海外農業技術セミナー / 酪農学園大学SDGsセミナー

持続可能な農業とは

-気候危機と生物多様性の喪失-

Sustainable Agriculture in the Age of Climate and Biodiversity Crises

2022年2月22日（火）　9:00～12:00（日本時間）
Tuesday, February 22, 2022 9:00 - 12:00 (JST)
酪農学園大学　C1号館1階　101教室（北海道江別市文京台緑町582）
101 Lecture Room, Ground Floor, C1-Building, Rakuno Gakuen University

共催：北海道アルバータ酪農科学技術交流協会/酪農学園大学
Hokkaido-Alberta Dairy Science & Technique Exchange Association / Rakuno Gakuen University

プログラム [Program]

司会進行 [MC]： 酪農学園社会連携センター　センター長 吉中 厚裕 （環境共生学類 准教授） Atsuhiro YOSHINAKA, Director of RGU Extension Center Dept. of Environmental Sciences 副センター長 亀岡 笑 （循環農学類 講師） Emi KAMEOKA, Deputy Director of RGU Extension Center Dept. of Sustainable Agriculture

9:00 ～ 9:20	**開会あいさつ** Opening remarks 北海道アルバータ酪農科学技術交流協会 会長 **谷山 弘行** Dr. Hiroyuki TANIYAMA Director of Hokkaido - Alberta Dairy Science and Technique Exchange Association 国際連合生物多様性条約(CBD) 事務局長 **エリザベス・マルマ・ムレマ** Ms. Elizabeth Maruma Mrema Executive Secretary of the Convention on Biological Diversity, United Nations
9:20 ～ 9:50	**基調講演** Keynote **持続可能な農業～生物多様性と気候危機とのつながり～** Sustainable Agriculture - Linkages with biodiversity and climate change 国際連合食糧農業機関(FAO) 気候変動・生物多様性・環境局生物多様性 担当部長 **イレーナ・ホフマン** Dr. Irene Hoffmann Secretary of the Commission Genetic Resources for Food and Agriculture
	休 憩 Intermission
10:00 ～ 11:10	**テーマ別講演** Thematic lectures **気候変動下で小麦・大麦の収穫量はどう変化するか？～カナダにおける収量変化を予測する～** Response of wheat and barley crop yields to climate change using process-based modeling in agricultural lands of Canadian Prairies アルバータ大学 理学部地球大気科学科 准教授 **モニレ・ファラマーズィ** Dr. Monireh Faramarzi Associate Professor, Faculty of Science, University of Alberta **気候危機への対応における社会的な障壁と実現可能性～アルバータ州の農家での実例をもとに～** Social and organizational dimensions of climate change mitigation among Alberta farmers アルバータ大学 農業・生命・環境科学部 教授 **デブラ・デイビッドソン** Dr. Debra Davidson Professor, Faculty of Agricultural, Life and Environmental Sciences, University of Alberta
	休 憩 Intermission
11:20 ～ 11:50	**質疑応答** Questions and comments
11:50 ～ 12:00	**閉 会** Closing 酪農学園大学 学長 **堂地 修** Dr. Osamu DOCHI President of Rakuno Gakuen University

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エリザベス・マルマ・ムレマ
国際連合生物多様性条約（CBD） 事務局長

Ms. Elizabeth Maruma Mrema,
Executive Secretary of the Convention on Biological Diversity, United Nations

エリザベス・マルマ・ムレマ氏は２０年以上に渡り国連環境計画(UNEP)に取り組むと共に、法務部長、生態系部副部長、野生動物の移動性種の保護に関する協定の事務局の事務局長を含む様々な役割を果たしてきました。UNEPでの彼女の仕事は、国、地域、国際レベルでの環境法の開発、履行、施行に焦点を当ててきました。2021年、国際自然保護連合(IUCN)の世界環境法委員会は、UNEPと共同で彼女にニコラスロビンソン環境法優秀賞を授与しました。

She has worked with the UN Environment Programme (UNEP) for over two decades and has served in various roles, including as Director of the Law Division, Deputy Director of the Ecosystems Division, and Executive Secretary of the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. Elizabeth's work at UNEP has focused on the development, implementation and enforcement of environmental laws at national, regional and international levels. In 2021, the IUCN World Commission on Environmental Law, in collaboration with UNEP, awarded Elizabeth with the Nicholas Robinson Award for Excellence in Environmental Law.

Opening remarks by

ELIZABETH MARUMA MREMA
Executive Secretary of the Convention on Biological Diversity

at the 2021 Overseas Agricultural Science Seminar: Sustainable Agriculture in the Age of Climate and Biodiversity Crisis

Hokkaido-Alberta Dairy Science and Technique Exchange Association &
Rakuno Gakuen University

22 February 2022, 09:00 - 12:00 (JST)

Greetings to you all! *Thank you, Dr. Hiroyuki Taniyama, for your introduction,*

Dear Experts, Colleagues and Friends,

It is my honour to participate in this year's Overseas Agricultural Science Seminar, organized by the Hokkaido-Alberta Dairy Science and Technique Exchange Association and Rakuno Gakuen University.

Let me begin by highlighting the strong collaborative nature of the Hokkaido-Alberta Dairy Science and Technique Exchange Association. Established in 1973, the Association has helped promote dairy farming through the exchange of science and technology and has strengthened bilateral relations between the two regions.

Social and economic sectors of our societies rely on healthy ecosystems to flourish. Biodiversity, on which our agriculture, forests, aquaculture and fisheries depend, lays the foundation for the health, livelihoods, food security and nutrition for people around the world.

From Hokkaido, Japan, to Alberta, Canada, cultivation continues to outcompete other sectors for land. Industrial agricultural practices have often degraded ecosystems and accelerated biodiversity loss, expecting a trade-off for more productivity and lower costs.

However, modern techno-centric thinking has put a new focus on what indigenous peoples and local communities have always known and continue to teach – that is to build systems that works with biodiversity rather than against it.

Healthy ecosystems are vitally important for agricultural production however, we continue to see the loss of biodiversity, land degradation and pest and disease outbreaks – compounded by the impacts of climate change through unprecedented warming, extreme weather and unpredictable precipitation patterns.

Alternatively, biodiversity conservation as well as restoration and sustainable use of ecosystems can help reverse these trends and can simultaneously be a solution to the environmental crises we face today. Sustainable agricultural practices such as agroecology and ecosystem-based approaches can deliver multiple benefits to food and water security while also mitigating and adapting to climate change and reversing land degradation.

For example, encouraging integrated production systems such as agroforestry, no-till agriculture and appropriate crop rotation can be simple solutions that are biodiversity-friendly and can help reverse ecosystem and land degradation. In fact, many ecosystem-based approaches also help ecosystems become more resilient to extreme weather while contributing to climate change mitigation, adaptation and disaster risk reduction.

For these solutions to be fair, equitable and truly sustainable, they need to be implemented with the full inclusion and participation of all stakeholders, including smallholder farmers, indigenous peoples and local communities, who often grow a large portion of regional produce and who hold knowledge on the land they cultivate.

Colleagues,

We will not be able to reverse the loss of biodiversity or limit the global temperature increase to 1.5 degrees unless we transform our food systems.

I would like to draw your attention to the fifth edition of the *Global Biodiversity Outlook*, which outlined two major transitions that are relevant today.

First – the sustainable agriculture transition aims to redesign agricultural systems and recognize the role of biodiversity through agroecological approaches that minimize negative impacts, while enhancing productivity and resiliency, and making efficient use of land, water and other resources.[1]

Second – the sustainable food systems transition focuses on enabling more sustainable and healthier diets. More diverse foods and food systems have obvious nutritional benefits. More moderate consumption of meat and fish and a deep reduction of food waste can reduce global demand-driven pressures and ensure food security for all people.[2]

Dear decision-makers,

These ideas for more sustainable agriculture are not new. Leaders around the world have already agreed that change is needed, under the UN 2030 Agenda for Sustainable Development. This year, under the Convention on Biological Diversity, the world will adopt a global biodiversity framework that aims to bridge the gap between where we are and where we need to be, regarding the state of nature of our planet.

The post-2020 global biodiversity framework will enable us to maximize synergies between international processes and instruments so that they not only address the issues of climate change,

[1] GBO-5 Sustainable Agriculture Transition
[2] GBO-5 Sustainable Food Systems Transition

biodiversity loss, desertification and ecosystem degradation in a more holistic way, but that they also support the transformation of our food systems.

The current draft of the framework includes a target that aims to ensure that all areas under agriculture, aquaculture and forestry are managed sustainably. We need to ensure that this target is ambitious and holistic and secures the productivity and resilience of food systems.

In addition, agroecology and the importance of soil biodiversity have gained significant international attention. The CBD will also adopt a plan of action for the conservation and sustainable use of soil biodiversity,[3] produced in consultation with FAO.

The plan aims to encourage the conservation, restoration and sustainable use of soil biodiversity, including through agroecological practices, with a view to support the implementation of the post-2020 global biodiversity framework. Since biodiversity plays a critical role in the sustainable management of food systems, the full and active participation of agricultural sectors within the post-2020 framework will be essential for its success.

Lastly, and most importantly, the framework is intended to be a global framework for all and thus universally applicable. To attain this, we must recognize and support the roles and rights of indigenous peoples, smallholder farmers and small-scale food producers so that we can reverse biodiversity loss.

It is with these successes that we will achieve the Sustainable Development Goals and the 2050 vision of living in harmony with nature.

Thank you. I wish you great success in today's seminar.

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[3] Annex contained in CBD/SBSTTA/24/L.7

イレーナ・ホフマン

国際連合食糧農業機関（FAO）
気候変動・生物多様性・環境局
生物多様性担当部長

Dr. Irene Hoffmann

Secretary of the Commission on Genetic Resources for Food and Agriculture

イレーナ・ホフマン博士は、2002年から2015年まで、FAOの動物遺伝資源課長および動物生産サービス課長を務め、動物遺伝資源に関する政府間技術作業部会の事務局を務めました。農業科学者であり、ホーエンハイム大学で博士号、ゲッティンゲン大学で修士号を取得しています。1994年から2002年までギーセン大学家畜生態学研究所の助教授を務め、国際的かつ学際的な研究プログラムをまとめました。それ以前は、開発分野（アフリカのGIZ）で、科学編集者として、また開発NGOsのために働いていました。彼女は、国際的な政策・技術的な会議を開催してきたとともに、科学的・政策的なテーマで幅広く発表しているほか、様々な諮問委員会や審査委員会で活躍しています。

Between 2002 and 2015, Ms. Irene Hoffmann was Chief of the Animal Genetic Resources Branch and Chief of the Animal Production Service in FAO, and acted as Secretary of the Intergovernmental Technical Working Group on Animal Genetic Resources. Irene is an agricultural scientist with a Ph.D. from Hohenheim University and an MSc from Göttingen University. Between 1994 and 2002 she was assistant professor at the Institute of Livestock Ecology, Giessen University, where she coordinated international and interdisciplinary research programmes. Earlier in her career she worked in development (GIZ, Africa), as scientific editor, and for development NGOs. She has organized international policy and technical conferences and published extensively on scientific and policy topics, and she has served in various advisory committees and review panels.

持続可能な農業 ～生物多様性と気候危機とのつながり～

概要

膨れ上がる世界の人口、持続不可能な管理方法による天然資源の劣化、生物多様性の喪失、そして気候変動は、根本的な懸念を呼び起こします。即ち、今日の食糧及び農業システムは、現在および将来の世代のニーズを満たすことができるのかということです。どのようにしたら、差し迫った地球規模の問題に取り組みながら、社会はより持続可能な食料システムに移行できるのでしょうか？世界の食料システムの要である食料と農業のための生物多様性は脅威にさらされ、侵食されつつあります。しかし、何千もの種とその遺伝的多様性は、食料安全保障と気候変動を含む新しい状況に適応するために必要不可欠なものです。私たちの農業食糧システムの未来は、いくつかの持続可能な開発目標（SDGs）の達成の中心となるでしょう。たとえば、飢餓の撲滅、責任ある生産と消費、そして陸域・水域の生態系と生物多様性の保全と持続可能な利用を含む「環境に対する責務（environmental stewardship）」の促進などが挙げられます。今回の発表では、現在の地球規模の課題と持続可能な農業へのアプローチに光を当てますが、どこにでも通用する万能の解決策は存在しないのだということを強調しています。日本における実例を示すとともに、国際的な協力と、共同して政策を作り対応することの必要性を強調しています。イレーナ・ホフマン博士は、国連食糧農業機関（FAO）の「食糧と農業のための遺伝資源委員会(CGRFA)」の事務局長を務めています。この委員会は、食糧と農業のための生物多様性について専門的に取り組んでいる唯一の政府間組織です。また、食糧と農業のための生物多様性の保全と持続可能な利用を支援するための共同行動と地球規模の政策について各国が合意するためのフォーラムを提供しています。

Sustainable Agriculture
– linkages with biodiversity and climate change

Abstract

An expanding world population, natural resource degradation from unsustainable management practices, biodiversity loss and climate change give rise to fundamental concerns: Are today's food and agricultural systems capable of meeting the needs of present and future generations? How can societies transition to more sustainable food systems while addressing pressing global issues? The backbone of the world food systems -biodiversity for food and agriculture- is under threat and eroding. Yet the thousands of species and their genetic variability are indispensable to food security and to adapt to new conditions, including climate change. The future of our agri-food systems will be central to the achievement of several Sustainable Development Goals (SDGs), such as, the elimination of hunger, responsible production and consumption, and the promotion of environmental stewardship, including the conservation and sustainable use of our terrestrial and aquatic ecosystems and biodiversity. The presentation sheds light on current global challenges, and on approaches to sustainable agriculture, highlighting that there is no one-size fits all solution. It provides illustrative examples of Japan and emphasizes the need for international collaboration and joint policy responses. Dr. Irene Hoffmann serves as the Secretary of the Commission on Genetic Resources for Food and Agriculture (Commission) of the Food and Agriculture Organization of the United Nations. The Commission is the only intergovernmental body that specifically addresses biodiversity for food and agriculture. It offers countries a forum to agree on joint actions and global policies to support the conservation and sustainable use of biodiversity for food and agriculture.

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Sustainable agriculture – linkages with biodiversity and climate change

Irene Hoffmann, Secretary, Commission on Genetic Resources for Food and Agriculture

Overseas Agricultural Science Seminar, February 22, 2022, Rakuno Gakuen University

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Structure

- Food & agriculture at the crossroads
- Approaches to sustainable agriculture
- Global responses & international cooperation
- Conclusion

Food & agriculture at the crossroads

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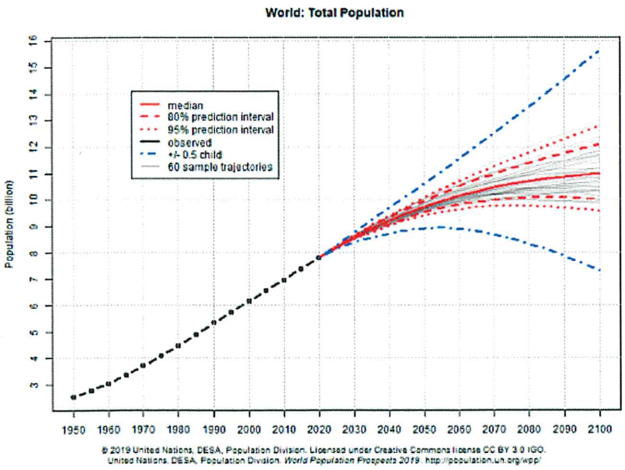
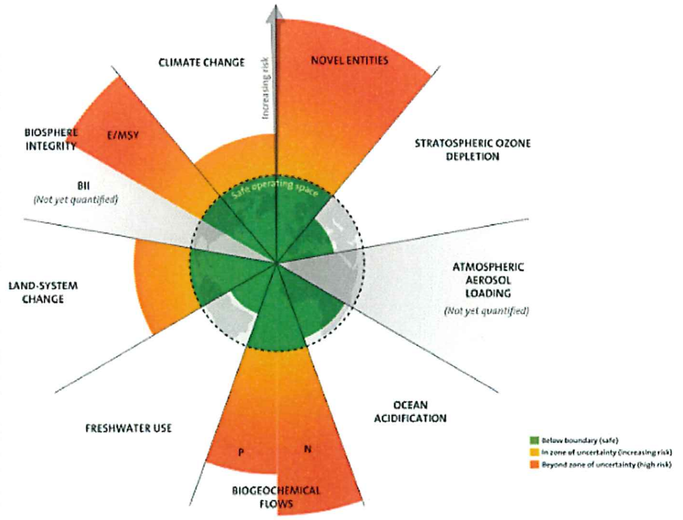
Planetary boundaries





Stockholm Resilience Centre, 2022

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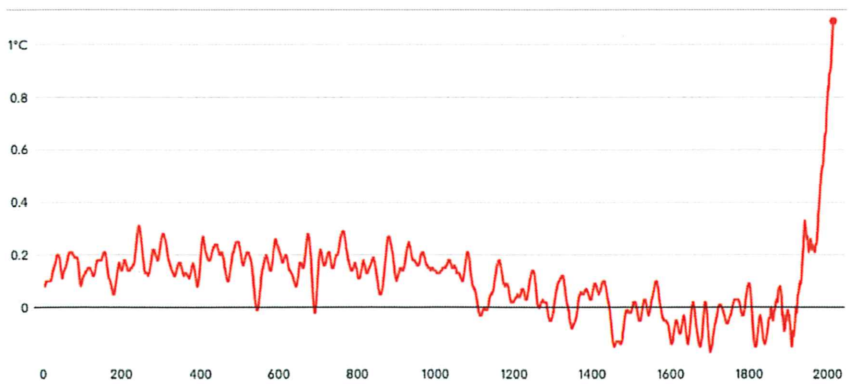
Climate change

Change in global surface temperature (decadal average) as reconstructed (1-1850) and observed (1850-2020)



Figures represent the central estimate for years 1-1850

Source: Intergovernmental Panel on Climate Change

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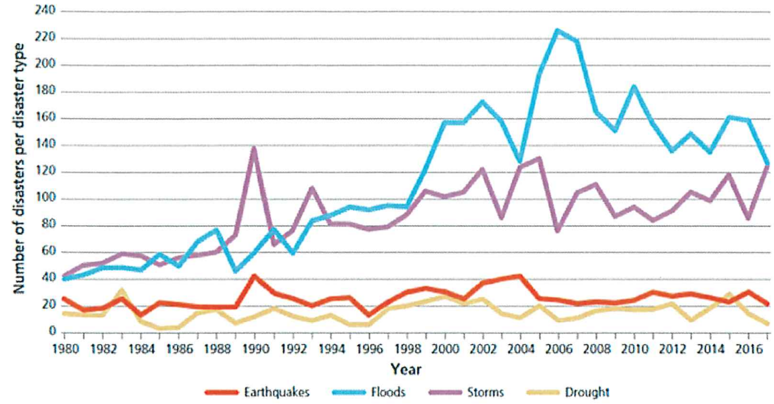
Climate change – Global trends in the occurrence of natural disasters



Source: EM-DAT, the OFDA/CRED International Disaster Database, www.emdat.be

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Example Japan: Effects of climate change & GRFA

Table 1: Main effects on paddy-field rice (nationwide)

Main effects	2008	2009	2010 *	2011	2012	2013	2014	2015	2016
Occurrence of white immature grains	33	21	46	28	29	27	17	20	27
Occurrence of cracked grains	7	7	...	10	10	8	5	3	5
Insufficient growth in grains	8	5	...	12	10	10	8	8	6
Frequent occurrence of insect damage	14	8	...	8	5	8	4	6	8

Source: "Fact-Finding Survey Concerning the Effects of Global Warming on Agricultural Production" The same unless otherwise stated.
Note: As a different type of survey was conducted in 2010, only the estimated occurrence of white immature grains is shown for the year. As figures for other effects are unavailable, "..." is shown for them.

Figure 2: Cross-section surface of white immature grain (left) and normal grain (right)

Figure 3: Cracked grains

Source: MAFF, 2018

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Example Japan: Effects of climate change & GRFA

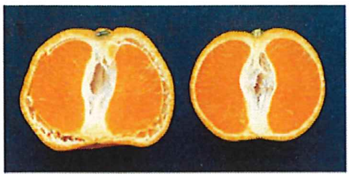
Table 5: Effects on unshu mikan

Main effects	Citrus fruits (Note)		Unshu mikan					
	2008	2009	2011	2012	2013	2014	2015	2016
Occurrence of peel puffing	7	9	12	6	5	8	11	14
Defective coloring or delayed coloring	10	7	5	4	7	1	2	6
Occurrence of tanning	9	6	5	5	6	4	2	5

Note: Figures for 2008 and 2009 are reference data on the number of prefectures where effects on citrus fruits (including unshu mikan) occurred.
Reference: Fact-Finding Survey Concerning the Effects of Global Warming on Agricultural Production

Table 6: Effects on apples

Main effects	2008	2009	2011	2012	2013	2014	2015	2016
Defective coloring or delayed coloring	6	4	4	11	8	4	4	8
Occurrence of tanning	4	1	3	7	6	6	6	6
Occurrence of freeze or frost damage	2	1	-	-	-	-	2	2
Frequent occurrence of insect damage (by spider mites, etc.)	2	1	-	2	1	1	1	2



Source: MAFF, 2018

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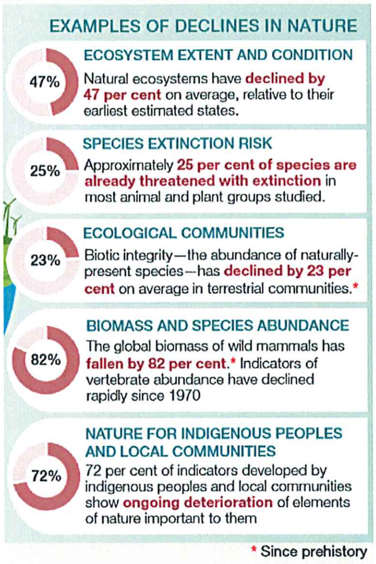
Biodiversity crisis



- Direct and indirect drivers of change have accelerated during the past 50 years
- Biodiversity and ecosystem functions and services are deteriorating worldwide
- Biodiversity can be conserved, restored and used sustainably while simultaneously meeting other global societal goals through urgent and concerted efforts fostering transformative change.

Source, IPBES, 2019

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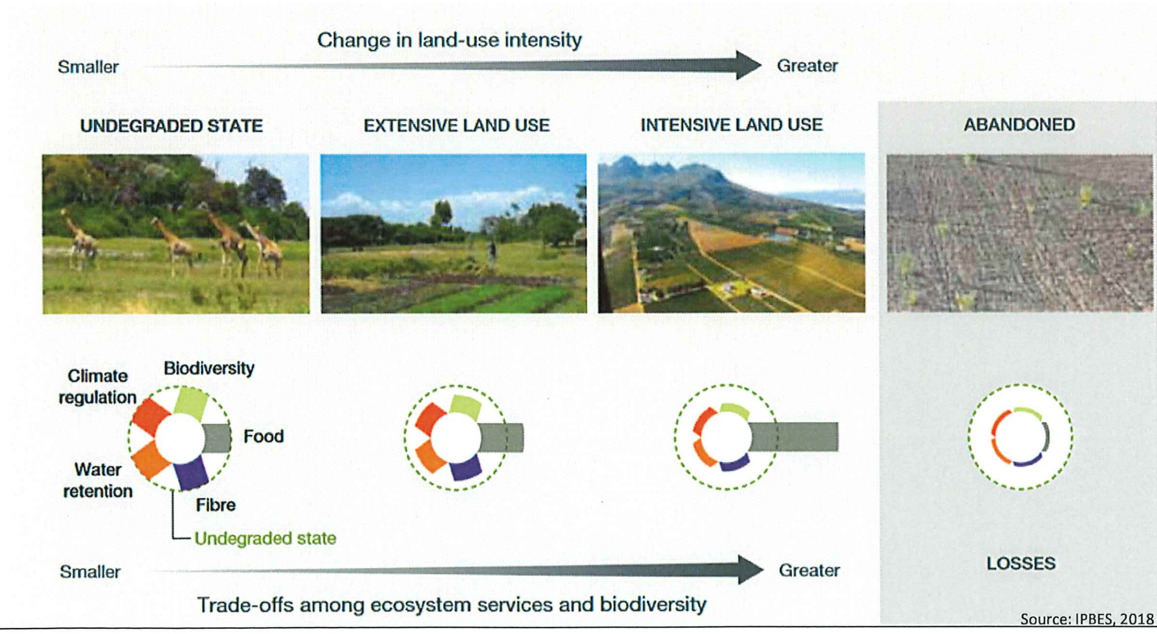

Source: IPBES, 2018

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Biodiversity and healthy ecosystem are key to food security and nutrition

Biodiversity for food and agriculture is the variety of life at genetic, species and ecosystem levels that contributes to agriculture and food production.

- Genetic resources for food and agriculture
- Wild foods from non-domesticated species
- Associated biodiversity
  - Micro-organisms, fungi, invertebrates
  - Vertebrates, including wild relatives
  - Wild and cultivated terrestrial and aquatic plants other than crops and crop wild relatives

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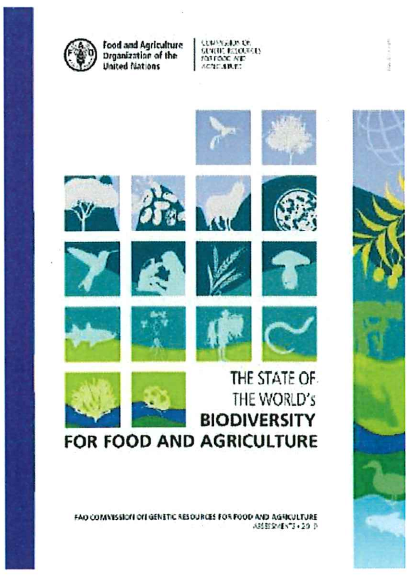
Biodiversity for food and agriculture is declining



FAO, 2019 SOW-BFA

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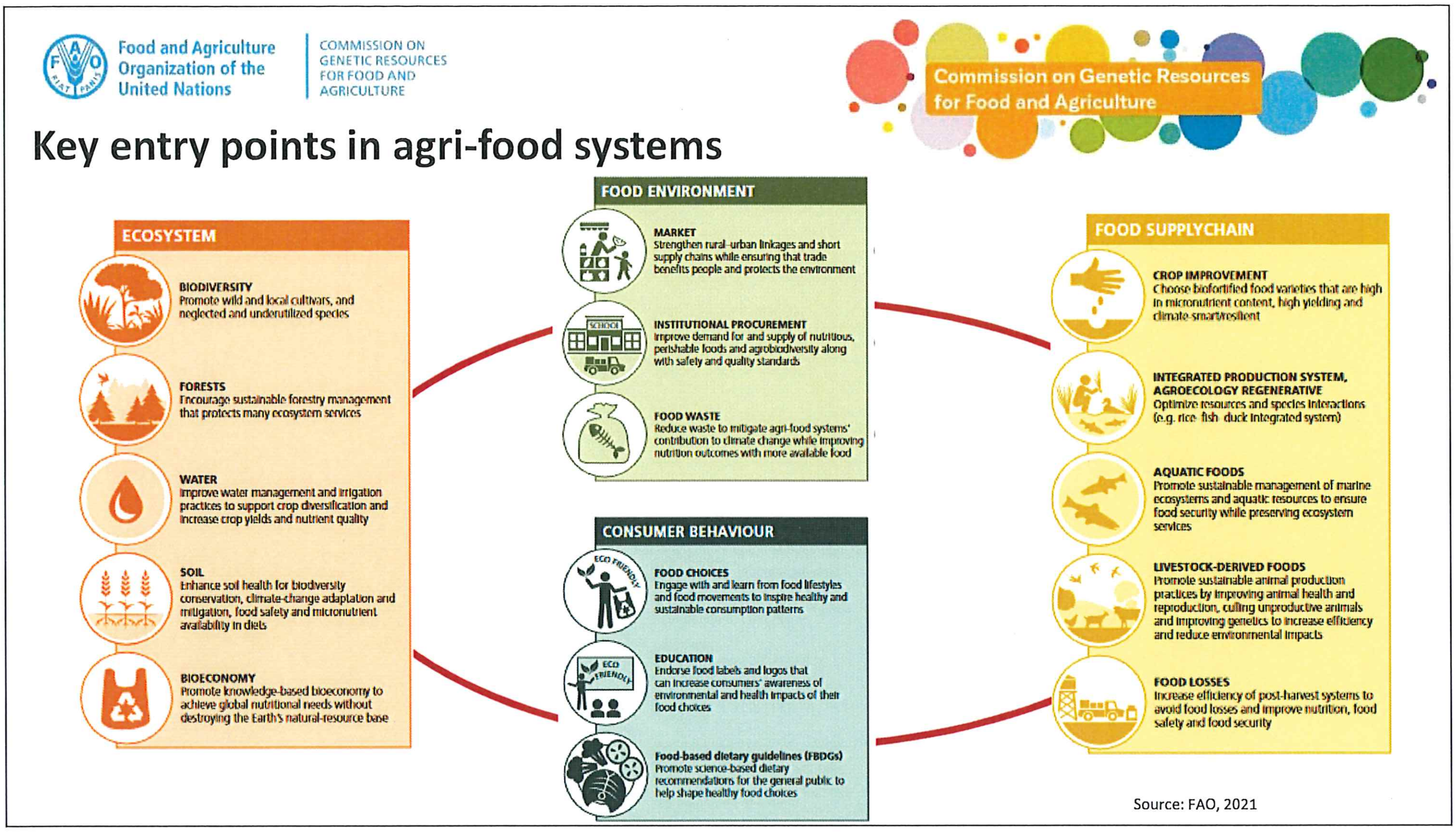
Multiple interacting drivers of change

	Drivers of change	Reported effect on biodiversity for food and agriculture
	Population growth and urbanization	- -
Economic and social	Markets and trade	-
	Changing economic, sociopolitical and cultural factors	+ / -
	Climate change	- -
Environmental drivers	Natural disasters	- -
	Pests, diseases, invasive alien species	- -
	Changes in land and water use and management	- -
Drivers at production system level	Pollution and external inputs	- -
	Overexploitation and overharvesting	- -
Other	Advances and innovations in science and technology	+
	Policies	+ +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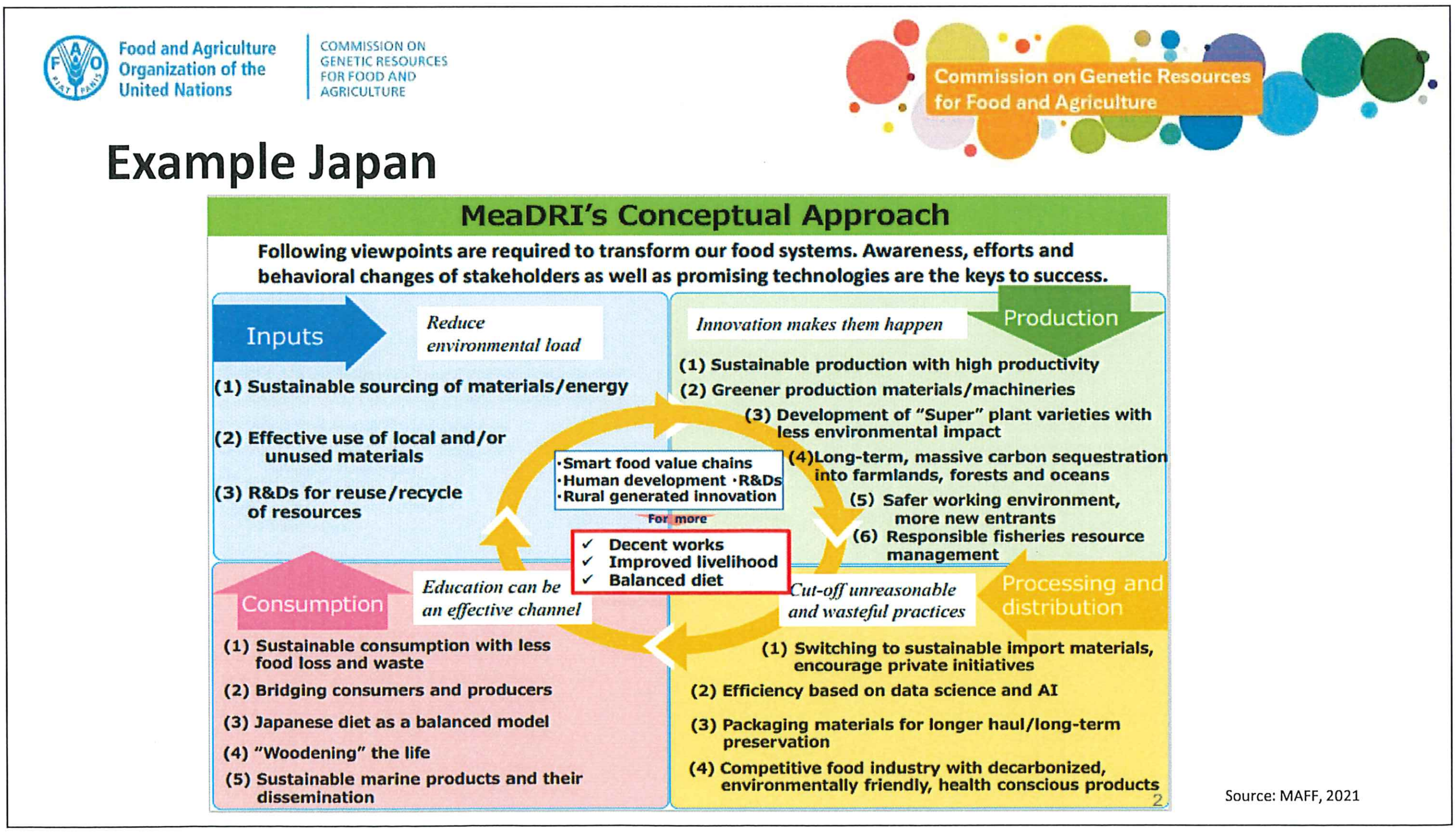
Key entry points in agri-food systems
ECOSYSTEM
BIODIVERSITY Promote wild and local cultivars, and neglected and underutilized species
FORESTS Encourage sustainable forestry management that protects many ecosystem services
WATER Improve water management and irrigation practices to support crop diversification and increase crop yields and nutrient quality
SOIL Enhance soil health for biodiversity conservation, climate-change adaptation and mitigation, food safety and micronutrient availability in diets
BIOECONOMY Promote knowledge-based bioeconomy to achieve global nutritional needs without destroying the Earth's natural-resource base
FOOD ENVIRONMENT
MARKET Strengthen rural–urban linkages and short supply chains while ensuring that trade benefits people and protects the environment
INSTITUTIONAL PROCUREMENT Improve demand for and supply of nutritious, perishable foods and agrobiodiversity along with safety and quality standards
FOOD WASTE Reduce waste to mitigate agri-food systems' contribution to climate change while improving nutrition outcomes with more available food
CONSUMER BEHAVIOUR
FOOD CHOICES Engage with and learn from food lifestyles and food movements to inspire healthy and sustainable consumption patterns
EDUCATION Endorse food labels and logos that can increase consumers' awareness of environmental and health impacts of their food choices
Food-based dietary guidelines (FBDGs) Promote science-based dietary recommendations for the general public to help shape healthy food choices
FOOD SUPPLYCHAIN
CROP IMPROVEMENT Choose biofortified food varieties that are high in micronutrient content, high yielding and climate-smart/resilient
INTEGRATED PRODUCTION SYSTEM, AGROECOLOGY REGENERATIVE Optimize resources and species interactions (e.g. rice–fish–duck integrated system)
AQUATIC FOODS Promote sustainable management of marine ecosystems and aquatic resources to ensure food security while preserving ecosystem services
LIVESTOCK-DERIVED FOODS Promote sustainable animal production practices by improving animal health and reproduction, culling unproductive animals and improving genetics to increase efficiency and reduce environmental impacts
FOOD LOSSES Increase efficiency of post-harvest systems to avoid food losses and improve nutrition, food safety and food security
Source: FAO, 2021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Example Japan
MeaDRI's Conceptual Approach
Following viewpoints are required to transform our food systems. Awareness, efforts and behavioral changes of stakeholders as well as promising technologies are the keys to success.
Inputs
Reduce environmental load
(1) Sustainable sourcing of materials/energy
(2) Effective use of local and/or unused materials
(3) R&Ds for reuse/recycle of resources
Innovation makes them happen
Production
(1) Sustainable production with high productivity
(2) Greener production materials/machineries
(3) Development of "Super" plant varieties with less environmental impact
(4) Long-term, massive carbon sequestration into farmlands, forests and oceans
(5) Safer working environment, more new entrants
(6) Responsible fisheries resource management
・Smart food value chains
・Human development ・R&Ds
・Rural generated innovation
For more
✓ Decent works
✓ Improved livelihood
✓ Balanced diet
Consumption
Education can be an effective channel
(1) Sustainable consumption with less food loss and waste
(2) Bridging consumers and producers
(3) Japanese diet as a balanced model
(4) "Woodening" the life
(5) Sustainable marine products and their dissemination
Cut-off unreasonable and wasteful practices
Processing and distribution
(1) Switching to sustainable import materials, encourage private initiatives
(2) Efficiency based on data science and AI
(3) Packaging materials for longer haul/long-term preservation
(4) Competitive food industry with decarbonized, environmentally friendly, health conscious products
2
Source: MAFF, 2021

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Example Japan

Measures for achievement of Decarbonization and Resilience with Innovation (MeaDRI)

Abstract

~ Innovation will enhance potentials and ensure sustainability in a compatible manner~ MAFF Japan

"MeaDRI," the medium-long term strategy will pave the way for the future.

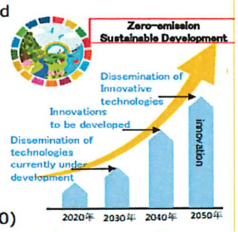
- Enhancing engagement of stakeholders at each stage of food supply chains
- Promoting innovation to reduce environmental load

Challenges

- Depopulation and aging of producers
- Stagnant rural communities
- Climate change and increasing natural disasters
- Disrupted supply chains due to the COVID-19
- Achievement of SDGs

By 2050, MAFF aims to achieve;

- **Zero CO2 emission** from the agriculture, forestry and fisheries sectors
- **50% reduction in risk-weighted use of chemical pesticides** by dissemination of the Integrated Pest Management and newly-developed alternatives
- **30% reduction in chemical fertilizer use**
- **Increase in organic farming to 1Mha** (equivalent to 25% of farmland)
- **At least 30% enhancement in productivity of food manufacturers** (by 2030)
- **Sustainable sourcing for import materials** (by2030)
- **90% and more superior varieties and F1 plus trees** in forestry seedling
- **100% of artificial seedling rates** in aquaculture of **Japanese eel, Pacific bluefin tuna,** etc.



which will be enabled through:
- development and dissemination of innovative technologies
- greening of MAFF's policy tools

MAFF endeavors to accomplish the triple win of;

Economic sustainability	Social sustainability	Environmental sustainability
Ensure robust and resilient food industry	Improve livelihood, promote balanced diet	Save global environment for the future generation

Source: MAFF, 2021

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The use of many biodiversity-friendly practices is reported to be increasing

Management practices and approaches	Production systems (PS): Livestock grassland-based systems	Livestock landless systems	Naturally regenerated forests	Planted forests	Self-recruiting capture fisheries	Culture-based fisheries	Fed aquaculture	Non-fed aquaculture	Irrigated crop systems (rice)	Irrigated crop systems (other)	Rainfed crop systems	Mixed systems
Landscape management	↗	↗	↗	↗					↗	↗	↗	↗
Ecosystem approach to fisheries					↗	↗	↗					
Restoration	↗		↗	↗	↗				↗	↗	↗	↗
Diversification	↗	↗	↗	↗	↗	↗	↗		↗	↗	↗	↗
Home gardens	↗	↔	↗	↗					↗	↗	↗	↗
Agroforestry	↗	↗	↗	↗					↗	↗	↗	↗
Polyculture/aquaponics							↗					↗
Organic agriculture	↗	↗	↗	↗					↔	↗	↗	↗
Low external input agriculture	↗↙	↗	↗	↗					↗	↗	↗↙	↗
Sustainable soil management	↗	↗	↗	↗					↗	↗	↗	↗
Management of micro organisms	↗		↗	↗	↗				↗	↗	↗	↗
Conservation agriculture	↗	↗	↗	↗					↗	↗	↗	↗
Integrated plant nutrient management	↗	↗	↗	↗					↗	↗	↗	↗
Integrated pest management	↗	↗	↗	↗	↗				↗	↗	↗	↗
Pollination management	↗	↗	↗	↗						↗	↗	↗
Enrichment planting			↗	↗								↗
Reduced-impact logging			↗	↗								
Domestication	↗	↔	↗↙	↗			↗		↗	↗	↗	↗
Base broadening	↗	↗	↗↙	↗					↗	↗	↗	↗

Notes: Analysis based on 91 country reports. See main report for details of the methodology.

Proportion of countries reporting the PS that report any trends (%)

- 0–9
- 10–19
- 20–29
- 30–39

FAO, 2019 SOW-BFA

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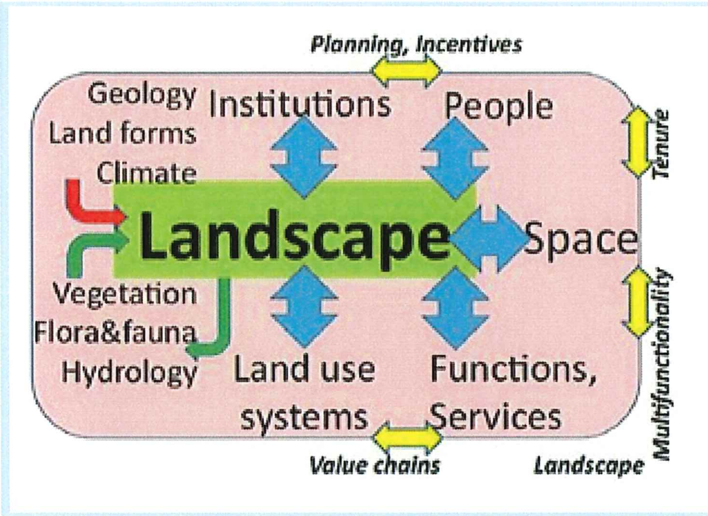
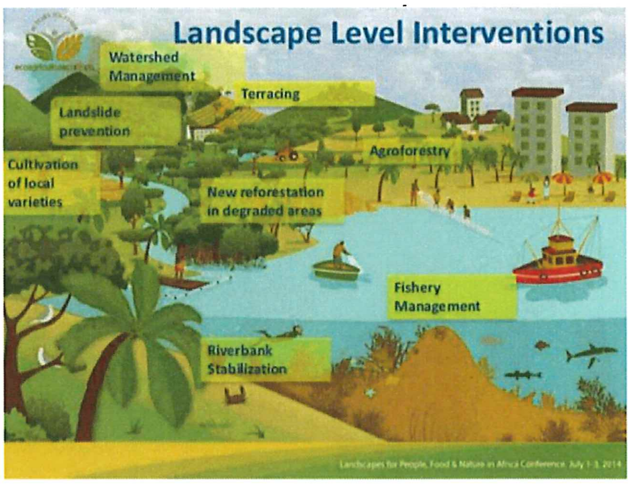
The Landscape approach





Source: Scherr, 2013

Landscape as interaction between human actions, ecosystems and the abiotic factors that shape the physical environment (Minang et al., 2015; Scherr, 2013)

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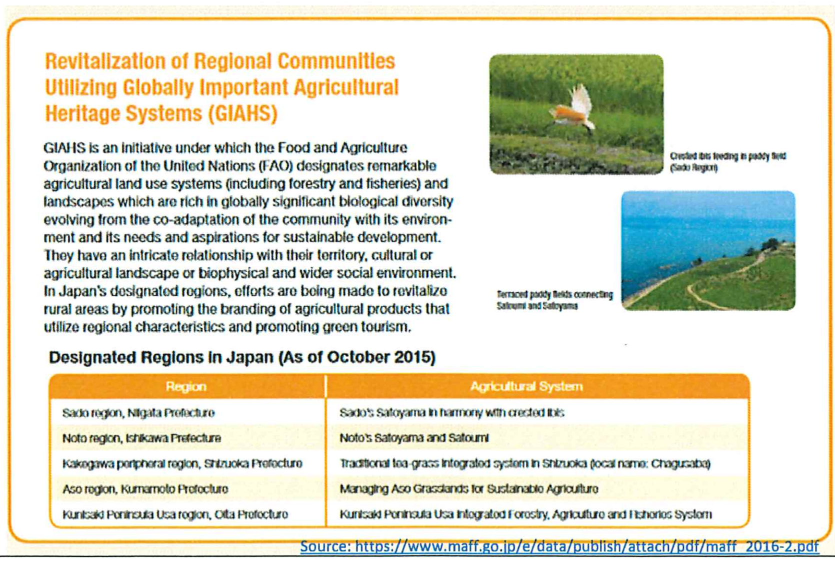
Globally Important Agricultural Heritage Systems (GIAHS)

Combining agricultural diversity, resilient ecosystems, traditional farming practices and cultural identity



Revitalization of Regional Communities Utilizing Globally Important Agricultural Heritage Systems (GIAHS)

GIAHS is an initiative under which the Food and Agriculture Organization of the United Nations (FAO) designates remarkable agricultural land use systems (including forestry and fisheries) and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of the community with its environment and its needs and aspirations for sustainable development. They have an intricate relationship with their territory, cultural or agricultural landscape or biophysical and wider social environment. In Japan's designated regions, efforts are being made to revitalize rural areas by promoting the branding of agricultural products that utilize regional characteristics and promoting green tourism.

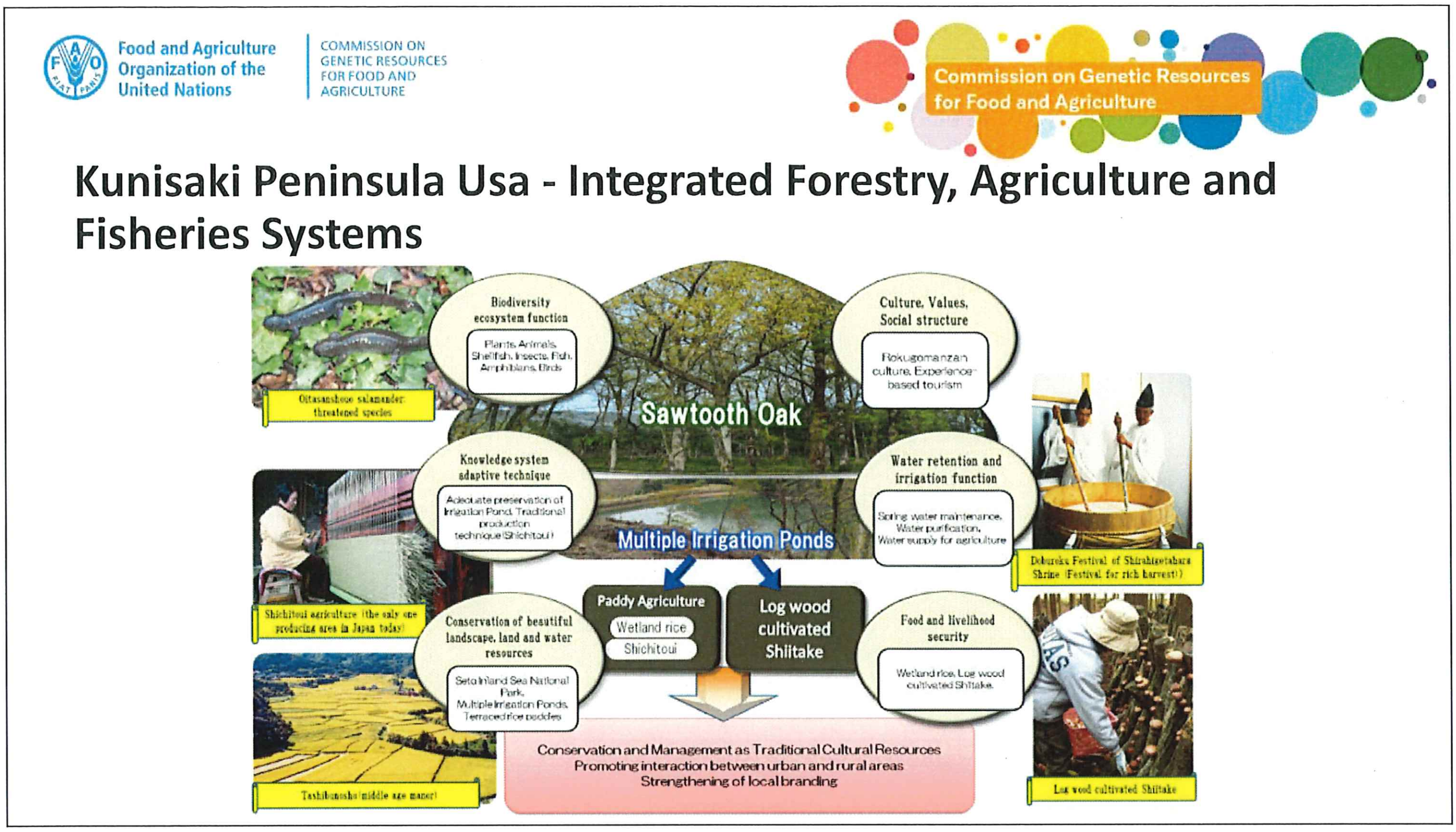
Crested ibis feeding in paddy field (Sado Region)

Terraced paddy fields connecting Satoumi and Satoyama

Designated Regions in Japan (As of October 2015)

Region	Agricultural System
Sado region, Niigata Prefecture	Sado's Satoyama in harmony with crested ibis
Noto region, Ishikawa Prefecture	Noto's Satoyama and Satoumi
Kakegawa peripheral region, Shizuoka Prefecture	Traditional tea-grass integrated system in Shizuoka (local name: Chagusaba)
Aso region, Kumamoto Prefecture	Managing Aso Grasslands for Sustainable Agriculture
Kunisaki Peninsula Usa region, Oita Prefecture	Kunisaki Peninsula Usa Integrated Forestry, Agriculture and Fisheries System

Source: https://www.maff.go.jp/e/data/publish/attach/pdf/maff_2016-2.pdf



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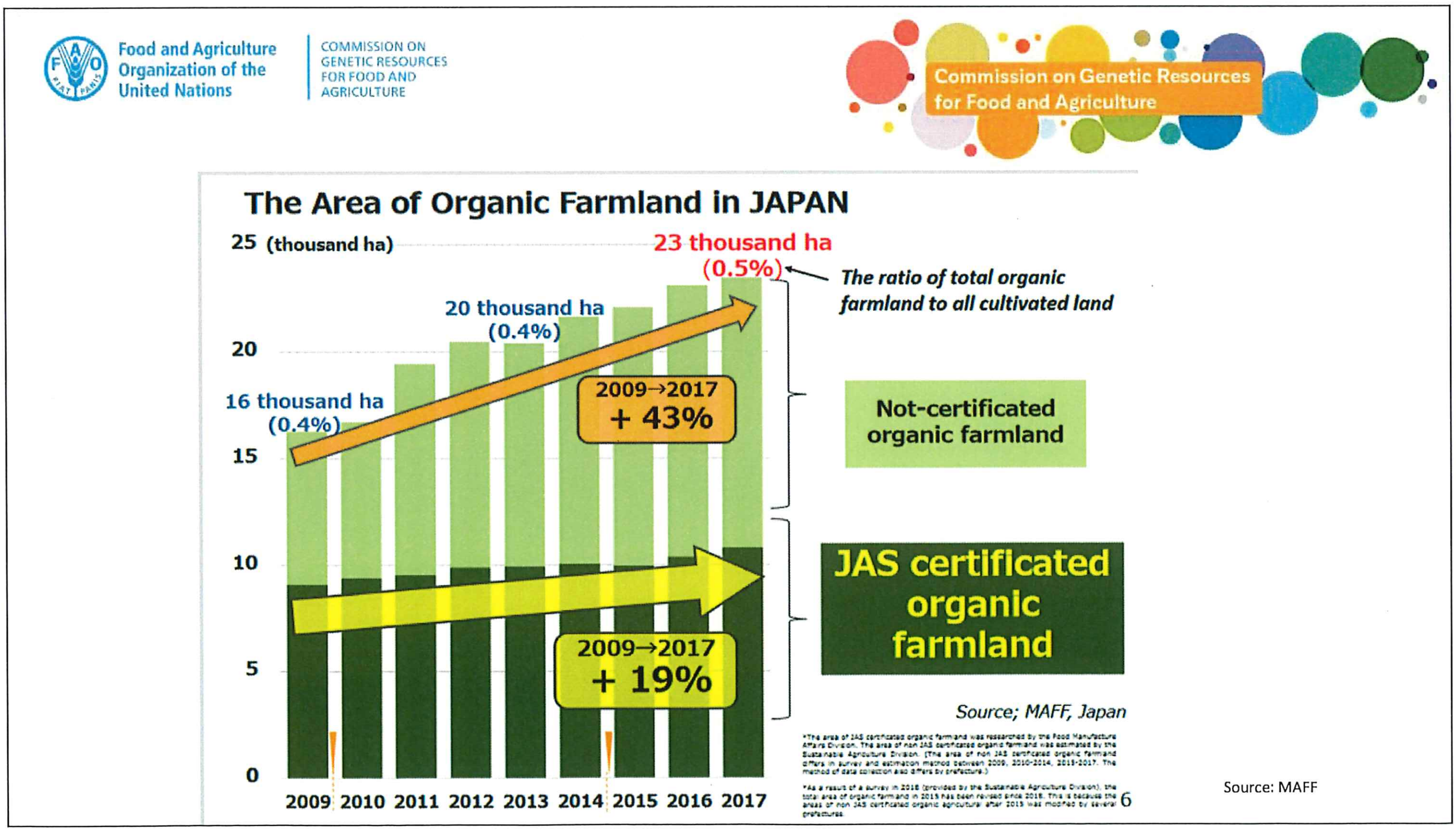
Kunisaki Peninsula Usa - Integrated Forestry, Agriculture and Fisheries Systems
Biodiversity ecosystem function
Plants, Animals, Shellfish, Insects, Fish, Amphibians, Birds
Oitasanshoo salamander threatened species
Culture, Values, Social structure
Rokugomanzan culture, Experience-based tourism
Sawtooth Oak
Knowledge system adaptive technique
Adequate preservation of Irrigation Pond, Traditional production technique (Shichitoui)
Water retention and irrigation function
Spring water maintenance, Water purification, Water supply for agriculture
Multiple Irrigation Ponds
Dobureku Festival of Shirahigetahara Shrine (Festival for rich harvest!)
Shichitoui agriculture (the only one producing area in Japan today)
Paddy Agriculture
Wetland rice
Shichitoui
Log wood cultivated Shiitake
Conservation of beautiful landscape, land and water resources
Seto Inland Sea National Park, Multiple Irrigation Ponds, Terraced rice paddies
Food and livelihood security
Wetland rice, Log wood cultivated Shiitake
Conservation and Management as Traditional Cultural Resources
Promoting interaction between urban and rural areas
Strengthening of local branding
Tashibunosho (middle age manor)
Log wood cultivated Shiitake



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The Area of Organic Farmland in JAPAN
25 (thousand ha)
20
15
10
5
0
23 thousand ha (0.5%)
The ratio of total organic farmland to all cultivated land
20 thousand ha (0.4%)
16 thousand ha (0.4%)
2009→2017 + 43%
2009→2017 + 19%
Not-certificated organic farmland
JAS certificated organic farmland
Source; MAFF, Japan
2009 2010 2011 2012 2013 2014 2015 2016 2017
6
Source: MAFF

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Sustainable use of biodiversity / genetic resources for food and agriculture

- Breeding of GRFA for multiple objectives
- Maintain local genetic diversity on farm / in situ
- Promote sustainable use of BFA / GRFA and integrated approaches to its management at production system, ecosystem, landscape and seascape levels
- Improve landscape structure and connectivity to provide habitats for associated biodiversity and wild food species
- Reduce impacts on BFA from the inappropriate use of chemical pesticides, veterinary medicines and fertilizers
- Manage soil biodiversity to ensure soil health and soil fertility

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Example Japan: Adaptation

Table 8: Adaptation measures for unshu mikan

Purpose	Measures taken	2012	2013	2014	2015	2016
Curb peel puffing	Use of plant growth regulators	2	3	4	3	5
Curb peel puffing Address defective coloring	Use of multi-sheets	3	7	3	6	10
Curb tanning	Thinning (thinning of tree crowns and focused thinning at late stage)	1	1	1	1	1
Address defective coloring	Cooling (facilities and greenhouse-raised mikan)	-	-	-	-	1

Table 9: Adaptation measures for apples

Purpose	Measures taken	2012	2013	2014	2015	2016
Address defective coloring	Shift to breeds of excellent coloring or yellow breeds	-	1	1	1	1
Address defective coloring Curb tanning	Thorough technological management such as brine water and multi-sheet	-	1	1	1	1
Curb tanning	Curb leaf thinning	-	-	2	1	1
	Use light-shielding materials	1	1	1	1	1

Table 3: Ratio of planted area of rice breeds resistant to high temperature to planted area of paddy-field rice for staple diet

	Cropped in 2010	Cropped in 2016	Difference
Planted area of rice breeds resistant to high temperature	37,700ha	91,400ha	–
Planted area of paddy-field rice breeds for staple diet	1,580,000ha	1,381,000ha	–
Ratio of planting	2.4%	6.6%	Up 4.2 points

Source: "2010 Paddy-Field Rice Yields" and "2016 Paddy-Field Rice Yields," Statistics Department, Ministry of Agriculture, Forestry and Fisheries

Table 4: Number of prefectures where planting of rice breeds resistant to high temperature was reported and the number of breeds

	2010	2011	2012	2013	2014	2015	2016
Reported number of breeds	13	16	20	24	26	27	27
Reported number of prefectures	19	20	25	30	33	33	33

Source: MAFF, 2018

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Conservation of GRFA

In Situ Conservation

- **wild species/relatives in natural habitats and ecosystems**
- **on-farm conservation of domesticated GRFA in traditional farming systems**
- Supporting on-farm management and improvement

A. Huth

Ex Situ Conservation

- **Maintenance of genetic material outside of the natural environment where the species have evolved**
- **Gene banks, botanical gardens, zoos etc**
- Supporting targeted collecting of genetic resources for food and agriculture
- Sustaining and expanding ex situ conservation of germplasm
- Regenerating and multiplying ex situ accessions

Crop Trust

FAO

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Global responses and international cooperation

SUSTAINABLE DEVELOPMENT GOALS

SUSTAINABLE DEVELOPMENT GOAL 2

Zero Hunger

End hunger, achieve food security and improved nutrition and **promote sustainable agriculture**

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Convention on Biological Diversity

BIODIVERSITY CONVENTION | CARTAGENA PROTOCOL | NAGOYA PROTOCOL | COUNTRIES | PRO

Post 2020 documents | Working Group 2020 (WG2020-3, WG2020-2, WG2020-1) | Regional consultations | Other Consultations | Peer Review | Submissions | Co Chairs' Updates | Virtual Display Table | Gender-responsive process | Action Agenda

CBD // CONFERENCES // POST2020

Preparations for the Post-2020 Biodiversity Framework

Third meeting of the Open-ended Working Group on the Post-2020 Global Biodiversity Framework

The Open-Ended Working Group on the Post-2020 Biodiversity Framework is tasked with advancing preparations for the development of the post-2020 global biodiversity framework. This process is expected to lead to the adoption of a post-2020 global biodiversity framework during the second phase of the UN Biodiversity Conference in May 2022, in Kunming, China.

Tweets by @UNBiodiversity

UN Biodiversity @UNBiodiversity
STARTING SOON. Join a discussion on a new study analysing the need for transformative action for biodiversity

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Key messages

- The global food system is under pressure, e.g. population growth, biodiversity loss and climate change negatively impact food security
- Good governance, enabling frameworks, and integrated system approaches are needed to facilitate sustainable agriculture
- Enhanced efforts to sustainably use and conserve BFA and to transform to more resilient and sustainable agriculture
- International policy responses and collaboration are essential
- There is no one-size fits all solution! Local-regional
- More data are needed on impacts of practices on biodiversity

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Thank you!

For more information:

Commission on Genetic Resources for Food and Agriculture: http://www.fao.org/cgrfa/

FAO Office of Climate Change, Biodiversity and Environment: https://www.fao.org/about/office-of-climate-change-biodiversity-environment/en/

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Examples Japan:

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モニレ・ファラマーズィ

アルバータ大学
理学部地球大気科学科 准教授

Dr. Monireh Faramarzi

Associate Professor, Faculty of Science, University of Alberta

モニレ・ファラマーズィ博士は、カナダのアルバータ大学地球大気科学部の准教授です。彼女は2010年にスイス連邦工科大学チューリッヒ校で博士号を取得しました。彼女は現在、気候変動の文脈で水と食料の課題を研究する目的で、水循環、農業、気候モデルなどのような物理的及びプロセスベースのツールの開発及び応用に関与した流域科学及びモデル研究所を率いています。彼女の研究は、取引の評価、水と土地の相互作用、作物生産、環境に基づいた管理計画の社会経済的推進力に焦点をあてたものです。現在まで、彼女の研究は、気候変動と管理要員が作物の収穫量、河川の流れ、洪水、干ばつに及ぼす影響に関連するテーマ、そしてごく最近では、カナダの草原の農地における栄養素と化学物質の負荷と輸送に関連する研究について詳しく掘り下げてきました。彼女の研究目標は、人類の不確実な未来の下で「水一食ーエネルギーと環境」の結びつきの科学に貢献することです。

Dr. Monireh Faramarzi is an Associate Professor in the Department of Earth and Atmospheric Sciences, University of Alberta, Canada. She received her PhD from the Swiss Federal Institute of Technology ETHZ in 2010. She is currently leading the Watershed Science and Modelling Laboratory that involves developing and applying physical and process-based tools such as hydrological, agricultural, and climate models to study water and food challenges in the context of climate change. Her research focuses on assessing trade-offs and interactions between water and land resources, crop production, and socio-economic drivers for an environmnetaly-informed management plans. To date, her research has elaborated on subjects related to the impacts of climate change and management factors on crop yields, streamflow, floods, droughts, and more recently, on nutrients and chemical loads and transport in agricultural lands of Canadian Praries. Her research goal is to contributes to the science of “water-food-energy and environment” nexus under an uncertain future in the Anthropocene.

気候変動下で小麦・大麦の収穫量はどう変化するか？
～カナダにおける収量変化を予測する～

概要

持続可能な農業は、水(の利用性)の確保、食料の安全保障、自然保護という切羽詰まった三重の課題に直面しています。しかし、生物地球化学的および水循環気候変数の変化に対する作物成長の非定常的応答は、作物収量の予測を不確実にし、その結果持続可能な農業のための適応戦略の実施における曖昧さをもたらします。カナディアンプレイリーズの生産性の高い農地は、国民経済にだけではなく、世界 100 か国以上に食糧を供給することに貢献しています。ただし、気候変動やその他の新たな環境問題（水や土壌の劣化など）により、作物の収穫量が変化し、これらの土地の現在の生産レベルが制限される可能性があります。この研究は、カナディアンプレイリーズの農地におけるさまざまな気候変動と窒素施用シナリオの下での小麦と大麦の収穫量の経時変化をシミュレートしたものです。この結果は、将来の気候変動シナリオの下で、より大きな成長度合とより大きな土壌水分によって作物収量が増加すると予想される一方で、土壌栄養分の利用可能性と土壌窒素を取り込む作物の能力が収量向上のレベルを大きく左右することを示唆しています。このモデルの結果は、将来的に大気中の二酸化炭素が飽和状態になると、気孔の閉鎖が早まり、それによって栄養素の取り込みと作物の収穫量を制限する可能性があることを示しました。窒素肥料を多く施用した場合の作物収量の増加が予測されることから、施肥は気候変動下で収量を増加させるための適応策となり得ることが示唆されました。しかし、肥料の使用率が高いことによる土地、生物多様性、水質への懸念は、環境問題を引き起こし、この地域の農業実践の持続可能性の目標を制限する可能性があります。この研究は、土壌の健康とその養分利用性を促進することの重要性を明らかにし、地域の将来の気候変動の下での潜在的な管理オプションとしての再生農業実践の検討の基礎を提供するものです。

Response of wheat and barley crop yields to climate change using process-based modeling in agricultural lands of Canadian Prairies

Abstract

Sustainable agriculture is confronted by an intimidating triple challenge of ensuring water availability, meeting food security, and conserving nature. However, the non-stationary response of crop growth to changes in biogeochemical and hydro-climatic variables makes crop yield projection uncertain and thus ambiguity in the implementation of adaptation strategies for sustainable agriculture. The productive agricultural lands of the Canadian Prairies not only contribute to the national economy but also supply food to over a hundred countries worldwide. However, climate change and other emerging environmental concerns (e.g., water and soil degradation) may alter crop yields and limit current production levels in these lands. This study simulated the time-varying behavior of wheat and barley crop yields under various climate change and nitrogen application scenarios in the agricultural lands of the Canadian Prairies. The results suggest that while crop yields are expected to increase due to larger growing degree days and greater soil moisture under future climate change scenarios, the soil nutrient availability and the ability of crops to uptake soil nitrogen can highly regulate the level of yield enhancements. The model results showed that saturated atmospheric CO2 in the future can induce earlier stomatal clousure, thus limiting nutrient uptake and crop yields. The predicted increases in crop yields under a higher nitrogen fertilizer application suggests that fertilizer application can be considred as a potential adaptation measure to enhance yields under a changing climate. However, land, biodiversity, and water quality concerns due to a higher rate of fertilizer use can raise environmental issues and limit the sustainability goals of agricultural practices in the region. This study highlights the importance of promoting soil health and its nutrient availability, and it provides the basis for examination of the regenerative farming practices as a potential management option under future climatic changes in the region.

WSML Watershed Science & Modelling Laboratory

Modeling crop yields in response to climate change in Alberta, Canada

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Associate Professor and CAIP Chair in Watershed Science
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University of Alberta, Canada

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February 2022; 2021 Overseas Agricultural Science Seminar
Rakuno Gakuen University, Ebetsu city, Hokkaido, Japan

WSML Watershed Science & Modelling Laboratory

Content

- Introduction: Canadian agriculture
- Introduction: Climate change and crop growth
- Methods: hydrology and crop growth simulator
- Results: barley, wheat

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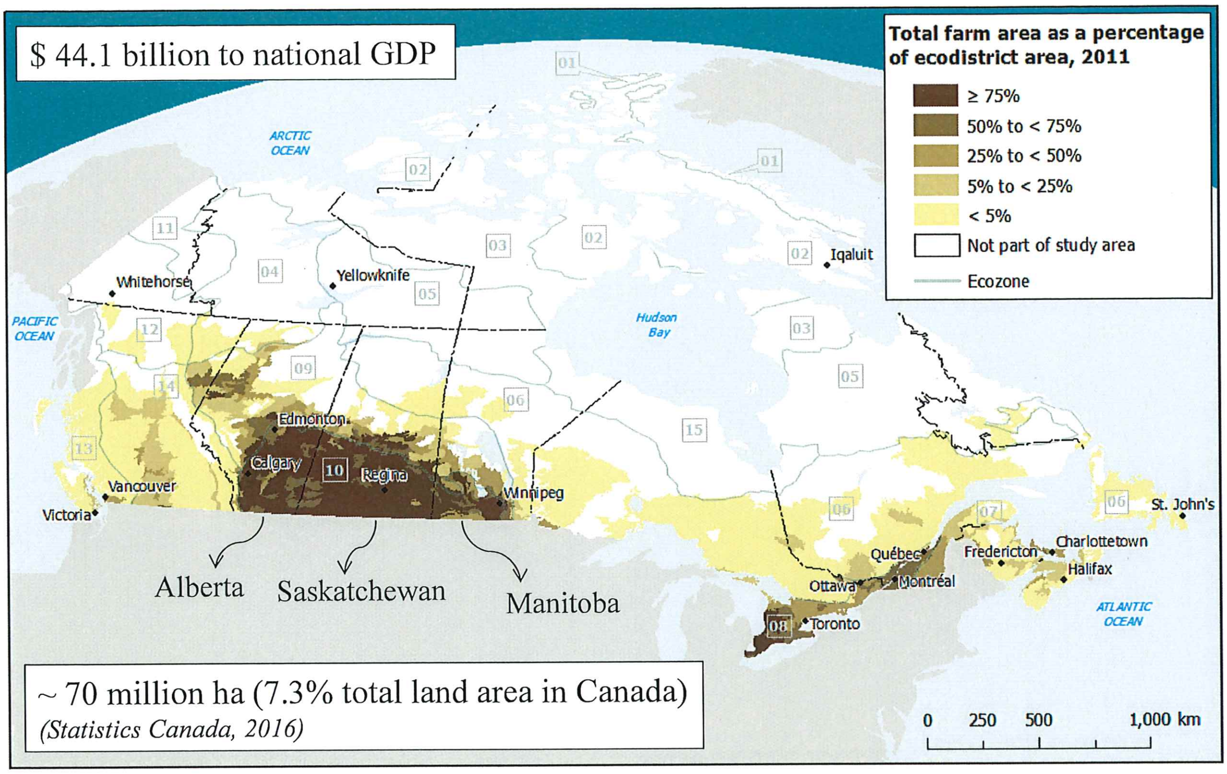
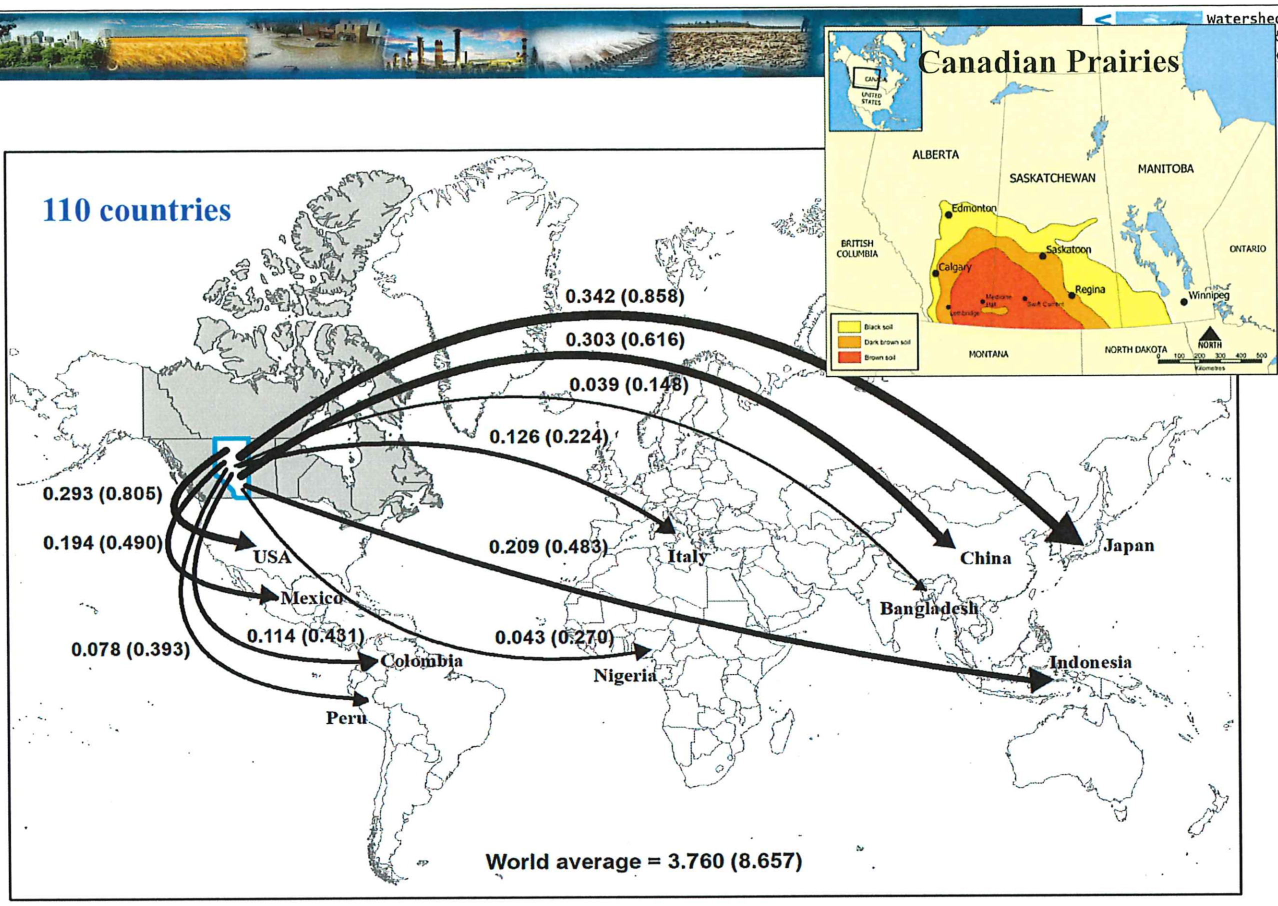
Agricultural lands



https://www150.statcan.gc.ca/n1/daily-quotidien/141113/dq141113a-eng.htm

$200 billion from agriculture and petroleum in Canada



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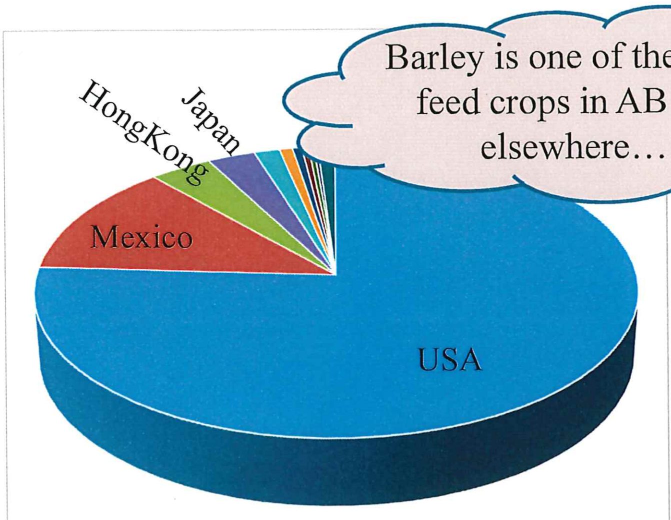
5

Economy and development

Canada is home to ~12 million head of cattle with majority of beef production occurring in Alberta.



Country	Export (*1000) ton
USA	218.504
Mexico	35.873
HongKong	10.79
Japan	8.276
Russian Federation	4.378
Macao	2.271
Taiwan	1.576
Philippines	1.178
Indonesia	0.929
Egypt	0.619
Other countries	2.937

Source: Stat Canada, 2011

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WSML Watershed Science & Modelling Laboratory

Alberta
Campus Alberta Innovates
Program Chair Funding

ALBERTA INNOVATES

Alberta Agriculture and Forestry

NSERC CRSNG
Discovery Grant Program

Water quantity

- Predicting Water Related Risks and Opportunities for Albert's Beef Industry (**AAF**, 3 years, completed)
- Adapting to Changing Water in Alberta (**AI**, 3 years, completed)
- Predicting Alberta's Water Future (**AI**, 3 years, completed)

Water quality, soil health, and climate change mitigation (NbS)

- Predicting Water Related Risks and Opportunities for Albert's Beef Industry
- Adapting to Changing Water in Alberta
- Predicting Alberta's Water Future

(**Caip Chair**, 7 years, on-going; NSERC DG, 5 years on-going)

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Climate change impacts on crop yields

2021 — Khalili, P., Masud, B., Qian, B., Mezbahuddin, S., Dyck, M., Faramarzi, M. Non-stationary response of rain-fed spring wheat yield to future climate change in northern latitudes. *Science of the Total Environment*. DOI: https://doi.org/10.1016/j.scitotenv.2021.145474

2019 — Masud, M.B., Wada, Y., Goss, G., Faramarzi, M., Global implications of regional grain production through virtual water trade, *Science of the total environment* 659: 807-820. DOI: 10.1016/j.scitotenv.2018.12.392.

2018 — Masud, M.B., McAllister, T., Cordeiro, M.R.C., Faramarzi, M., Modeling future water footprint of barley production in Alberta, Canada: Implications for water use and yields to 2064, *Science of the Total Environment* 616-617: 208-222. DOI: 10.1016/j.scitotenv.2017.11.004.

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Climate change impacts on crop yields

Direct impacts:

- Increased heat stress *(Yang et al., 2017a, 2017b)*
- Frequent extreme temperatures *(Zhang et al., 2016)*
- Intermittent heavy rainfall and waterlogging of soils *(Li et al., 2019)*
- Changes in atmospheric composition and CO2 *(Swann et al., 2016)*

Indirect impacts:

- Changes in ice and snowmelt dynamics
- Hydrologic cycle *(Wang et al., 2017)*
- Pests and diseases *(Jabran et al., 2020)*

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Climate change impacts on crop yields

Magnitude of impacts:

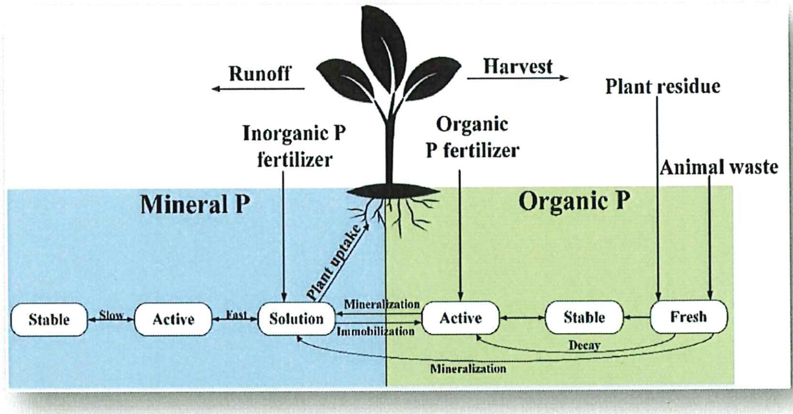
- Crop type
- Stage of growing season
- Geographic location

- Numerous biogeochemical and hydro-climate factors
- Spatiotemporal variability

Question: is crop response to changes in future climate change stationary?

Nutrient cycle

- Nutrient supplement by **fertilizer** or **manure** application to the cropping systems may form insoluble minerals and may be transported out from lands and loaded into water bodies *(Hansen et al., 2001)*.



Nutrient cycle and transport in Canadian Prairies

- Runoff-soil interface is primarily affected by frozen soil and the amount and rate of snowmelt → erosion and export of nutrients

Processes involved:

- Long non-growing seasons,
- Release of nutrients from soils and crop residue after freeze–thaw cycles
- Slower biogeochemical reaction rates by low temperature
- Snowmelt runoff and variability
- Restricted nutrient retention and infiltration to the frozen soil

https://goodineverygrain.ca/2021/12/06/facts-for-teachers-winter-and-farming/

https://www.producer.com/news/weather-network-predicts-abrupt-mid-march-shift-into-spring/

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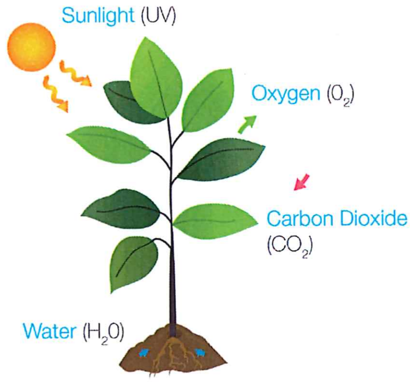
Factors affecting crop yield under future climate change scenarios

- Water (snow-ice)
- Temperature
- Solar radiation
- Air humidity
- CO2
- Soil type

<u>Management factors:</u>

- Soil nutrients, tillage operation
- Planting
- Harvesting
- Irrigation
- etc.



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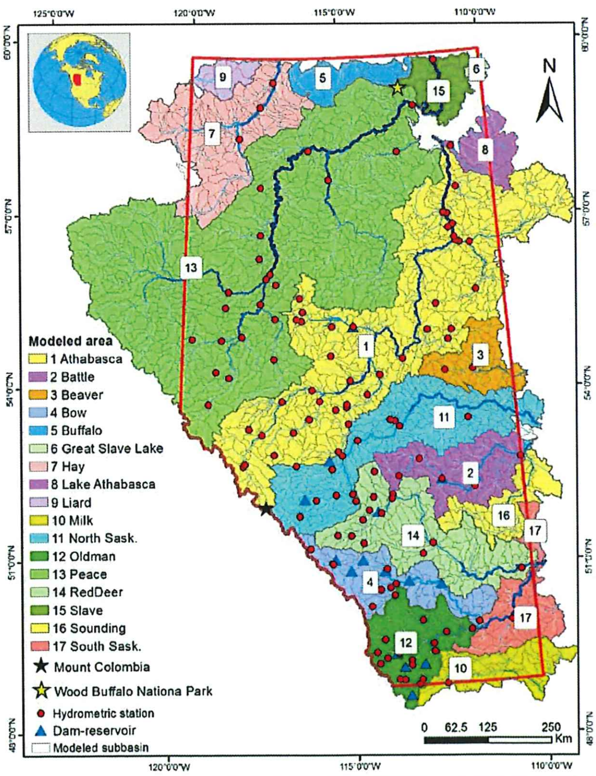
Alberta's watersheds

- **Total land area:** ~700,000 km^2
- **Study area:** 2255 sub-basins were delineated using SWAT with a 200 km^2 drainage area
- **Model calibration-validation (1983-2007):** at 129 hydrometric stations



Reference:

Faramarzi et al., *Environmental Modelling & Software, 2015.*

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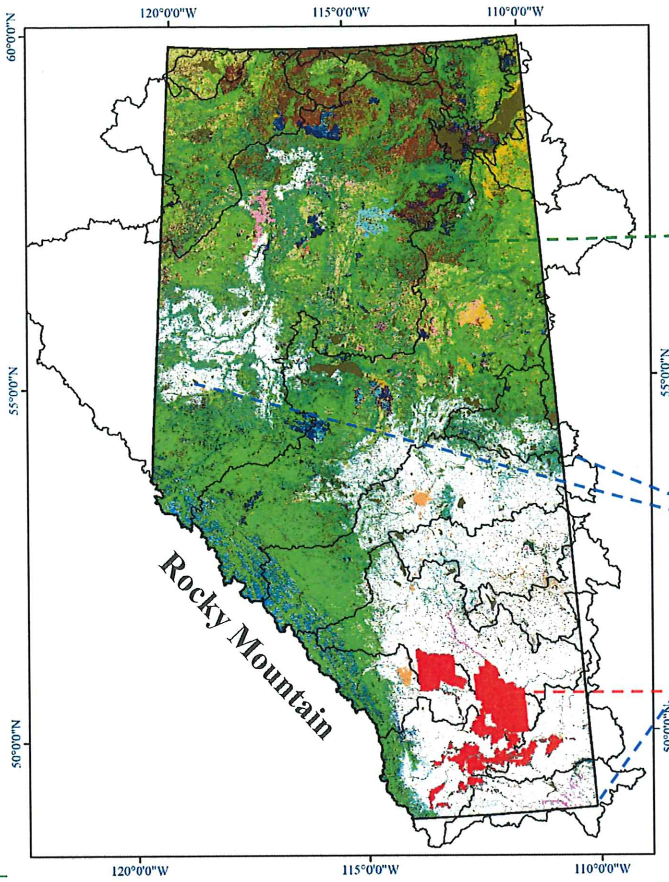
Alberta's lands



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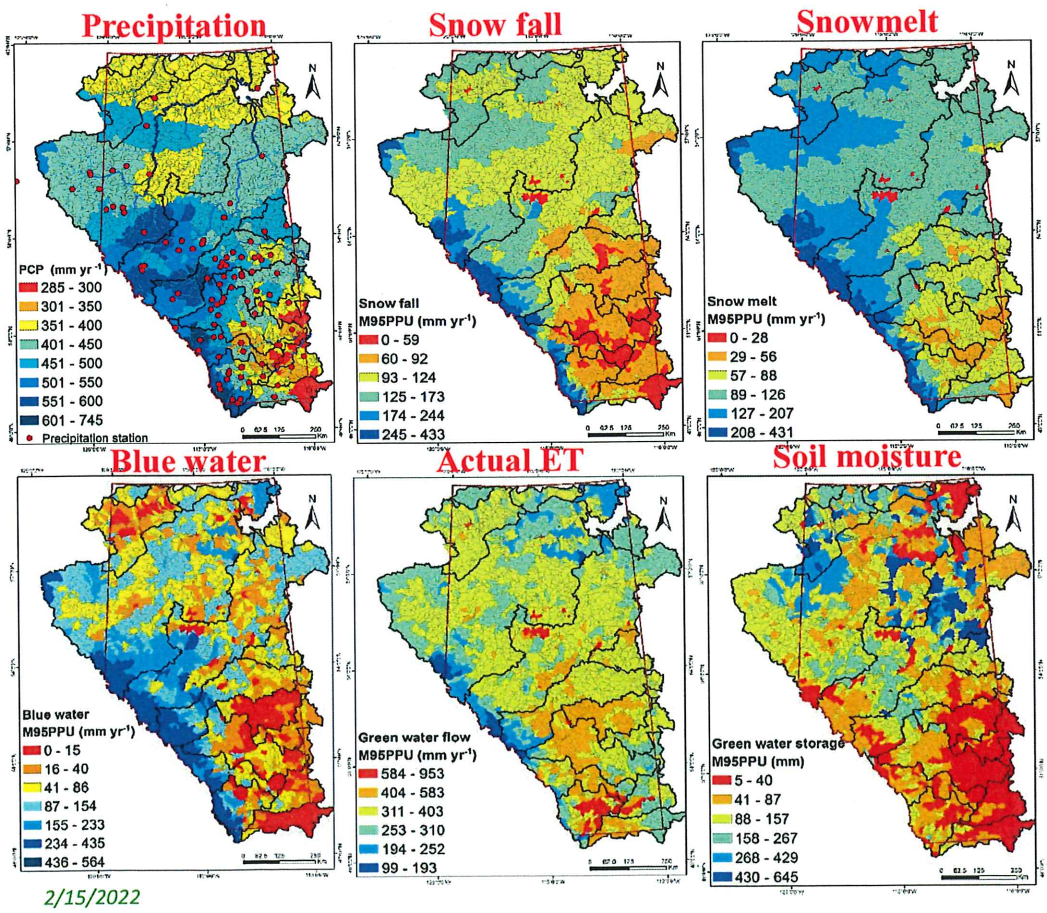

Long term average: 1986-2007

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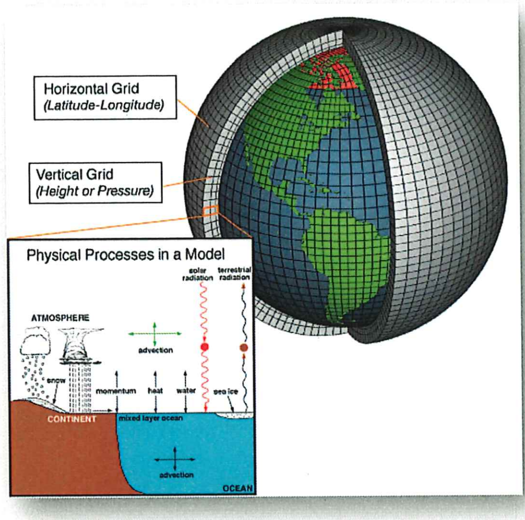
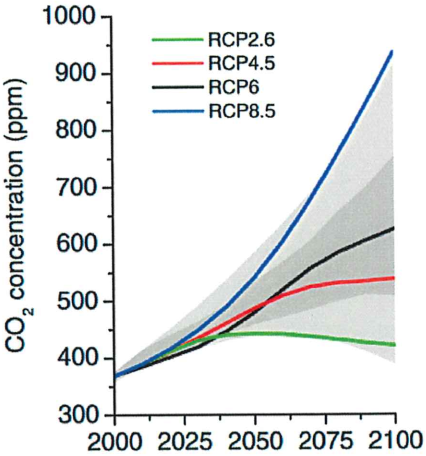
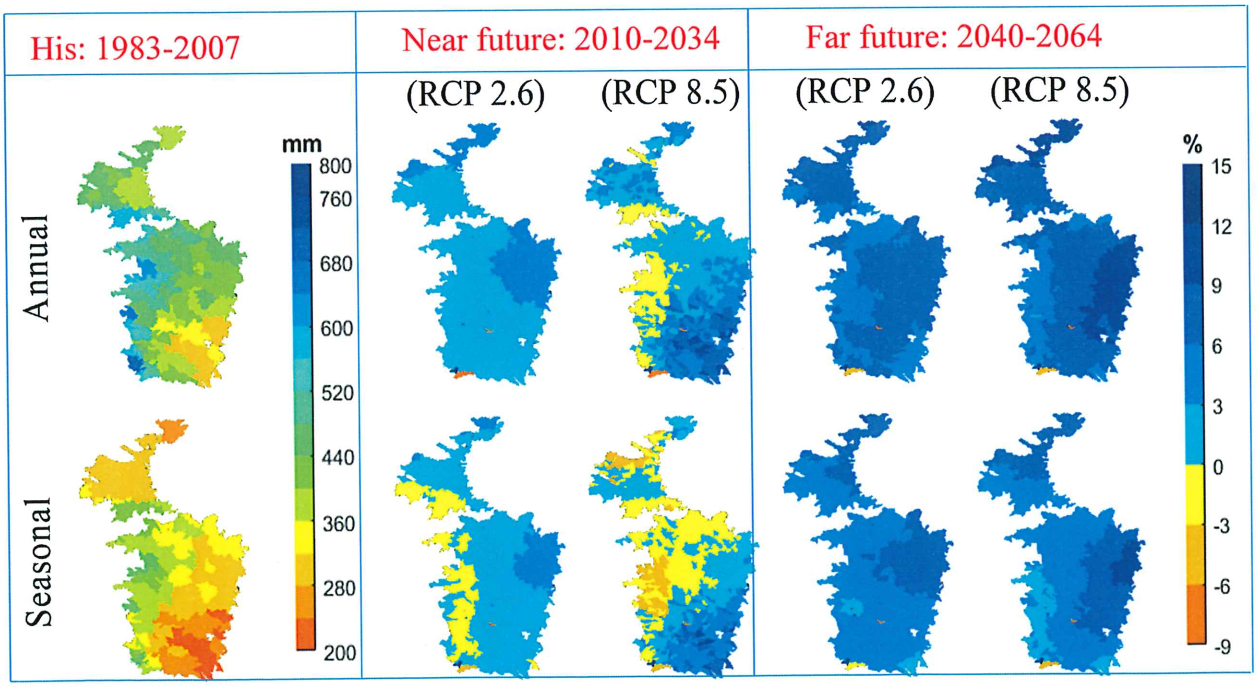
CO_2 driven climate change (anthropogenic)

IPCC global climate models



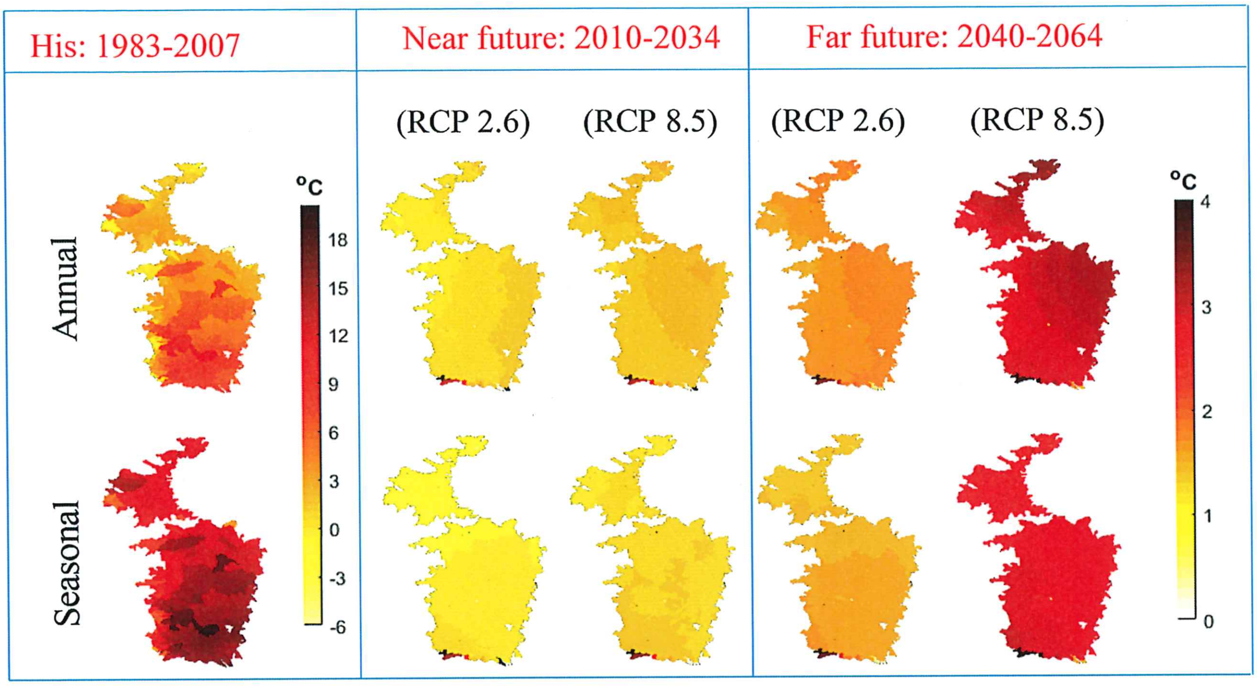


Mean seasonal and annual precipitation and their projected changes (%)



2018 — Masud, M.B., Ferdous, J., Faramarzi, M., Projected changes in hydrological variables in the agricultural region of Alberta, Canada, *Water* 1–20. DOI: 10.3390/w10121810.

Seasonal and annual temperature and their projected changes (°C)



2018 — Masud, M.B., Ferdous, J., Faramarzi, M., Projected changes in hydrological variables in the agricultural region of Alberta, Canada, *Water* 1–20. DOI: 10.3390/w10121810.

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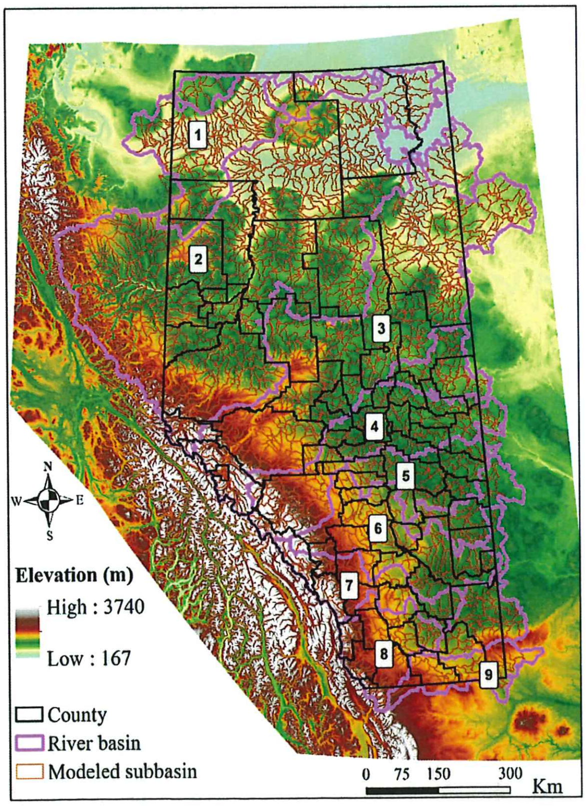
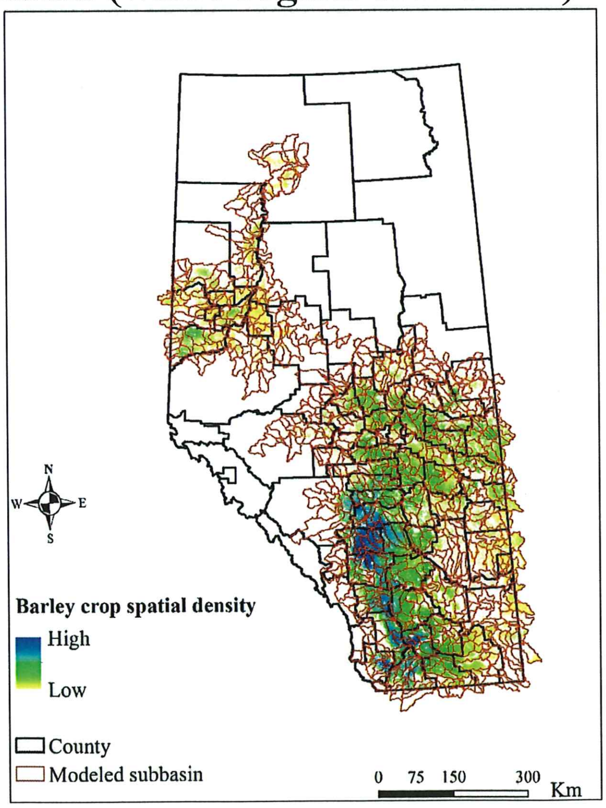
Yield simulation: over 900 sub-basins (white region of Alberta)





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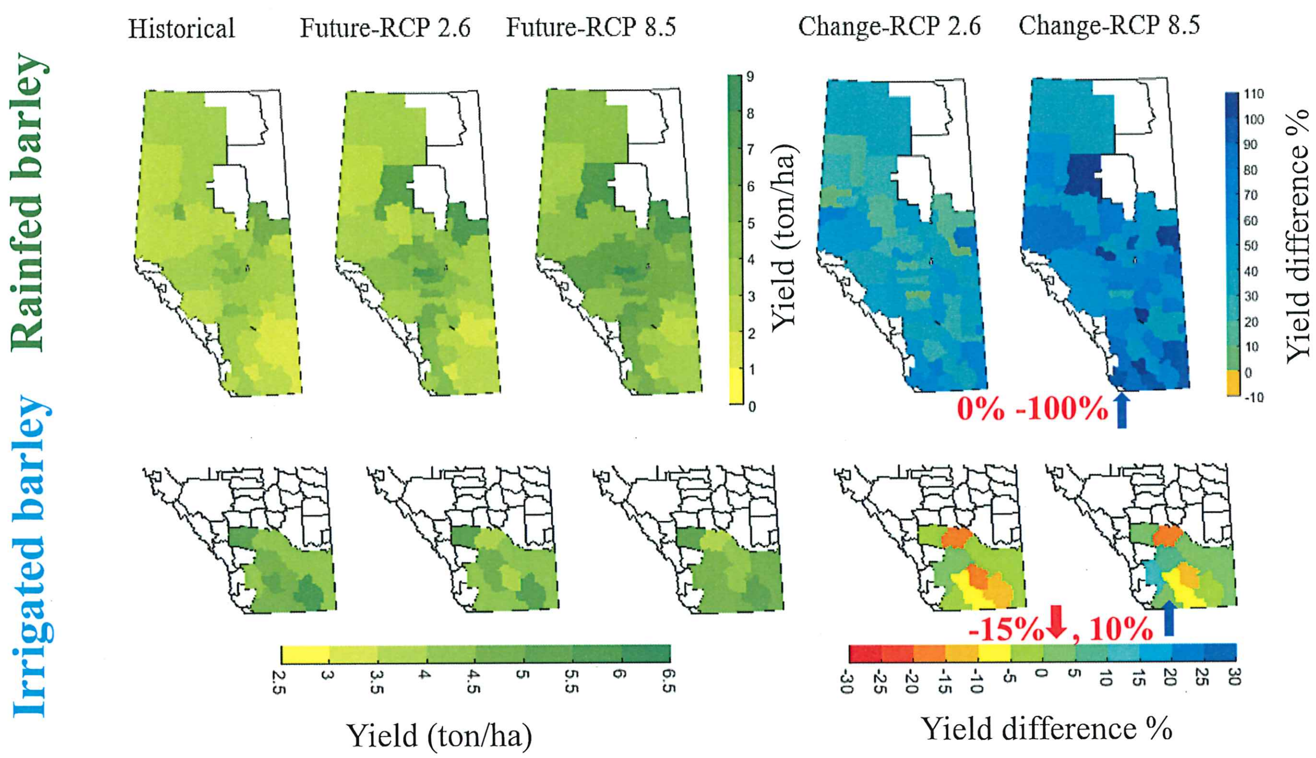
Projected changes in rainfed barley yield (2040-2064)



Source: *Masud, M.B., McAllister, T., Cordeiro, M.R.C., Faramarzi, M., Modeling future water footprint of barley production in Alberta, Canada: Implications for water use and yields to 2064, Science of the Total Environment 616-617: 208-222. DOI: 10.1016/j.scitotenv.2017.11.004.*

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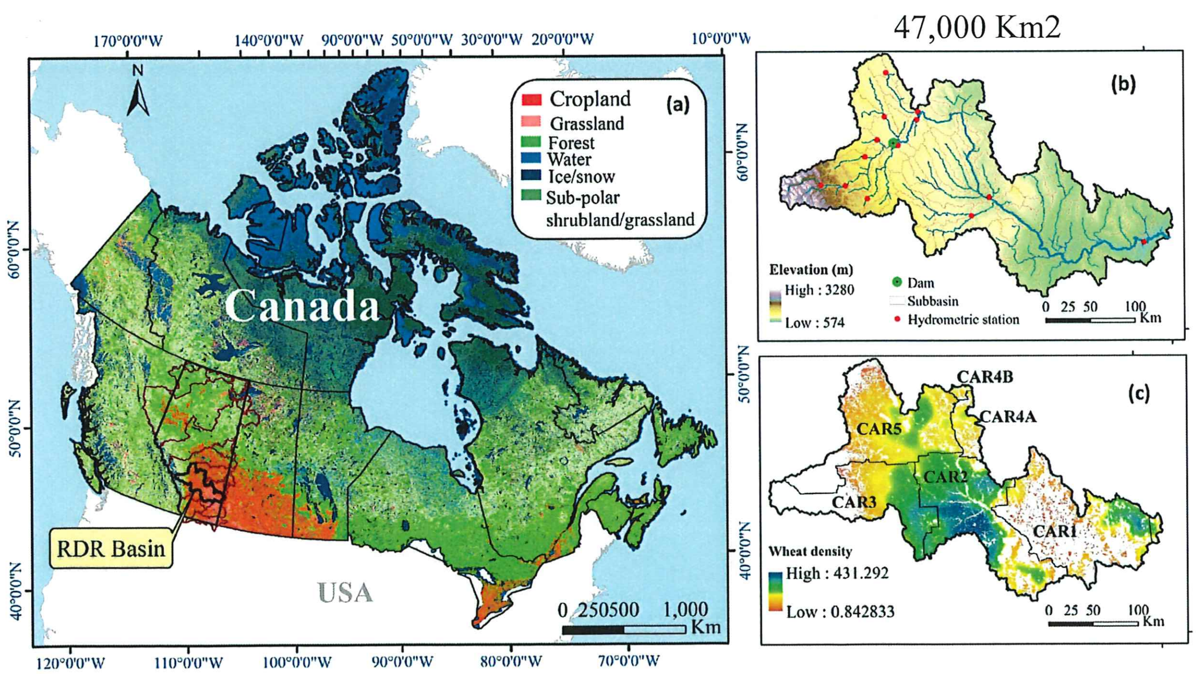
Red Deer River Basin: case study to assess future **wheat** yields



2021 — Khalili, P., Masud, B., Qian, B., Mezbahuddin, S., Dyck, M., Faramarzi, M. Non-stationary response of rain-fed spring wheat yield to future climate change in northern latitudes. *STOTEN*. DOI: https://doi.org/10.1016/j.scitotenv.2021.145474

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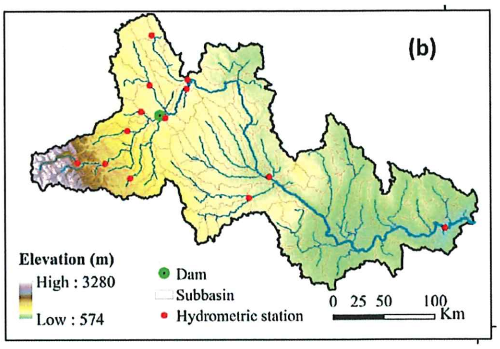
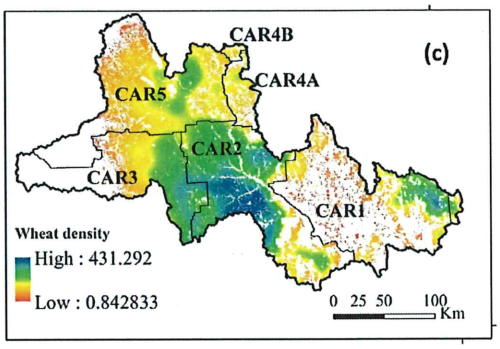
2/15/2022 22

- **Watershed area:** 47,000 km^2
- **Elevation:** 574 -1700 in the croplands, up to 3280 m in the mountain
- **Temperature:** –25 - 35 °C year-round; 2 - 34 °C growing season
- **Precipitation:** 400 mm year-round; 250 mm growing season
- **Snowmelt:** plays a vital role in supplying water needs early in the growing season in RDR
- **Soils:** black soils, the most productive soils

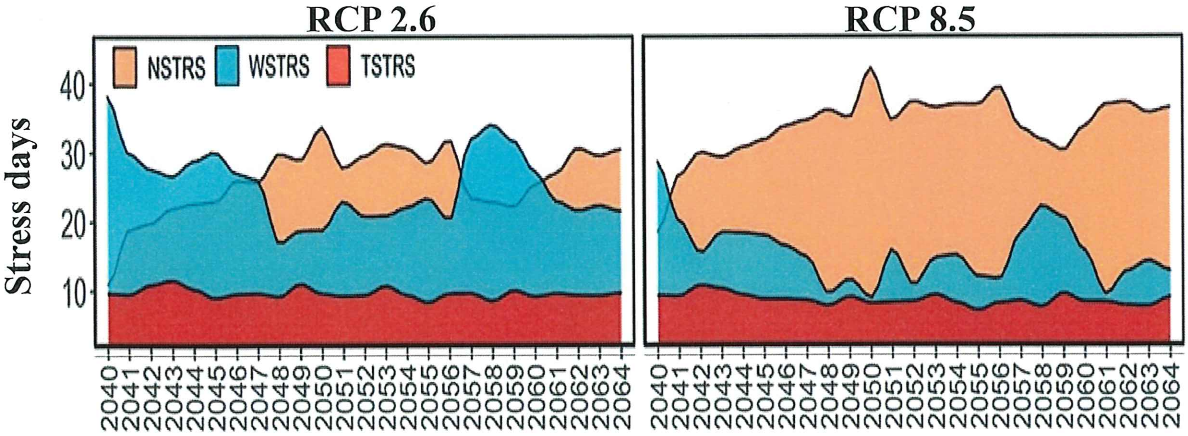
- **Climate:** precipitation, temperature (max-min), solar radiation, wind speed, air humidity
- **Fertilizer and crop calendar:** Alberta Agricultural and Rural Development (AARD)
- **Crop yields:** Alberta Financial Service Corporation (AFSC); AARD, and for Census Agricultural Region
- **Heat units and other phonological parameters:** Literature review

Red Deer River Basin





CO_2 driven climate change impact on wheat yields stress factors (2040-2064)



(1) reduced evapotranspiration and earlier stomatal closure in response to saturated atmospheric CO2
(2) insufficient N availability in the soil
(3) insufficient moisture in the soil to produce soluble N for plants to uptake.

Summary and Conclusion

- Barley yields may increase under rainfed agriculture with the expense of more water consumption in some areas and less in some others.

- Barley yield increases are not identical in all regions.

- Irrigated barley yields may increase by up to 10% in some districts and may decrease by 15% in some other districts.

Summary and Conclusion

- Nitrogen (N) stress may dominate other stress factors in producing rainfed wheat yields in the future as compared to the current conditions that water-stress is a dominant factor.

- The future N stress might be due to **(1)** reduced evapotranspiration and earlier stomatal closure in response to saturated atmospheric CO2, **(2)** insufficient N availability in the soil, and **(3)** insufficient moisture in the soil to produce soluble N for plants to uptake.

Summary and Conclusion

- Higher N application with supplement irrigation might be a potential measure to enhance yields under a changing climate. However, land, biodiversity, and water quality concerns due to a higher rate of fertilizer use can raise environmental issues and limit the sustainability goals of agricultural practices in the region.
- This study highlights the importance of promoting soil health and nutrient availability, and it provides the basis for the examination of regenerative farming practices as a potential management option under future climatic changes in the region.
- More studies need to include effects of large-scale modes of natural climate variabilities such as PDO.

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Acknowledgements

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ALBERTA INNOVATES

デブラ・デイビッドソン

アルバータ大学
農業・生命・環境科学部 教授

Dr. Debra Davidson

Professor, Faculty of Agricultural, Life and Environmental Sciences, University of Alberta

デブラ・デビットソン博士はアルバータ大学の環境社会学の教授です。1999年から同大学に勤務し、環境と気候変動への社会的反応、特にエネルギーと農業・食品システムに関する研究・教育に取り組んでいます。最近ではキラム年次教授賞を受賞し、気候変動に関する政府間パネルの第5次評価報告書の筆頭著者でもあります。一連の研究は、*Science*、*Nature Climate Change*、*Climatic Change*、および*Environmental Research Letters*などの国際誌に掲載されています。近著として、『Oxford Handbook of Energy and Society』（2018年）、『Environment and Society：Concepts and Challenges』（2018年）の共著を担当しました。デビッドソン博士は1998年にウィスコンシン大学マディソン校で社会学の博士号を取得しています。

Dr. Debra Davidson is Professor of Environmental Sociology at the University of Alberta, where she has been working since 1999. Her research and teaching are focused on social responses to environmental and climate change, particularly in our energy and agri-food systems. She was the recent recipient of the Killam Annual Professorship Award, and was a Lead Author on the 5th Assessment Report of the Intergovernmental Panel for Climate Change. Her research has been featured in journals such as *Science; Nature Climate Change; Climatic Change; and Environmental Research Letters.* She is the co-author of two recent books, including the *Oxford Handbook of Energy and Society* (2018)*, and Environment and Society: Concepts and Challenges* (2018). Dr. Davidson received her Ph.D. in Sociology from the University of Wisconsin at Madison, in 1998.

気候危機への対応における社会的な障壁と実現可能性
～アルバータ州の農家での実例をもとに～

概要

私たちのアグリフードシステムに気候変動の緩和と適応を実施する緊急の必要性があります。しかし、気候変動は単に科学的または技術的な問題ではありません。気候変動に対処する上で最も顕著な障壁のいくつかは、経済的、政治的、文化的構造を含む組織的なものです。しかし、農家は積極的なエージェントであり、彼らの多くはこれらの障壁にもかかわらず有益な実践に従事しています。しかし、私たちの農業システムを変革するためのより高いレベルの組織的支援は依然として不可欠です。このプレゼンテーションでは、高度に工業化された農業セクターがあり、気候変動の影響に非常に敏感な地域であるカナダのアルバータ州の事例について説明します。アルバータ州の農家への調査とインタビューに基づいて、アルバータ州の農家の間で観察された構造的障壁と機関(媒介)について議論します。私たちは、このセクターの気候変動を促進することができる一連の戦略で締めくくります。

Social and organizational dimensions of climate change mitigation and adaptation in agriculture: A case study of Alberta

Abstract

There is an urgent need to implement climate change mitigation and adaptation in our agri-food systems. Climate change is not simply a scientific or technological issue, however. Some of the most salient barriers to addressing climate change are organizational: including economic, political and cultural structures. However, farmers are active agents and many of them are engaging in practices that are beneficial despite these barriers. However, higher levels of organizational support for transforming our agricultural systems is still essential. In this presentation, we discuss the case of Alberta, Canada, a region with a highly industrialized agricultural sector, and one that is highly sensitive to the impacts of climate change. Based on surveys and interviews with Albertan farmers, the structural barriers, and agency observed among Albert's farmers is discussed. We conclude with a set of strategies that can enhance the climate transformation of this sector.

Social and organizational dimensions of climate change mitigation and adaptation in agriculture: A case study of Alberta

Dr. Debra J. Davidson, Professor
Department of Resource Economics and Environmental Sociology
University of Alberta
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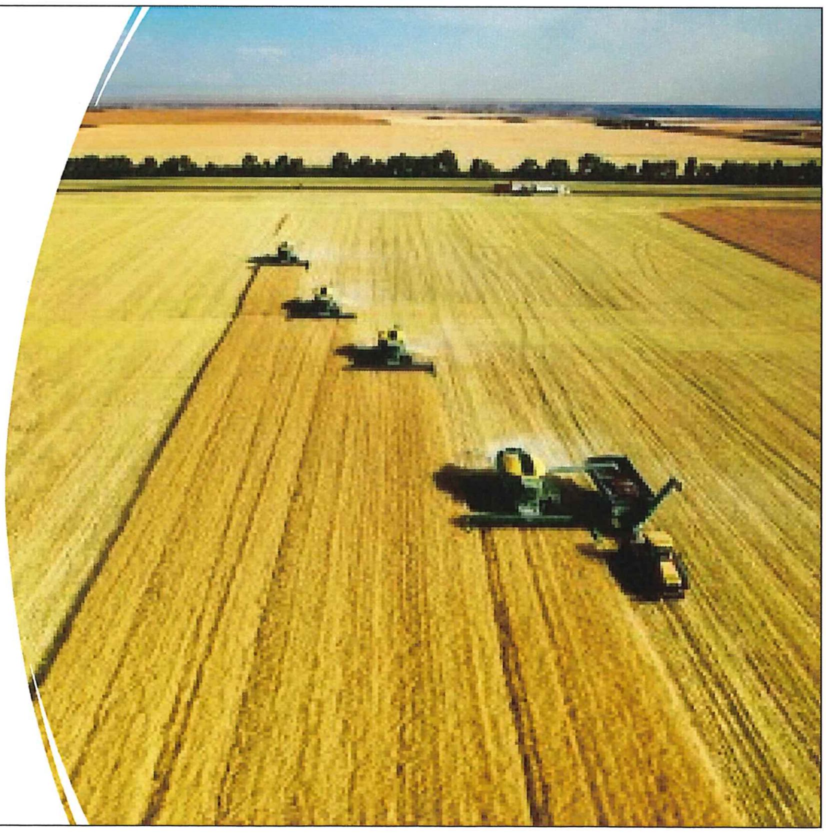
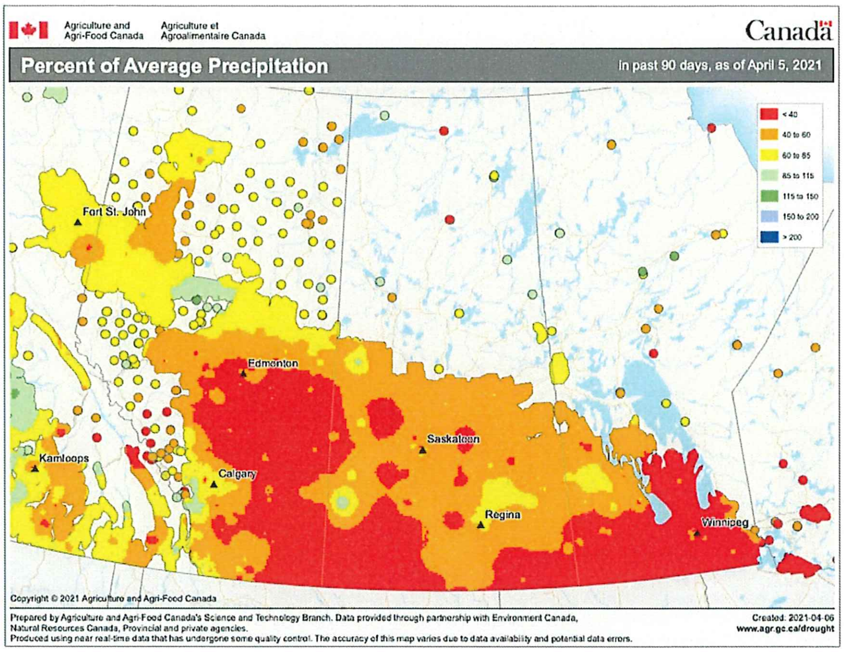
Brief Overview of Alberta Agriculture

- Since time immemorial, various forms of agriculture were practiced by Indigenous peoples in the region now known as Alberta.
- Alberta has been occupied by European settlers who began engaging in a very different form of farming over a century ago.
- Farming has continued to play a major role in Alberta's economy since that time.
- In recent decades, several policy and technological changes have favoured large-scale, highly industrialized production of a small number of commodities, including beef, canola and wheat, primarily for export.
- Consequently, the number of farms has declined, to about 40,000, while average farm size has increased to an average of 1,230 acres, and the average age of farmers is over 50 years.



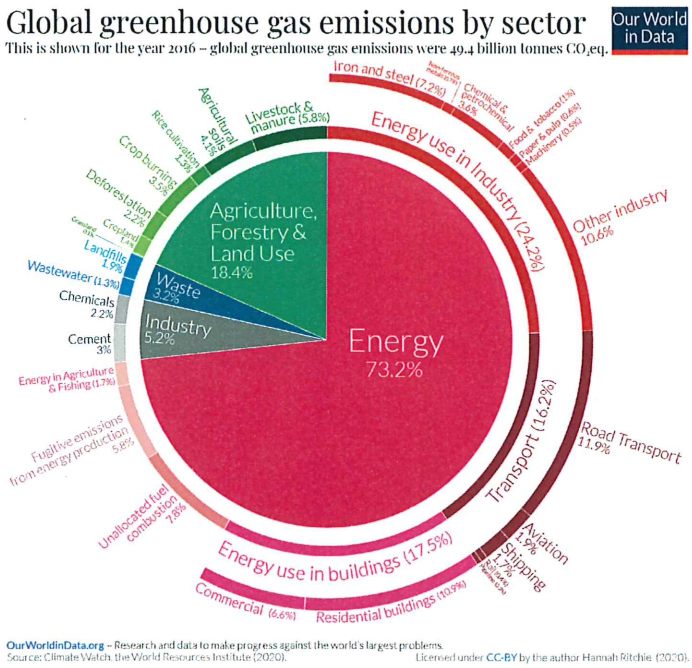
Recent Extreme Events attributed in part to climate change

- Several disasters that have been attributed to climate change have affected harvests in recent years including flooding, drought, unexpected freeze events, and most recently, supply chain disruptions.
- Other projected climate impacts include pest and weed outbreaks, decline in soil moisture, and more variable water availability for irrigation.
- The need for farmers in the Canadian Prairies to adapt to the impacts of climate change is urgent.



Mitigation in agriculture systems is also needed!

- Agriculture is also a major contributor to climate change, particularly in highly industrialized systems like Alberta's.
- Main sources of emissions:
  - use of fossil fuels in heavy equipment
  - application of chemicals esp. nitrogen fertilizers
  - enteric digestion and manure from livestock
- We have several strategies for reducing emissions, including precision agriculture, soil regeneration, changing livestock feed, adoption of renewable energy on the farm.

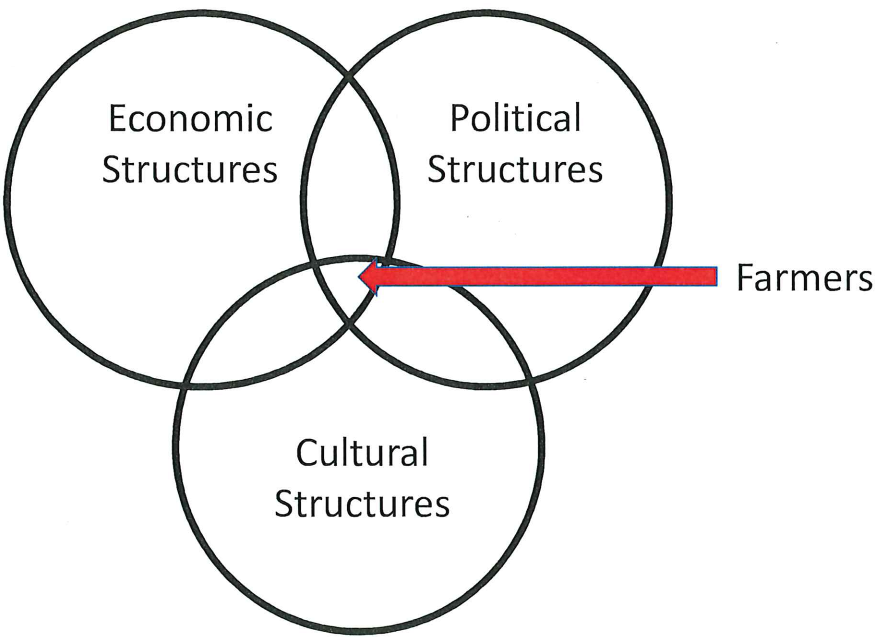


Prospects for Climate Mitigation and Adaptation in Alberta Agriculture

As with so many other sectors of our socioeconomic systems, recognizing the problem, and even having strategies to address the problem, do not mean that the problem will automatically be addressed.

I will draw from a recent case study involving 301 surveys and 31 interviews with Alberta farmers to highlight the social and organizational dimensions of transitioning our agricultural systems.

Three key social structures constrain opportunities for changes in farmer behavior



Economic 'lock-in' effects in Alberta Agriculture

Operating in a global staples marketplace means no producer control over price, and those prices are highly volatile.

Industrialization means capitalization, so farmers must acquire expensive heavy equipment, accumulating debt in the process.

Shrinking profit margins incentivize further production growth for economic survival.

Younger generation of farmers can't afford to enter the sector, so the average age of farmers goes up.

Political 'lock-in' effects in Alberta Agriculture

Agriculture policies in recent decades have been written to support large farms, and industrialization, favouring a small number of crops, for export. Making operational changes will require policy change.

Neoliberalism has been a strong feature of Alberta politics, which favours minimal regulation, and free markets. This limits the types of policies likely to be introduced.

No policies have been established to support a coordinated effort at climate mitigation or adaptation in agriculture. Some policies, like disaster relief, may actually discourage adaptation.

Cultural 'lock-in' effects in Alberta Agriculture

- Many farmers abide by cultural norms that dictate farm cleanliness (weed free, e.g.), conformity, economic success, which conflict with many strategies favouring mitigation and adaptation.
- Farmers tend to live in rural communities, with a strong conservative political orientation that influences their reaction to certain policies, such as carbon taxes.
- Farmers form close-knit groups, group borders reinforce information silos, and within these groups distrust of outsiders and misinformation can circulate.
- As one outcome of this, we have deeply instilled support for the goal of production maximization as opposed to a balanced management system that puts environmental and climate protection on the same level.

Another notable outcome: We observe very high levels of climate denial in this group

Survey Responses to the Following Belief Statements	Percent of Responses who agree
Climate change is occurring, and it is caused mostly by human activities	10
Climate change is occurring, and it is caused more or less equally by natural changes in the environment and human activities	36
Climate change is occurring, and it is caused mostly by natural changes in the environment	28
There is not sufficient evidence to know with certainty whether climate change is occurring or not.	19
Climate change is not occurring	2
Prefer not to answer	4

Breaking the Impasse to Support Climate Mitigation

What I have just described is a system in which multiple processes pose barriers to mitigation.

But, all systems are dynamic, and we can't forget that farmers are autonomous and reflexive human beings who are capable of changing course.

Many farmers are already adopting several climate mitigative practices

Practice	Adopted	Would Consider	Not Adopted	N
Leave/spread crop residue in fields after harvest	97	2	1	260
Zero-tillage	82	12	6	252
Use GPS, precision agriculture, or variable rate technology for fertilizer application	81	16	3	250
Installed LED lights	80	19	1	299
Manure composting	79	19	2	148
Include perennial, forage, and/or legume crops in rotations	71	23	6	231
Improved the energy efficiency of buildings	68	30	2	289
Introduce legumes or other nitrogen fixers into grazing lands	67	29	3	147
Maintain wetlands	62	23	14	222
Fence off riparian areas and sensitive ecosystems to protect from livestock	60	27	12	139
Planted permanent/perennial vegetation on marginal lands	51	33	16	250
Plant cover crops	36	46	18	192
Restored wetlands	33	42	25	209
Installed solar panels	19	67	14	276
Production of bioenergy	10	61	29	165
Built a covered manure storage facility	5	41	54	99

Those farmers most likely to adopt these practices:

- Have a strong conservationist identity
- Have a strong learning orientation

Most frequent stated reasons for adoption include:

- Wildlife protection
- Soil and water quality
- Economic benefits

Note: Beliefs and concern about climate change does NOT predict best management practice adoption in this group!

Change is happening in other ways too

We observe an upsurge in young ecologically-minded farmers seeking to enter the sector.
New organizations such as *The Young Agrarians*, *Organic Alberta*, and *Farmers for Climate Solutions* are providing support for new farmers.

These new farmers are seeking to change the dialogue in the agricultural community to generate awareness about climate change, and introduce different farming techniques.

Strategies to Enhance Climate Change Mitigation and Adaptation in Alberta Agriculture

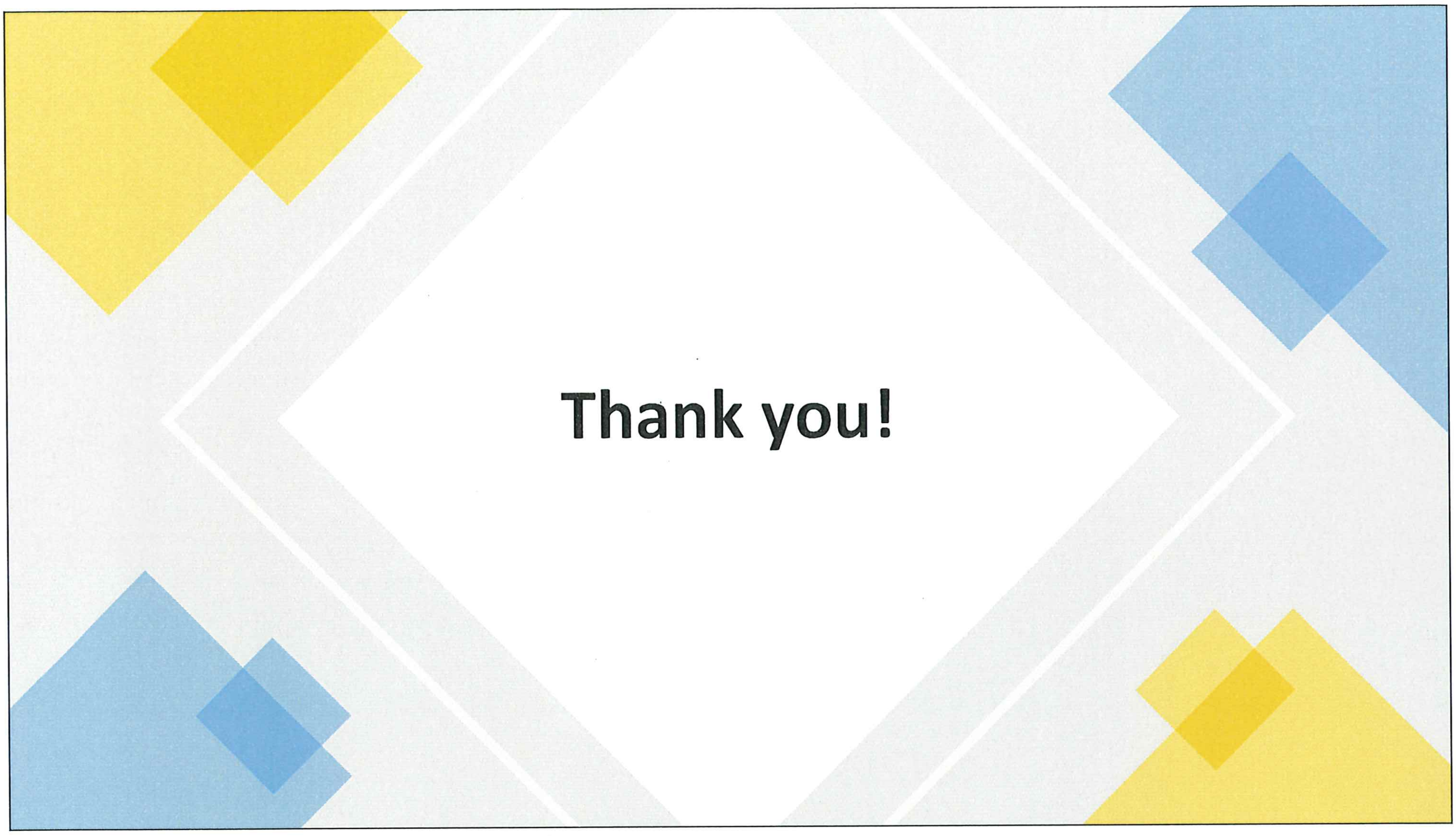
Farmers, consumers and stakeholders need to put pressure on government to enact:

- Policies to support farmers, not agri-businesses: supporting new technology adoption, and value-added, diversified, multi-functional farming operations
- Government support for transition, in the form of financial and informational needs.
- Engagement with farmers themselves to craft those support systems, so their knowledge and values are incorporated.

Strategies to Enhance Climate Change Mitigation and Adaptation in Alberta Agriculture

Policy change is slow, but farmers, consumers and stakeholders can also take action now:

- Supporting farmer-led organizations that are working for change.
- Building relations between farmers and urban consumers.
- Get food systems on the agenda: Bring the urgent threat of climate change to our agri-food systems into our conversations.


Thank you!

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