moderator:** Bill Gould, National Lead, USDA Climate Hubs, United States Department of Agriculture • *Why does Equity Matter and Why is it Challenging? –* Gideon Kruseman, Coordinator Community of Practice Socio-Economic Data, CGIAR Platform for Big Data in Agriculture, Netherlands (virtual) • *Environmental Justice and Climate Adaptation in the USDA Forest Service –* Elisabeth Grinspoon, U.S. Forest Service, United States (virtual) • *The Power of Indigenous Inclusivity–* Shiloh Babbington, Policy Analyst, Indigenous Research Network, Global Research Alliance, Ministry for Primary Industries, New Zealand (virtual) *20 minute panel presentations followed by 20 minutes discussion and Q&A*
12:10 p.m.-1:40 p.m.	Lunch (90 minutes)
1:40 – 3:00 p.m.	**SESSION 3 - Resilience and Adaptation to Climate Shocks, Extreme Weather Events and Long-Term Adaptation Planning: Focus on Hubs and Innovation Centers** **Moderator:** Bill Gould, National Lead, USDA Climate Hubs, United States Department of Agriculture • *Future Drought Fund: Drought Resilience Adoption and Innovation Hubs –* Katrina Baxendell, Director, R&A Strategy and Hub Management, Department of Agriculture, Fisheries, and Forestry, Australia (virtual) • *Building Climate & Community Resilience with the USDA Climate Hubs –* Julian Reyes, National Coordinator, US Department of Agriculture Climate Hubs, United States (in person) • *Living Labs to Tackle Climate Change –* François Chrétien, Acting Director, Research, Development and Technology, Geomatics and Earth Observation Division and Living Labs, Canada (in person) *20 minute panel presentations followed by 20 minutes discussion and Q&A*
3:00 - 3:20 p.m.	Break

3:20 - 4:40 p.m.	**SESSION 4 - Best Practices and Solutions for Increasing Agriculture and Climate Investments, and Utilizing Investments for Adaptation and Resilience** **Moderator:** Bill Gould, National Lead, USDA Climate Hubs, United States Department of Agriculture • *Peruvian Private Facility to Boost Climate Investments for Adaptation & GHG Mitigation in Amazonian Bio Businesses –* Claudia Godfrey, Director of Innovation and Strategic Management, Profonanpe, Peru (in person) • *Agriculture Sector Readiness for Enhanced Climate Finance and Implementation of Koronivia Joint Work on Agriculture in Southeast Asia –* Imelda "Dada" Bacudo, Advisor, Association of Southeast Asian Nations (virtual) • *The Global Subnational Climate Fund, Scalable Impact Through Investments in Mid-size Emerging Markets Climate Infrastructure –* Michael Chorske, Operating Partner, Pegasus Capital Advisors, LP, United States (virtual) *20 minute panel presentations followed by 20 minutes discussion and Q&A*
4:40 – 4:50 p.m.	Evaluation (10 min)
4:50 – 5:00 pm	Closing Remarks **Bill Gould**, National Lead, USDA Climate Hubs, United States Department of Agriculture **Tiffany Landry**, Climate Policy Advisor, Multilateral Affairs, United States Department of Agriculture

Annex 2. Speaker Biographies

Opening Remarks

Ms. Allison A. Thomas serves as the Managing Director for Trade Policy and Geographic Affairs in the USDA Foreign Agricultural Service (FAS). She is an international advocate and proponent for agricultural trade having spent the last 20 years working on agricultural trade policy and development issues. She began her career at USDA as a summer intern and has served in several capacities including Assistant Deputy Administrator in the Office of Country and Regional Affairs, (2018-2019), FAS Acting Associate Administrator and General Sales Manager (2017-2018), FAS Chief of Staff, (2014-2017) Mission Support Director for Afghanistan and Iraq (2010-2014), Special Assistant to the Deputy Administrator in Global Analysis (2009- 2010). Ms. Thomas obtained a B.S. in agricultural economics from Southern University and A&M College and a M.S. in agricultural economics from the University of Arkansas. Ms. Thomas sits on the board of Women Empowering Nations, an international nonprofit organization that provides development opportunities to underserved young women throughout the world.

Moderator

William A. Gould is the National Lead of the USDA Climate Hubs and a Research Ecologist with the USDA Forest Service. He is stationed at the USDA Forest Service International Institute of Tropical Forestry in San Juan Puerto Rico. The USDA Climate Hubs are a unique collaboration across the department's agencies. Ten Regional Climate Hubs are led and hosted by the USDA Agricultural Research Service and the USDA Forest Service, with contributions from many USDA agencies. They develop and deliver science, tools, and outreach to reduce the risks of climate change and improve the sustainability of forestry and agriculture.

SESSION 1 - Innovations in Methane Reduction and in Fertilizer Use: Manure Management, Enteric Fermentation, Rice Cultivation, and Enhanced Efficiency Fertilizers

Hayden Montgomery is the director Agriculture Program at the Global Methane Hub. Montgomery has been Special Representative of the Global Research Alliance on Agricultural Greenhouse Gases since 2016, representing its 65 member countries in all international fora and facilitating mitigation research between its members and partner organizations. From 2013 to 2016 he was New Zealand's Ambassador to Argentina, Paraguay, and Uruguay. Prior to these appointments Hayden gained considerable experience within the United Nations climate change process, representing New Zealand in agriculture, land use and forestry negotiations between 2006 and 2012. During this time (2010-2012) he was also based in the New Zealand Embassy in Paris from where he

represented New Zealand in other relevant processes and organizations including the OECD, UNEP and FAO, and spear-headed New Zealand's international research cooperation on agricultural greenhouse gases. In addition to his international experience Hayden was involved in the development of New Zealand's domestic agricultural climate change policy.

Nguyen Anh Phong has a Ph.D. in Agricultural Economics from Tamil Nadu Agricultural University, India since 2007. He is a member of the network of Viet Nam's Public Policy Research Institutes. With about 26- years working in agricultural study, Dr. Phong has extensive experiences in agriculture and rural development policies research and consultancy in Viet Nam and in the Greater Mekong Subregion. He is currently leading some key activities such as: *Strategy of Science and Technology development in agriculture sector toward 2030 and vision to 2050; Policy recommendation to promote high-tech application in agriculture production in Vietnam; The Food Innovation Hub development in Viet Nam; Development Strategy for the Circular economy in agriculture: Opportunities and challenges in investment to agriculture and rural of Viet Nam; Evaluate the sustainable rice cultivation practice application (i.e. 1M5R, 3R3I and AWD techniques) of farmers and farmer organizations in the MRD of Viet Nam; Mainstreaming the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests (VGGT) principles in the revision of the Vietnamese Land Law 2013; Assessment of farmer capacity in response to climate change in Viet Nam, etc.*

Josh McGrath joined OCP North America in August 2022 as Lead, Technology Development. Prior to joining OCP Josh served as an extension specialist at the University of Kentucky (2014 – 2022) and University of Maryland (2006 – 2014), where he established an internationally recognized integrated research and extension program focused on developing, teaching, and implementing management practices that increase farm efficiency while protecting natural resources. Josh earned a B.A. from Johns Hopkins University and a Ph.D. from the University of Delaware; he conducted post- doctoral research at Virginia Tech.

Douglas Smith is a Research Soil Scientist and Research Leader at the USDA – Agricultural Research Service – Grassland, Soil and Water Research Laboratory in Temple, Texas. He has a BS and MS degrees from Texas A&M University – Commerce, and a PhD in Soil Science from the University of Arkansas. Dr. Smith has authored or coauthored more than 130 peer-reviewed papers and is currently the Editor-in-Chief for the Journal of Environmental Quality. During his more than 20-year career with the Agricultural Research Service, he has been recognized for expertise in nutrient fate and transport from agricultural landscapes. The current focus of his research program is using precision agriculture technologies to optimize crop production with on-farm economics and off-site environmental quality outcomes.

SESSION 2 - Diversity and Inclusivity: Examples and Best Practices for Inclusive Decision Making (Indigenous Peoples, Women, Youth, other underrepresented communities, and local representation)

Gideon Kruseman is a development economist by training with a PhD from Wageningen University, through work on a variety of subjects such as changing food systems, rural transformation, foresight, water management, soil degradation and non-point source pollution versed in environmental and ecological economics, and in complex models and data analysis. He has a passion for working towards a more inclusive, just society and a more sustainable planet. He has over 30 years of experience in national and international agricultural research, academia, private sector, and NGOs operating on the border between the social and biophysical sciences. Gideon currently works for the Alliance of Bioversity International and CIAT, international agricultural research for development organization that is part of CGIAR. He leads the work on enhancing the access, transparency and use of foresight models and tools, data and metrics, and related documentation in the CGIAR initiative on Foresight. He also coordinates the community of practice on socio-economic data in the CGIAR Platform for Big Data in Agriculture.

Elisabeth Grinspoon is a Forest Service subject matter expert on environmental justice. She joined the Agency after receiving a master's degree from Yale University (1996) and a PhD from University of California at Berkeley (2002). Early in her Forest Service career, Dr. Grinspoon began undertaking environmental justice analyses for land management planning in the Pacific Northwest. In 2012, she served as the team lead for the development of the Striving for Inclusion training guides for environmental justice work in Forest Service, which were published in 2014 and are still in use today. She also served as a co- author on Environmental justice, low-income and minority populations, and forest management in the northwest forest plan area. In addition to working at the Forest Service, Dr. Grinspoon has experience working at the State Department and USAID. Prior to joining the federal government in 2002, her work focused on forest resource use in China. Dr. Grinspoon is fluent in Mandarin Chinese. She has authored numerous publications including academic journal articles and articles for the LA Times and Economist Intelligence Unit.

Shiloh Babbington is a 22-year-old Māori who grew up in a rural community in New Zealand. She became the first person in her entire family to graduate University, confronting the structural barriers that indigenous peoples face in education. Shiloh has a Bachelor of Arts Degree, Triple Major in International Relations, Political Science, and Education from Victoria University of Wellington. She is a Policy Analyst in the Global Research Alliance (GRA) where she leads the newly established, Indigenous Research Network. She has devoted her work at the Ministry for Primary Industries to the Inclusivity and empowerment of indigenous peoples, enabling traditional knowledge to be utilised as a tool against Climate change. Shiloh is also the MPI lead for an indigenous organisation called Kohimarama Aotearoa, where she has helped organise

exchanges of indigenous resilience to Climate Change among indigenous peoples from countries such as Mexico, Australia, and the Pacific through digital workshops. She plans on using her personal experiences in her work to build capability and create opportunities for more young Indigenous people.

SESSION 3 - Resilience and Adaptation to Climate Shocks, Extreme Weather Events and Long-Term Adaptation Planning: Focus on Hubs and Innovation Centers

Katrina Baxendell is a Director in the Australian Federal Department of Agriculture, Fisheries and Forestry with extensive experience in government policy and program delivery. Her diverse legal background has supported Katrina's work in the Australian Taxation Office and in the Federal Defence and Agriculture departments. Late last year Katrina took on management of one of the Future Drought Fund's foundational grant program, the Drought Resilience Adoption and Innovation Hubs.

Julian Reyes is the National Coordinator for the USDA Climate Hubs program. In this role, he provides connection and cohesion across the regional Hubs, integrates Climate Hub work across USDA agencies, coordinates with other climate networks, and engages with stakeholders. Prior, Julian was a AAAS Science and Technology Policy Fellow at the U.S. Department of State in their climate change office. Julian was also a Climate Hub Fellow with the USDA Southwest Climate Hub from 2016 to 2019 where he spearheaded development of the AgRisk Viewer, a new platform to provide accessible and discoverable crop insurance loss data. Julian has broad expertise in hydroclimatology, climate change and impacts in agroecosystems, and eco-hydrologic modeling. Julian earned both his B.S. and PhD in civil engineering from Washington State University. He was a Science Policy Fellow at the U.S. Global Change Research Program and a Fulbright Research Scholar in Germany.

François Chrétien is a Director of Research, Development and Technology at AAFC, Science and Technology Branch. In this role, he provides leadership on multiple science priorities, including climate change, agri-environmental challenges and living labs. Since 2017, he has been responsible for the development of AAFC Living Laboratories Initiative aimed at building resilience in the agricultural landscape and the recently launched Agricultural Climate Solutions program. He has worked with multiple Canadian and international partners in order to develop a new approach to agricultural innovation. In this user-centred approach, farmers and scientists work together from start to finish; transdisciplinary teams, including experts from various disciplines and backgrounds, tackle a common issue together; and projects are conducted in real life experimental setups meaning that working farms are the incubators of innovative technologies. François received his Bachelor of Sciences in agriculture from McGill University and his master's degree in Water Sciences from the National Institute of Scientific Research. Following his graduated studies he has been involved in numerous

water-focused initiatives throughout Canada and around the world. He served as: Water Sourcing and Planning Specialist in the Prairie Farm Rehabilitation Administration; Water Management Specialist within the Agri-Environmental Services Branch; as the Head of the water management team at the Quebec Research and Development Centre; as acting Associate Director Research-Development- Technology Transfer of the Sherbrooke Research and Development Centre; before moving on to executive management as Associate Director for AAFC's Living Labs and Director Research, Development & Technology for Saint-Jean-sur-Richelieu, Agri-environment, Agro-Climate, Geomatics and Earth Observation Division (ACGEO) and Living Labs. Prior to his employment by Agriculture and Agri- Food Canada (AAFC) in 2007, François worked on integrated water and pest management in the wine- growing areas of British Columbia and New Zealand. He was also employed as Agricultural and Agri-Food Accounts Director for the RBC Royal Bank of Canada.

SESSION 4 - Best Practices and Solutions for Increasing Agriculture and Climate Investments, and Utilizing Investments for Adaptation and Resilience

Claudia Godfrey is a Forest Engineer with 25 years of experience in climate finance and developing nature-based solutions strategies. She is currently the Innovation and Strategic Management Director at the Peruvian Environmental Fund - Profonanpe. In addition, she is the current Chair of the Global Network of Accredited Entities by the Green Climate Fund and the Adaptation Fund (Community of Practice of Direct Access Entities - CPDAE) with studies in Adaptive Management and Open Standards for Conservation, Economic Conservation Tools, and Forest Certification; and a Member of the Conservation Coaches Network.

Imelda "Dada" Bacudo is a senior advisor to ASEAN and its ten Member States for strengthened regional and international policies to support the transformation of ASEAN to low emissions and resilient agrifood sector. She has been instrumental in guiding the ASEAN Climate Resilience Network---a platform for knowledge exchange and support on climate smart land use--to push the agriculture sector into engagement with the UNFCCC. Under her leadership, the ASEAN CRN's efforts through G77 and China, have contributed to the Koronivia Joint Work Action Plan, a landmark decision for agriculture of the UNFCCC. She worked as Principal Advisor of the Forest and Climate Change Project under the ASEAN-German Programme on Response to Climate Change (GAP-CC) implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Currently, she remains the guiding technical expert of the ASEAN Negotiation Group for Agriculture (ANGA) which pushes the agriculture sector of ASEAN to jointly shape climate policies of the UNFCCC. She is on various assignments with the UN-Food Agriculture Office (FAO) to support ASEAN on tasks as described above. She is also the international coordinator for the UN Environment Programme's Climate and Clean Air Coalition (CCAC) programme in Viet Nam assisting the Ministry of Agriculture in ensuring several low-emissions agriculture practices contribute to its Nationally Determined Contributions (NDCs); and also as a regional climate change expert for E- READI an EU-ASEAN dialogue programme.

Michael Chorske is a senior investment and operating executive with a record of building entrepreneurial enterprises and managing alternatives funds and portfolios. As an Operating Partner at Pegasus Capital Advisors, he manages the Global Subnational Climate Fund's agriculture investments and other activities within the impact portfolio. He has 20 years of experience in venture, growth and infrastructure, and 10 years of operating experience in technology, CPG and sustainable food production. Mr. Chorske was a founder and executive managing director of Emergent Holdings, LLC, an investor in and developer of land-based aquaculture and controlled environment agriculture businesses. He is a director of Silver Spike Investment Corporation, a publicly traded business development company, and a Venture Partner with NextGen Venture Partners. Mr. Chorske began his career managing venture, growth equity, and LBO portfolios for a large family office, investing across the capital structure in technology, healthcare services, biotechnology, recreational products, and natural resources. He is a graduate of Middlebury College and Columbia University School of Business.

Annex 3. Additional Resources

Asia Pacific Economic Cooperation (June 2023). *Green Synergy Solutions for Sustainable Community on Agriculture Residue-Based Energy and Circular Economy.* Green Synergy Solutions for Sustainable Community on Agriculture Residue-Based Energy and Circular Economy | APEC

Asia Pacific Economic Cooperation (July 2022). *APEC Workshop on Practices and Promotion of Circular Agriculture.* APEC Workshop on Practices and Promotion of Circular Agriculture | APEC

Asia Pacific Economic Cooperation (May 2021). *APEC Workshop on the R&D and Promotion of Smart Agriculture.* APEC Workshop on the R&D and Promotion of Smart Agriculture | APEC

Asia Pacific Economic Cooperation (October 2017). *Best Practices for Developing the Green Energy Smart Farm in the APEC Region.* Best Practices for Developing the Green Energy Smart Farm in the APEC Region | APEC