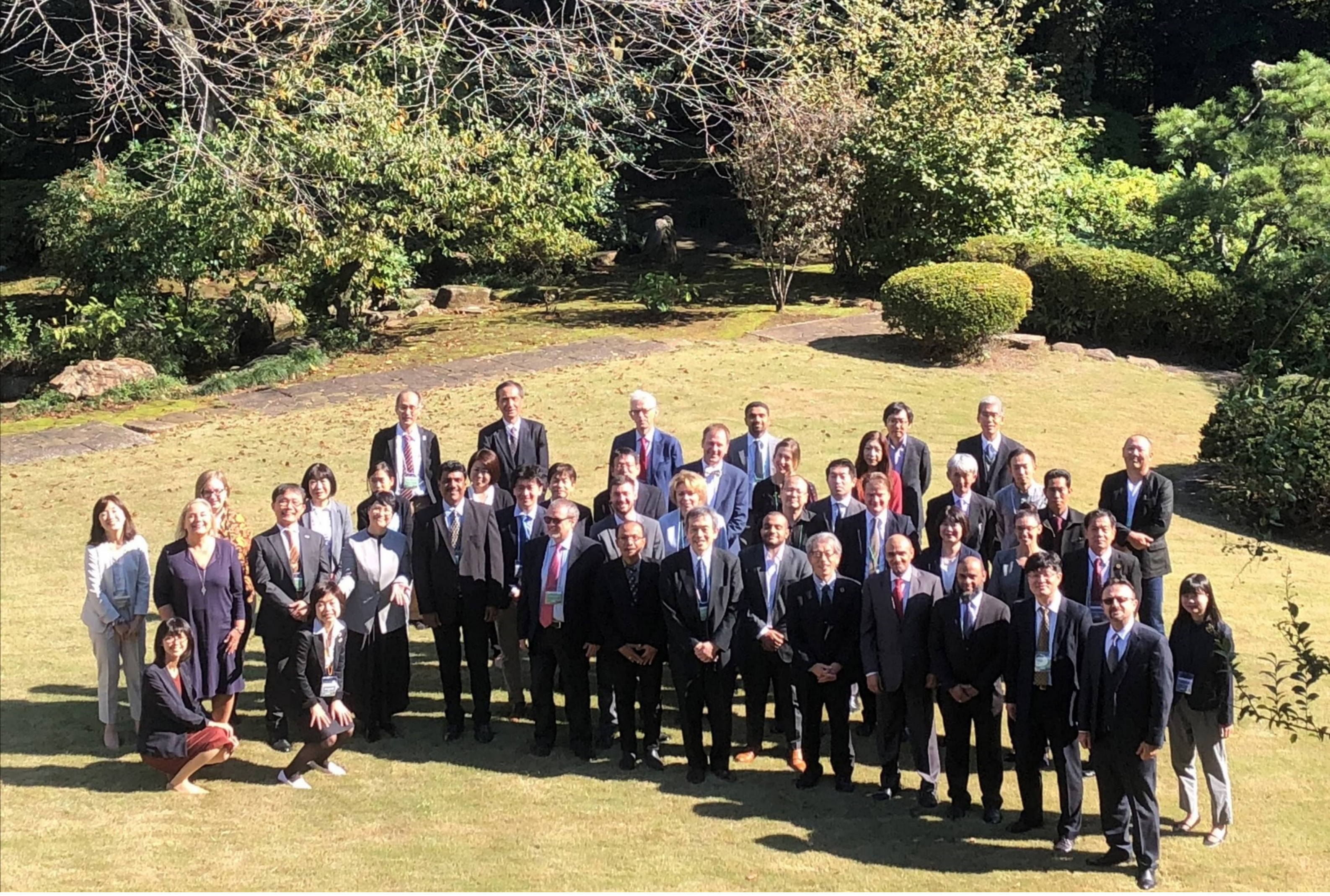

Final Report on the “International Workshop on Scaling up and out of Climate-smart Technologies and Practices for Sustainable Agriculture”

Summary of the Workshop

February 2020



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Executive Summary of the Workshop

Recognizing the urgency faced by the increased frequency and intensity of extreme weather as evidenced by recent global events and the IPCC special reports*, workshop participants highlighted that the need to accelerate scaling up and out of climate-smart technologies and practices was a priority in the agriculture sector. The richness of case studies on introduction of climate-smart technologies and practices in combination with supporting measures to facilitate adoption by users (e.g. farmers) provided valuable findings and opportunities which could stimulate further activities.

Participants shared the view that the research community can significantly contribute to enhancing the scale and adoption rate of climate-smart technologies and practices by;

- Using landscape-level approaches covering the entire agricultural and social landscape
- Providing scientific evidence through monitoring and data collection, advices based on evidence, and supporting capacity building
- Applying the mutually complementary approaches as below;
  a. Collaboration with policy makers
  b. Collaboration with the private sector
  c. Collaboration with farmers in the center throughout the process of research and development
  d. International collaboration

*IPCC Special Report on 1.5 degrees (Oct 2018), Special Report on Climate Change and Land (Aug 2019), Special Report on Ocean and Cryosphere (Sep 2019)

I Introduction

1. Rationale

The global food production systems are experiencing significant pressures to meet the demand for fast growing population. People are demanding more of higher quality of food, cleaner energy and water. Agriculture is a sector vulnerable to climate change and frequent drought and flood events have become a great threat to food production. At the same time, agriculture is a significant source of emission; AFOLU (agriculture, forestry and other land uses) sector is responsible for almost 1/4 of global anthropogenic greenhouse gas (GHG) emission (IPCC Special Report on Climate Change and Land[1] (2019)). However, with development and implementation of innovative agricultural technologies, GHGs could be reduced and simultaneously food production sustained.

In order to scale up and out climate-smart technologies and practices, it is important that research institutes possessing technologies, in collaboration with research institutes of the countries/regions in which those technologies are to be introduced, conduct on-site trials and adapt the practices and technologies to optimize performance in the target area. In case of mitigation technologies, they often need to be introduced in combination with some kind of measure to facilitate their adoption. Therefore, it is effective to progressively introduce technologies through social experiment-like approaches by collaboration between natural and social science and through international partnership.

2. Outline of the process

Japan, as the chair country proposed "climate-smart technologies" as one of the topics at the 8th G20 Meeting of Agricultural Chief Scientists (G20 MACS) held in Japan in April 2019. At the meeting, participants shared the view that the development and implementation of innovative agricultural technologies and practices can support sustainable food production, climate resilience, carbon sequestration, and reduce GHG emissions from agriculture[2]. In this respect, the proposal from Japan to hold a workshop later in 2019 to share the experiences and the latest information and facilitate research collaboration in the development and scaling up and out of climate-smart technologies and practices for sustainable agriculture was supported[3].

November 5 to 7, 2019, the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) organized an international workshop in Tokyo which was attended by researchers/experts of interested countries including G20 members and international organizations. At the workshop, participants shared their experiences in introducing climate-smart technologies and practices in combination with supporting measures, and discussed the lessons learned.

Prior to the workshop, MAFF invited countries and international organizations to provide case studies in introducing climate-smart technologies/practices in combination with supporting measures to facilitate

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1 an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

2 Paragraph No. 8 on the communique of 8th G20MACS (2019 Japan)

3 Paragraph No. 9 on the communique of 8th G20MACS (2019 Japan)
https://www.macs-g20.org/fileadmin/macs/Annual_Meetings/2019_Japan/MACS-G20_2019_Communique_Final.pdf

farmers' or other users' adoption. A total of 31 cases were submitted from 12 countries and 3 international organizations. Among these, 27 cases were presented at the workshop.

Photo: Field trip to Chiba Prefecture on November 7th, 2019

List of case studies[4]

No.	Submitter	Title
International organizations		
01	CGIAR CCAFS	Climate Smart Villages in Latin America
02	CABI	Mirroring the CABI Plantwise approach to create global network of on-the-ground extension hubs to facilitate rapid and large-scale communication of proven and locally-relevant climate-smart technologies and practices to support enhanced resilience
03	CIMMYT – India	Science informed policy for sustainable, scalable and farmer friendly climate smart agriculture technology with impact at scale to eliminate crop residue burning in India
Countries		
11	India	Climate smart technologies and practices for sustainable agriculture in India
12	Indonesia	Conservation Agriculture Reduces Disaster Risks Caused By Changing Climate in NTB and NTT Provinces in Indonesia
13	Russian Federation	Development of SLM Technologies and Approaches System to Achieve LDN at the Local Level in Russian Federation
14	Canada	The Living Laboratories Initiative in Canada: Early Lessons
15	Brazil	Reducing the negative impacts of climate change on agriculture with cover crops and zero tillage
16	Brazil	The adoption of sustainable technologies in Brazil: the case of the Agro-Climate Risk Zoning (ZARC) methodology and use in Agricultural Policies
17	China	Abatement of greenhouse gas intensity with application of biochar and optimized water-nitrogen management
18	Netherlands	sustainability management in the dairy chain, that highlights the role of the industry in supporting farmers and consumers
19	Netherlands	Smart energy management in glass-house horticulture
20	Netherlands	Mainstreaming precision farming
21	France	A strategy for estimating cropland carbon budgets at plot scale over large areas and quantify the effects of cover crops
22	France	A scientific network in West Africa as a laboratory to assess and co-design with stakeholders climate smart practices
23	France	An innovative way to produce manure in labour- and rain-scarce environment
24	France	Agrisource open innovation platform
25	France	Foresight tools for adaptation to climate change across the wine industry
26	Saudi Arabia	Culture and propagation strategies of Sea cucumber in Red Sea
27	Saudi Arabia	Action Plan for promoting Date Palm Cultivation in the Kingdom of Saudi Arabia
28	UK	Cool Farm Tool (CFT), and Carbon footprinting tool for cereal and oilseed farmers[5]
29	UK	Agri-EPI (Engineering-Precision-Innovation) bridging between science and industry
30	Italy	IRRISAT – Irrigation advice based on satellite technologies
31	Japan	"COOL VEGE": Sequestering soil carbon with biochar through eco-branded vegetables
32	Japan	Weather Parametric Insurance in China
33	Japan	Smart sampling and Sowing failure assessment in India
34	Japan	Introduction of solar sharing system in Chiba, Japan
35	Japan	Introduction of a recently published social experiment Francisco Alpízar, María Bernedo Del Carpio, Paul J. Ferraro & Ben S. Meiselman (2019) The impacts of a capacity-building workshop in a randomized adaptation project, Nature Climate Change, volume 9, pages587–591.
36	Japan	N_2O mitigation in Japanese Tea production
37	Japan	Dam in the Paddies
38	Japan	A social experiment for collective auction to encourage farmers to reduce the use of irrigation water collectively

[4] Country cases are in order of submission, with Japanese cases in the end.
[5] "Cool Farm Tool" was submitted as a case study, and the "Carbon foot printing tool for cereal and oilseed farmers" was presented by the participant from UK, at the workshop.

II Current approaches used by research organizations

1. Experiences in scaling up and out of climate-smart technologies and practices for sustainable agriculture

An international workshop including an expert workshop, international symposium and a field trip was held in Tokyo and Chiba, Japan on November 5 to 7, which was attended by 14 countries and 1 international organization.

At the workshop, presentations on the case studies were provided, and participants discussed scaling up and out climate-smart technologies and practices along 4 themes; (1) adaptation and risk management, (2) introduction by collaboration with policies, (3) technology dissemination to farmers by research organizations, (4) introduction of mitigation technologies through economic mechanisms.

In the international symposium for scaling up and out of climate-smart technologies and practices for sustainable agriculture (Japanese subtitle “Climate change and agri-business”), presentations from CGIAR/CCAFS, Colorado State University, USDA and Patagonia were provided, and then a panel discussion with the presenters and farmers was held.

Photo: International symposium on November 5th, 2019

Prior to the workshop, in August to September 2019, submission of case studies was invited to G20 member countries and international organizations.

The outline of the 31 case studies collected prior to the workshop was reported. Of the 31 cases, 50% were related to both adaptation to and mitigation of climate change, 23% were primarily on adaptation, 20% primarily on mitigation, and 7% on risk management.

55% of the cases were implemented in collaboration with national and/or local policies, 39% involved the private sector, and 90% involved farmers.

(1) Challenges

Participants noted the richness of the case studies and agreed that sharing the lessons learned with others could stimulate further activities. They discussed how they could enhance learning from experiences in other countries or regions and in particular highlighted the following points as major challenges.

- ✓ Approaches for scaling up and out climate-smart technologies and practices must take into account the specific environmental, cultural, historical and political background of the target area which are largely variable according to national circumstances

- ✓ Activities for scaling up and out of climate-smart technologies and practices must be implemented covering the entire landscape, as it relates to food security, dietary habitats, health and other social concerns. Introduction of climate-smart technologies and practices also have side effects to other aspects including soil health, water quality and biodiversity, which must be considered in an integrated manner.

(2) New approaches for research organizations

Participants shared the view that it is fundamentally important to recognize that climate change is at a critical circumstance.

They then agreed on the need for research organizations to adopt new approaches which are different from their business as usual, namely to;

- ✓ Contribute to designing and constructing policies and measures related to climate change
- ✓ Contribute to developing innovative business models
- ✓ Engage farmers in the center of activities to facilitate scaling up and out of innovative technologies and practices

(3) The roles of research organizations

Further, they recognized the following key roles that research organizations should play;

- ✓ Provide precise scientific evidence to policy makers, farmers, private sector etc. in the target area through monitoring and data collection
- ✓ Develop a set of measure to quantify the effect of each technology or practice (e.g. amount of carbon sequestered) and robust monitoring systems for verification
- ✓ Provide advice based on those scientific evidence so that policy measures by policy makers, business cases by the private sector, and behavior change of farmers will be made adequately and effectively
- ✓ Contribute to developing partnerships among different sectors such as policy makers, companies, farmers and consumers and support capacity building in these sectors

Further, participants expressed their expectation to international research organizations to contribute to scaling up and out of technologies and practices across national and regional borders through coordination with international organizations related to climate change (UNFCCC, IPCC etc.) and with national and local governments.

2. Main lessons learned from country experiences

(1) Scaling up and out of climate-smart technologies and practices through collaboration with policies

Research institutes can facilitate scaling up and out of climate-smart technologies and practices by collaboration with national/local agricultural policy.
➢ Appropriate and effective technologies and practices could be developed based on scientific and economic assessment. ➢ Public mechanisms which support development and introduction of technologies, such as a stepwise funding scheme for research, can promote developing and scaling up and out of innovative technologies by reducing risks related to innovative challenges. ➢ Climate-smart agricultural systems could be promoted if big data could be developed by integrating various data collected by research organizations.

Experiences were presented by Brazil, Saudi Arabia, India, Italy, Swiss Reinsurance etc. related to scaling up and out of technologies and practices through research institutions' collaboration with policy by discussions with policy makers based on monitoring and data analysis in the target area.

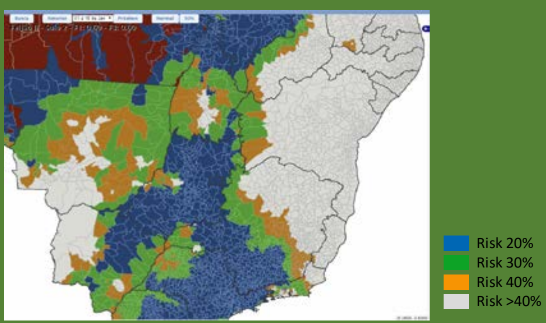
The major points discussed after the presentations include the following;

a. When transformation to new climate-smart food systems are being considered as part of the effort to scale up and out climate-smart technologies/practices, it will be closely linked to economical and societal concerns including food security. Also because introduction and dissemination of technologies/practices will have side effects in the production site, participants recognized that it would be critical to coordinate with national and/or local agricultural policies through dialogues with relevant policy makers.

ZARC in Brazil (No.16) - case linked with governmental subsidies

In order to reduce the risk of climate change on agricultural production, the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) officially applies the Agro-Climate Risk Zoning (ZARC), developed by the Brazilian Agricultural Research Corporation (Embrapa) and partners.

ZARC provides the indication of climatic risks for 40 crops considering dates of planting, sowing and genotype characteristics for each municipality. It considers, as well, historic weather series and soil type. The farmers must follow the indications of ZARC to be eligible for using the government agricultural insurance and other subsidies of the rural insurance premium. Using ZARC in the Agricultural Policy facilitates to scale up and out climate-smart technologies and practices.



Example of ZARC

b. Policy makers and natural scientists should both make effort to bridge the gap between them. To this end, it is important to develop frameworks for dialogues also involving social scientists.

c. Development of climate-smart technologies and innovations include research with risks of failure, and public research funding is key to promote this type of research. As an example, a stepwise funding program (the Conservation Innovation Grants in the USA) was introduced, which is a competitive funding scheme that stimulates development and adoption of innovative approaches and technologies. It supports high-risk initial stage research, and as the next step, can support on-farm trials and eventually initiatives with private companies, for successful researches. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

d. A participant explained that the global subsidies to farmers was reported to be around 530 to 550 billion US Dollars annually, which implies that use and coordination of agricultural subsidies may be useful in scaling up and out innovative technologies to tackle the challenge of climate change.

e. The primary role of research institutions is to provide evidence to policy makers, as well as farmers and the private sector. It is therefore necessary to develop measurement technologies, monitoring and verification mechanisms for on-site data of the target area as well as to promote assessment and provision of the collected information.

f. Climate-smart agricultural systems are expected to be promoted by development of big data by integrating various data collected by research organizations, and framework to facilitate use. However, cautious consideration must be given to the ownership of data possessed by private sectors because collecting data can become a business.

g. It was also highlighted that in order to allow researchers to actively participate in these attempts, evaluation systems of researchers should be considered to adequately evaluate activities which contributed to social impact or benefits, in addition to the customary academic performance evaluation.

(2) Co-designing business models through collaboration with the private sector

Research institutes can facilitate scaling up and out of climate-smart technologies and practices by co-designing business models with the private sector.

- Innovative ("unusual") business models are necessary in order to tackle the current "unusual" climate situation.
- Companies can provide incentives for farmers to adopt or change to climate-smart technologies and practices.
- Climate-smart technologies/practices can be standardized by companies' certification or recommendation to farmers who adopted those new technologies/practices.
- Research organizations can contribute to creating new carbon market opportunities to facilitate a transaction mechanism between carbon emitter and absorber.

Business cases were presented by Japan (the "Cool Vege"), France, Patagonia etc., and the Cool Vege production site etc. were visited in the field trip. These cases demonstrated new business models in which locally adapted climate-smart technologies/practices have been introduced, and their products being sold with special branding.

The major points discussed after the presentations include the following;

a. In recent years, multinational company (e.g. Patagonia) -led cases have been increasingly reported in which climate-smart technologies/practices have been successfully introduced at scale. Participants shared the view that private initiatives can accelerate scaling up and out.

b. "New" business models are necessary to tackle the current "unusual" climate circumstance never experienced before. It is key for research institutions to develop partnership with companies at the early stage and co-construct business models or mechanisms for scaling up and out.

The business model of "COOL-VEGE" in Japan (No.31) – combination with eco-branding of the products

In the "COOL-VEGE" project, a mixture of biochar produced from unused local biomass and compost is applied to agricultural lands in order to sequester carbon in soils. The agricultural products cultivated in fields amended with biochar are sold under the "COOL VEGE" eco-brand.
Companies can support the scheme financially and be identified on the eco-label.

Biochar application (Field trip on November 7th)

c. Farmers need incentives in order to adopt climate-smart technologies/practices. Such incentives may include increased profitability, reduced risks, and sustainability of agriculture. New business models to address these incentives or lessen farmers' anxieties are expected to facilitate scaling up and out.

d. In developing new business models, research organizations are expected to suggest suitable technologies, as well as scientific and economic evaluation.

e. It is also important to develop business models which suit various companies including small enterprises.

f. In the carbon market which has been in place in the US for about a decade, on-farm methodologies for soil carbon sequestration and methane reduction from paddies etc. have been developed and in practice with research institutions' collaboration. Research organizations can contribute to creating new market opportunities through establishing measurement or assessment methods.

(3) Engaging farmers in the center of development, introduction and on-farm trials

Research institutes can accelerate scaling up and out of climate-smart technologies and practices by engaging farmers in the center of development, introduction and on-farm trials of technologies.

- Introduction of climate-smart technologies/practices requires farmers to transform their production systems. By involving farmers in the initial stage of research and throughout the on-farm trial, useful technologies and practices could be developed.
- Farmers' capacity development and understanding for implementing the new production system will be facilitated.
- By taking into account the entire social and economic landscape, an integrated climate-smart food system adapted to the production site could be developed.

Experiences were presented by France, Canada, China, U.K., CCAFS etc., on successful establishment of locally adapted technologies/practices, through demonstration of climate-smart technologies/practices based on dialogue with farmers and local communities in the production site.

The major points discussed after the presentations include the following;

a. In developing new technologies to address global challenges like climate change, the technology should be assessed not only from scientific point of view, but also its benefits to farmers' business should be evaluated. However, some technologies are not adopted by farmers even though they are pragmatic from scientific and economic point of view. This means it is also important to consider technologies comprehensively from the standpoints of farmers. Therefore, farmers should be invited to participate from the initial stage of research and development of technologies.

b. Outreach activities by research organizations are key for adoption of new technologies. Communication in farmers' languages, and capacity development are especially important. As an

The "Agri-EPI" in United Kingdom (No.29) – a nation-wide public-private networking of satellite farms

Agri-EPI Centre established by government of UK developed a network of 28 Satellite Farms in the UK to lead the adoption of cutting-edge technologies to maximize productivity, optimize input applications and minimize environmental impact. Agri-EPI Centre optimizes and demonstrates technologies in cooperation with research organizations and companies. The Satellite Farm Network has led the evaluation and adoption of new technologies in the UK and is helping to translate science advancement into a practical solution to improve efficiency on the farm.

Variable rate nitrogen application


28 satellite farmers

example, the CCAFS strategy was introduced that, in order to accelerate adopting the outcome of research, their research investments are divided into research itself, engagement of stakeholders, and outreach,

c. For farmers to adopt climate-smart technologies/practices, they would need, in addition to financial support, clear understanding of the expected impact, as well as support to reduce their risk associated to introducing/changing their practice. Therefore, research organizations should understand more about farmers and address their concerns by providing evidence based on long term monitoring, and improvement of the technologies etc.

ALL (Agroecosystem Living Laboratories)

ALL is defined as "transdisciplinary approaches which involve farmers, scientists and other interested partners in the co-design, monitoring and evaluation of new and existing agricultural practices and technologies on working landscapes to improve their effectiveness and early adoption." The international ALL working group was formed following a presentation by Canada at the 2018 G20 MACS in Argentina

Executive Report: https://www.macs-g20.org/fileadmin/macs/Annual_Meetings/2019_Japan/ALL_Executive_Report.pdf

d. Participants noted that a new "climate-smart food system" which integrates climate-smart production and the food system is necessary, for agriculture to cope with climate change.

e. The "climate-smart food system" is expected to involve the carbon market mechanism in addition to the current food market mechanism. In developing the systems, it is necessary to view the entire landscape of the agriculture and food industry, and plan with a long-term interdisciplinary approach.

f. Transformational change in agriculture and food production is necessary, at production sites. In order to promote the transformation, farmer-centric approach as implemented in the ALL (Agroecosystem Living Laboratories) is effective.

g. The European Innovation Partnership (EIP) was introduced as a program successful in introducing new technologies and practices. Technology development projects (usually around 50,000 euro/project) driven by farmers and implemented together with researchers and NGOs are funded.
European Innovation Partnership (EIP) -AGRI https://ec.europa.eu/eip/agriculture/en

(4) International and inter-regional collaboration

International and inter-regional research collaboration can facilitate scaling up and out of climate-smart technologies and practices.

- Efficiency in designing policies or measures by learning from experiences and lessons in other countries.
- Construction of effective policies or support systems through research collaboration with international research organizations.

- Scaling up and out of climate-smart technologies and practices to countries/regions in similar environment will be possible.

The major points discussed after the presentations include the following;

a. In EU, experiences and lessons are shared among its member states, to enable efficient designing of policy measures adapted to the respective country. This may be considered a model for experience sharing among countries with different context.
    - For example, the "Cool Farm Tool" (case study number 28) in UK, had been used as a model to develop similar tools in the Netherlands, Ireland and France.

b. International research organization has active partnerships with various organizations tackling the challenges posed by climate change (e.g. the UN Framework Convention for Climate Change). These international research organizations can arrange effective international research partnership for introduction of technologies, and develop support systems.
    - For example, use of the learning platform for climate change research collaboration in CCAFS may be useful.

c. International research organizations are implementing programs to support international and inter-regional research partnership, which enables transfer and upscaling of climate-smart technologies in countries and regions in similar environment. The role of International research organizations is especially important in south-south cooperation.
    - CCAFS has implemented pilot projects for introducing climate-smart agriculture in designated climate-smart villages (CSVs) in several countries in Latin America. CSV model has led to scaling up and out of climate-smart technologies and practices.

(5) The collaborative partnerships (1)-(4) are mutually complementing

Views expressed on overall approaches and the relationship between the collaborations with stakeholders in promoting (1) through (4) described above include the following;

a. In order to scale up and out climate-smart technologies and practices, approaches such as (i) collaboration with policy, (ii) co-designing business models through collaboration with companies, (iii) collaboration with farmers in the center of development and trials; should be applied boldly and with flexibility, taking into account the respective technology/practice and the situation regarding the target site and collection and analysis of scientific data.

b. Participants shared the view that the scope and magnitude of the impact depend on the approach (cooperation with policy makers ≧ co-designing business model ≧ collaboration with famers in activities for introduction of technologies), thus it is considered useful to combine the three approaches or apply them simultaneously in parallel.

c. In promoting adaptation to and mitigation of climate change in the agriculture sector, the key is efficient and effective scaling up and out of technologies and practices. Participants shared the view that therefore promotion should be based on scientific evidence, and that scientists should be actively involved.

d. Therefore, scientists are encouraged to proactively adopt a holistic approach by overlooking the economy and society at the agriculture production site. In doing so, it is important that scientists provide precise scientific evidence to stakeholders developed through data collection and monitoring etc. However, the urgent need in addressing climate change should also be noted, and some participants mentioned that activities should not be delayed because of insufficient scientific accuracy.

e. In order to maintain the compatibility between the speed and scientific accuracy, use of models such as the COMET, a quantification tool for estimating soil carbon and greenhouse gasses, which was introduced by the expert from the US, is an option. However, long-term monitoring is also necessary to develop precise models, and participants shared the view that speeding up and scientific accuracy should not be considered one or the other alternatives.

f. Participants also shared the view that international and inter-regional collaboration allows efficient transfer and scaling up and out of effective technologies/practices across countries and regions. When such transfer/scaling up and out is considered, the object is not only the climate-smart technologies/practices, but the approaches, know-how, lessons learned etc. obtained through try and error in the initial area should also be considered.

g. Therefore, it is beneficial to conduct analysis and evaluation of effectiveness and efficiency of the measures or approaches used for scaling up and out climate-smart technologies/practices. In conducting analysis/evaluation, it is important to assess the following points and the results transferred together to succeeding countries/regions.
   - ✓ Social and economic background
   - ✓ Institutional framework regarding agriculture
   - ✓ Challenges faced how they were overcome, lessons learned etc.

In order to conduct these, participants shared the view that interdisciplinary research promotion is important when promoting the approaches a.(i) to (iii) ((i) collaboration with policy, (ii) co-designing business models through collaboration with companies, (iii) collaboration with farmers in the center of development and trials). This may be done, for example by formation of a team including social scientists.

III Findings and Future Opportunities

Participants of the workshop, recognizing the critical circumstance of the increased frequency and intensity of extreme weather, shared the urgent need to accelerate scaling up and out of climate-smart technologies and practices. They agreed that research organizations can serve roles as highlighted below, and significantly contribute to sustainable agriculture, and eventually to transformation of the food system.

1. Findings

Finding 1
Acceleration of scaling up and out of climate-smart technologies and practices is a priority in the agriculture sector.
➢ Increased frequency and intensity of extreme weather, and increased risk of disaster related to weather including floods and droughts had been reported from G20 countries. Agriculture is facing critical situation, which must be urgently addressed before it is too late.

Finding 2
Research organizations should use landscape-level approaches covering the entire agricultural and social landscape.
➢ It is important to first recognize that the natural environment, cultural, historical and political backgrounds are different in each area, and to design methods to suit the target area. The ALL activities presented by Canada is a model of research approaches for research organizations. ➢ In the long term, transformation to a new system integrating climate-smart production and food systems should be considered, in addressing sustainable agriculture under climate change. ➢ Development of the new system is also related with food security, dietary habitats, food waste, health issues and other societal concerns. Introduction of climate-smart technologies would also have side effects to soil health, water quality, biodiversity etc., which should be holistically considered. ➢ Better utilisation of data analytic, big data, AI (Artificial Intelligence) and machine learning are expected to promote climate-smart agricultural systems.

Finding 3
Research organizations should provide scientific evidence to stakeholders including policy makers, farmers and the private sector, through monitoring and data collection. It is also important to provide evidence-based advices and support capacity building of stakeholders.
➢ Participants agreed that collaboration with agricultural policies as well as with business cases are effective for scaling up and out climate-smart technologies and practices. ➢ They also agreed that the important role of research organizations is to provide precise evidence to policy makers, farmers and the private sector etc., based on monitoring and data collection at the target site. ➢ Research organizations can contribute to developing enabling conditions by developing capacities of actors outside of the government, such as farmers and companies, noting that policies can change as a result of election.

- It is also important that research organizations provide advices and technical assistance based on evidence.
- For successful introduction and upscaling of technologies and practices, it is critical to clearly recognize "who" the science is to be delivered to, and then to use the languages of those persons you are speaking with, and not the scientists' language.

Finding 4
Research organizations' collaboration with stakeholders such as policy makers, private sector, farmers, international and foreign research institutes is key for efficient and effective scaling up and out of climate-smart technologies
➢ Through learning and discussing the case studies, participants agreed that collaboration with policy makers, companies, development and introduction and upscaling of technologies by engaging farmers in the center are key. They further agreed that on-farm trials across countries and regions conducted by international research organizations, especially by south-south cooperation scheme are effective.

2. Opportunities and the ways forward

Opportunity 1
Further discussion is required on approaches for scaling up and out of climate-smart technologies and practices.
➢ Scaling up and out of climate-smart technologies and practices is an important challenge for everyone, and participants agreed that the international workshop was a good entry point. The work should be further deepened.

Opportunity 2
Research organizations can contribute to scaling up and out of climate-smart technologies and practices by collaborating with policy makers.
➢ Successful cases in scaling up and out of climate-smart technologies and practices by collaboration with policy makers were reported. ➢ Participants agreed that an evaluation system to adequately evaluate contributions by researchers to policy must be developed. ➢ It is often considered the role of social scientists to bridge the gap between policy makers and natural scientists, but natural scientists should also bridge the gaps related to the outcome of natural science. ➢ Researchers can support policy making by providing new ideas to policy makers in drafting policy documents or meetings in ministries. ➢ Research organizations can significantly contribute to accelerating scaling up and out of climate-smart technologies and practices by evaluating the effectiveness of institutional arrangements, including their social feasibility.

Opportunity 3
Research organizations can contribute to scaling up and out of climate-smart technologies and practices by collaborating with the private sector.
➢ Companies involved in scaling up and out climate-smart technologies/practices are increasing, and various new approaches are being explored ➢ In order to introduce climate-smart technologies/practices to farmers, they need to economically viable to their businesses. As we are facing a circumstance and crisis never experienced before, innovative business models need to be developed and implemented. ➢ The cases visited in the field trip demonstrate opportunities for researchers to enable farmer-led business models in different context.

Opportunity 4
Research organizations can accelerate scaling up and out of climate-smart technologies and practices by engaging farmers in the center from the initial stage of research.
➢ Many cases involving farmers were reported. In particular, the ALL approach was supported. ➢ The importance to develop a climate-smart food system was pointed out. ➢ Involving farmers and other users of the technologies and practices in the initial stage of research and throughout the innovation process is key for early adoption of technologies. Such an approach is important to avoid and reduce possible future value conflicts among different stakeholders. ➢ Research organizations should provide solutions to farmers. They should also provide measurement and monitoring mechanisms, as well as support development of policy measures to reduce farmers' risks associated to adoption of new ways. Farmers should be invited to participate in the center of on-farm trials to support their adoption.

Opportunity 5
Research organizations can accelerate scaling up and out of climate-smart technologies and practices by international and inter-regional collaboration.
➢ National and international research organizations may have different roles; the latter can contribute to linking different countries. South-south cooperation may be effective in some cases, to which international organizations could contribute. ➢ Experiences in the EU demonstrate that mutual learning from other member states with diverse institutional arrangements can help enhance efficiency in designing activities. ➢ Linking with the learning platform and taskforce for scaling in CCAFS/CGIAR may be helpful to facilitate research collaboration around scaling up and out climate-smart technologies and practices.

Annex A List of Participants

Country /Organization	Title	Name	Organization and position
Australia	Ms.	Nadia Bouhafs	Counsellor (Agriculture) Australian Government Department of Agriculture
Canada	Dr.	Margaret Bancerz	Science Policy Analyst Agriculture and Agri-Food Canada
Canada	Mr.	François Chrétien	Associate Director of the Living Laboratories Division Agriculture and Agri-Food Canada
China	Prof.	Qingzhu Gao	Professor, Director of Climate Change Division, Team Leader Institute of environment and sustainable development in agriculture, Chinese academy of agricultural sciences
China	Dr.	Xiaobo Qin	Associate Professor Institute of environment and sustainable development in agriculture, Chinese academy of agricultural sciences
France	Dr.	Suzanne Reynders	Head of Environment Partnerships INRA Institut National de la Recherche Agronomique
India	Dr.	Prabhakar Mathyam	Principal Scientist & Principal Investigator, National Innovations in Climate Resilient Agriculture (NICRA) Indian Council of Agricultural Research (ICAR)-Central Research Institute for Dryland Agriculture (CRIDA)
Indonesia	Dr.	Edi Husen	Senior Researcher Indonesian Soil Research Institute, IAARD, Ministry of Agriculture
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Saudi Arabia	Dr.	Ali Mohammed Alshaikhi	Director General – General Directorate of Fisheries Ministry of Environment, Water and Agriculture
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Saudi Arabia	Mr.	Kunjali Nayana Veeran Nasser Ayaril	National Aquaculture Group
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United States of America	Dr.	Adam Chambers	SCIENTIST UNITED STATES DEPARTMENT OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE
CGIAR CCAFS	Mr.	Dhanush Arayamparambil Dinesh	Global Policy Engagement Manager CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
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Japan	Mr.	Kazuhiko Shimada	Deputy Director General, Agriculture, Forestry and Fisheries Research Council Secretariat MAFF
Japan	Ms.	Maiko Kubo	Director, Environment Policy Office, Policy Planning Division, Minister's Scretariat MAFF
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Japan	Dr.	Akira Kamidohzono	Senior Advisor JICA
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Country /Organization	Title	Name	Organization and position
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Annex B Case Studies

Category I: Technology

Adaptation: A, Mitigation: M, Risk Management: R

Category II: Approaches for scaling up and out of technologies and practices

Collaboration with policy: P, Collaboration with business: B,
Collaboration with farmers: F, International collaboration: I

Category III: Role of research organization

Development and on-farm trials of technologies: (1)
Providing scientific basis of regulatory measures: (2)
Providing scientific basis of supporting measures: (3)
Scientific assessment of the effect: (4)
Others: (5)

No.	Title (Submitter)	I	II	III	Outline
International organizations					
1	Climate Smart Villages in Latin America Submitter: CGIAR CCAFS	A M	F I	(1) (3) (4)	In the climate-smart villages (CSV) in Latin America (Colombia (Cauca), Guatemala (Olopa) and Honduras (Santa Rita)), CCAFS and local communities carried out the combination of CSA (climate-smart agriculture) options; improved varieties resistant to climate stresses, climate-smart home gardens using organic compost, rainwater harvesting and drip irrigation, water-related options, crop rotation and intercropping, etc. Each farm's hotspots of vulnerability to wind, precipitation and drought were aggregated to develop farm- and community level adaptation plans that identified potential adaptation measures and prioritize them.
2	Mirroring the CABI Plantwise approach to create global network of on-the-ground extension hubs to facilitate	A	I	(3)	Under CABI's Plantwise programme, a multi-partnership global programme on plant health system development, extension systems have been provided the diagnosis and advice of plant health in 34 countries. The information of occurrence of pests and the solution to the problems of plants in each area is shared and used through the

	rapid and large-scale communication of proven and locally-relevant climate-smart technologies and practices to support enhanced resilience Submitter: CABI				network of extension systems. The network also acts as surveillance points for new or emerging pests, thus providing early warning.
3	Science informed policy for sustainable, scalable and farmer friendly climate smart agriculture technology with impact at scale to eliminate crop residue burning in India Submitter: International Maize and Wheat Improvement Center (CIMMYT) - India	A M	P F I	(1) (2) (3) (4)	In order to eliminate rice residue burning to prepare land for wheat cultivation, the Government of India has facilitated to introduce Happy Seeder, no-till direct seeder with a straw management unit, in Indo-Gangetic Plains of India. The use of Happy Seeder facilitates sowing with rice residues remained in the field, and reduces labor requirements, irrigation needs and herbicide use. The Government of India has banned crop residue barning and provided technological and financial support to introduce technologies which can reduce crop residue burning in collaboration with international research organization such as CIMMYT and CCAFS, national research organization, universities, State Departments of Agriculture, and Krishi Vigyan Kendras (KVKs),
Countries					
11	Climate smart technologies and practices for sustainable agriculture in India Submitter: India	A M	P F	(1) (3) (4)	In 151 climatically vulnerable districts of the country, the climate resilient technologies and practices were demonstrated, based on the project ‘National Initiative on Climate Resilient Agriculture’ (NICRA) launched by the ICAR. Climate resilient practices and technologies demonstrated can be categorized into for modules:

	(Indian Council of Agricultural Research (ICAR), Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare (MoA&FW))				natural resource management, crop production systems, livestock & fisheries production systems and institutional mechanisms. The project was mainly implemented by ICAR. At the district level, the Krishi Vigyan Kendra (KVK) (Farm Science Centres) is responsible for implementing the project in farmers' fields by actively involving farmers.
12	Conservation Agriculture Reduces Disaster Risks Caused By Changing Climate in NTB and NTT Provinces in Indonesia Submitter: Indonesia (Indonesian Agency for Agricultural Research and Development)	A M	P F	(1) (3) (4)	In the provinces of East Nusa Tenggara (NTT) and West Nusa Tenggara (NTB) where are vulnerable to extreme climatic impacts such as drought, FAO and the Government of Indonesia (Ministry of Agriculture) introduced Conservation Agriculture (CA) technologies and approaches to help farmers increase productivity and resilience of climate change. The CA technologies included leguminous cover crops for maize, demonstration of water retardation pits, and plant residue accumulation. Those technologies were adopted and practiced by smallholder farmers through community-based participatory extension approaches facilitated by researchers and extension workers.
13	Development of SLM Technologies and Approaches System to Achieve LDN at the Local Level in Russian Federation Submitter: Russian Federation (Institute	A M	P F	(1) (3) (4)	SLM (Sustainable Land Management) technologies such as minimum tillage (no-till) were introduced to prevent soil erosion and deterioration of the soil structure in Samara region of Russian Federation where is at high risk of water erosion and dehumidification. The technology allows to reduce carbon emissions in the atmosphere and to increase the CCA. In addition, Nonprofit Partnership "National Conservation Agriculture Movement (NCAM)" was created with the aim of

	of Geography of Russian Academy of Sciences)				disseminating advanced agricultural practiced and participating in the formation and implementation of the new agrarian technological policy of Russian Federation.
14	The Living Laboratories Initiative in Canada: Early Lessons Submitter: Canada	A M	P B F I	(1) (3) (4)	Agriculture and Agri-Food Canada (AAFC) began the nationwide ALL (agroecosystem living lab) network in April 2019 with the establishment of two sites, one in Atlantic Canada (Prince Edward Island) and one in the Eastern Prairie regions (Manitoba). ALL is an integrated approach to agricultural innovation that brings farmers, scientists, and other partners together to co-develop, test, and monitor new practices and technologies on a real-life context. This approach accelerates both the development and adoption of beneficial management practices (BMPs) that will contribute to Climate Smart Agriculture (CSA).
15	Reducing the negative impacts of climate change on agriculture with cover crops and zero tillage Submitter: Brazil (Brazilian Agricultural Research Corporation - EMBRAPA)	A M	P F	(1) (3) (4)	Intensive soil tillage leads to uncovered soil surface prone to water erosion and decrease of soil carbon and nitrogen. In order to prevent that, Embrapa, regional agricultural research institutes, extension service and farm coops have been working together to promote adoption of cover crops in combination of zero tillage in several regions in Brazil. Embrapa has been involved in the generation and development of the technology together with state governmental organizations, farm coops and private companies. In the last few years Embrapa has also been involved in organizing public policies for the implementation of zero tillage systems and integrated crop-livestock-forestry systems as part of the Brazilian INDC (Intended Nationally Determined Contributions) on low-carbon agriculture.
16	The adoption of sustainable technologies in	A M	P F	(3) (4)	In order to reduce the risk of climate change on agricultural production, the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) officially

	Brazil; the case of the Agro-Climate Risk Zoning (ZARC) methodology and use in Agricultural Policies Submitter: Brazil (Brazilian Agricultural Research Corporation - EMBRAPA)				applies the Agro-Climate Risk Zoning (ZARC), developed by the Brazilian Agricultural Research Corporation (Embrapa) and partners. ZARC provides the indication of climatic risks for 40 crops considering dates of planting, sowing and genotype characteristics for each municipality. It considers, as well, historic weather series and soil type. The farmers must follow the indications of ZARC to be eligible for using the government agricultural insurance and other subsidies of the rural insurance premium.
17	Abatement of greenhouse gas intensity with application of biochar and optimized water-nitrogen management Submitter: China	M	F	(1) (3) (4)	In order to reduce greenhouse gas emission, universities and regional research organization etc. started the demonstration to apply biochar produced by crop residues in combination with water-saving technique and controlled release urea to the double rice cropping system in central China (Jingzhou) and southern China (Huizhou). Biochar amendment significantly decreased CH4 emission. Combination of water-saving and controlled release urea reduced total nitrogen input and GHG emission, and increased the income of per household. The activity of GHG reduction through applying biochar and optimized water-nitrogen management is gradually expanded to other places in China.
18	sustainability management in the dairy chain, that highlights the role of the industry in supporting farmers and consumers	M	P B F	(3) (4)	To achieve the climate goals, the Dutch Government conclude “National Climate Agreement” with several Dutch private and (semi-) public organizations. In the dairy sector, each dairy company has its own sustainability program to help realize the goals of the Sustainable Dairy Chain which is a joint initiative of the Dutch Dairy Association (NZO). Impact assessment of the

	Submitter: Netherlands (Ministry of Agriculture, Nature and Food Quality, Wageningen University and research)				NZO Sustainable Dairy Chain is carried out independently by Wageningen University and Research. For example, Royal FrieslandCampina, one of the world's largest dairy cooperatives, has a quality program for all its farmers regarding outdoor grazing and sustainable development as well as hygiene, quality& safety.
19	Smart energy management in the dairy chain, that highlights the role of the industry in supporting farmers and consumers Submitter: Netherlands (Ministry of Agriculture, Nature and Food Quality, Wageningen University and research)	M	P F	(1) (3) (4)	The glasshouse horticulture, an important sector in Dutch agriculture, has committed to reduce CO_2 emissions and to save energy, through the transition of source of energy of greenhouse. Priorities areas in the programme are the use of geothermal energy, energy efficiency by stimulating cooperation within and outside the sector. In 2009, 'New Cultivation Concept (NCC)' was introduced. The way to promoting the NCC is that relevant organizations work closely together and share knowledge, etc. The guidance offered by NCC experts and the mutual discussions aim to give the participants the confidence to make the transition to NCC.
20	Mainstreaming precision farming Submitter: Netherlands (Ministry of Agriculture, Nature and Food Quality, Wageningen University and research)	A M	P F	(1) (3) (4)	In order to transform to more circular and nature-inclusive agriculture, Government of the Netherlands promotes to scale up and out of precision farming though The National Program Precision Farming (NPPL). The aims of the program are intensive support by expert from Wageningen Research, intensive communication of best practices through communication channels, work experience for students of 'green education', connect with local and regional field labs, build on a common agenda of precision farming, etc., in which research

					institutes support innovation and adopt technology to local circumstances,
21	A strategy for estimating cropland carbon budgets at plot scale overlarge areas and quantify the effects of cover crops Submitter: France	M	B F I	(1) (3) (4)	INRA and relevant organizations developed a regional modeling approach that combines high resolution satellite remote sensing data with a crop model called SAFYE-CO_2 to estimate plot scale agro-environmental indicators at large scale, including carbon budgets. This modelling approach allows to account for the effects of some management practices on the cropland production and C budgets, such as the choice of the crop rotation and the effect of cover crop. This modeling approach began to be applied to calculate cropland C budgets at large scale in collaboration with the private popcorn company, which decided to pay the farmers they are working with for the amount of the amount of C they store in the soil by growing cover crops.
22	A scientific network in West Africa as a laboratory to assess and co-design with stakeholders climate smart practices Submitter: France	A M	F	(1) (4)	The platform in partnership for research and training called “ASAP” in Burkina Faso, Mali, Ivory Coast and Benin involves 6 research organizations. It has been working on the co-design and assessment with stakeholders (many farmers, advisers) of a diversity of practices aiming to sustainably increase farm productivity, Practice such as crop-livestock integration (compost, introduction of leguminous fodder crop) and conservation agriculture (intercropping, mulching and no till) which have co-benefits in terms of adaptation and mitigation have been explored with stakeholders and assessed quantitatively.
23	An innovative way to produce manure in labour- and rain-scarce environment Submitter: France	A	F I	(1) (3) (4)	In order to increase farm manure production in quantity and quality to renew soil fertility, researchers from dP ASAP (CIRAD, CIRDES), stakeholders and producers have worked together to design and support the production of manure in Burkina Faso. In the project, an innovative way

	(dP ASAP, CIRDES, CIRAD)				to produce manure in labor- and rain-scarce environment was developed and introduced through co-design "step-by-step" process. The co-design process started with an analysis of the initial situation, followed by exploration of possible solutions, then on-farms experiments and adaptations of innovative techniques, and finally a participative impact assessment.
24	Agrisource open innovation platform Submitter: France (Institut National de la Recherche Agronomique (INRA))	A M	P I	(1)	INRA and CIRAD developed an online platform "Agrisource" that aims at creating a free access repertoire on innovation and its actors for agriculture facing climate change, with the support of EIT Climate-KIC (EU's climate innovation initiative). Its objectives are disseminating innovations, enabling exchanges between all types of players, and fostering scaling up innovation, in order to mitigate GHG emissions and adapt to climate change. More than 500 players and more than 200 projects and innovations are registered to Agrisource. Agrisource has been designed to be available in different languages starting from French and English. It has the ambition to become a world platform.
25	Foresight tools for adaptation to climate change across the wine industry Submitter: France (INRA)	A	B F	(3)	A new foresight approach has been tasted within the framework of the LACCAVE (Long term Adaptation to Climate ChAnge in Viticulture and Enology) project, set up in France by INRA to study the impacts of climate change and the potential adaptations of the wine sector. In the project, participative forums were organized in seven wine regions (e.g. Bordeaux) where stakeholders (farmers, stakeholders of the industry, researchers, etc.) discussed the adaptation strategies. On the basis of proposals by the forum, a national climate strategic plan has been designed for wine industry.
26	Culture and propagation	A M	P F	(1) (3)	In order to cope with the declining population of sea cucumbers as fishery resources in Red Sea, culture and

	strategies of Sea cucumber in Red Sea Submitter: Saudi Arabia			(4)	propagation as well as resource management have been promoted in Saudi Arabia. It is also reported that sea cucumbers can control ocean acidification and reduce impact of climate change such as lowering damage done to coral reefs.
27	Action Plan for promoting Date Palm Cultivation in the Kingdom of Saudi Arabia Submitter: Saudi Arabia	A M	P F I	(1) (2) (3) (4)	Date Palm, as a suitable crop for desert, contributes towards climate change mitigation by absorbing CO_2. In order to cope with the infestations of pests such as Red Palm Weevils in Saudi Arabia, the Ministry of Environment, Water and Agriculture (MEWA) launched several initiatives such as farmer's pests and diseases reporting mobile application, environmentally friendly pest preventive and control measures, and farmers capacity building. These initiatives help to enhance production and increase the harvesting area of date palms, reduce the pests and diseases infections, and fix CO_2. In addition, MEWA is collaborating with universities inside and outside the countries to develop Good Agricultural Practices for fruits, vegetables, dates and field crops.
28	Cool Farm Tool (CFT) Submitter: UK (Defra (National Focal Point) on behalf of National Environment Research Council, United Kingdom Research and Innovation (UKRI))	A M	B F	(1) (3) (4)	Cool Farm Tool (CFT), developed by a NERC (Natural Environment Research Council) Knowledge Exchange Fellow developed the Cool Farm Tool (CFT) software to give a simple but accurate way to estimate a farm's GHGs. Farmers enter some simple information about their land, its soil type and what they do on it; they are then presented with a summary of emissions and potential steps to cut them. Companies use the software to present practices to reduce GHG emission to the farmers who supply them, including PepsiCo, Marks & Spencer, Tesco and Heineken.
29	Agri-EPI (Engineering-	A M	P B	(1) (3)	Agri-EPI Centre, funded as a part of the Agri-Tech Strategy of UK, developed a network of 28 farmers from

	Precision-Innovation) Submitter: UK (Defra (National Focal Point) on behalf of Innovate UK-URKI/Agri-EPI)		F	(4)	2013. The centre equipped those farms with advance technologies such as monitoring tools and demonstrated the economic and environmental value of the new technologies. For crop farmers, variable rate N fertilizer application technology was applied to maximize profits and minimize the environmental impacts such as N_2O emissions. In the livestock sector, the centre has demonstrated systems that monitor and measure beef animal growth, which allow farmers to decide the optimum finishing point for the animal. The centre also demonstrated the oestrus detection technology in the dairy sector, which allow to reduce the calving interval, increase economic benefits and reduce CH_4 emission.
30	IRRISAT - Irrigation advice based on satellite technologies Submitter: Italy (CREA - Council for Research in Agriculture and Economics)	A	P B F I	(1) (3) (4)	IRRISAT is a business service which provides advice for farmers on the timing of irrigation, based on technology which integrates satellite observations with high spatial and temporal weather forecasts. It is the result of an international and interdisciplinary research funded by the European Commission. Regional government in need to reduce overirrigation pays the company providing IRRISAT about 10 Euros/year for the service. Starting with the last irrigation made, it can provide forecast up to five days later.
31	"COOL VEGE": Sequestering soil carbon with biochar though eco-branded vegetables Submitter: Japan (NARO)	A M	P B F	(1) (3) (4)	Biochar made from unused biomass such as overgrown bamboo is applied to farms to reduce atmospheric CO_2 and improve soil quality at the same time. Vegetables harvested from the field are sold under "COOL VEGE" eco-brand, meaning "vegetables that cool the earth". The scheme which started in Kameoka City, Kyoto in 2008, has served as a model for "Hokuso COOL VEGE" which has started in Chiba Prefecture in 2011.
32	Weather Parametric Insurance in China	R	B F	(1) (3)	Most of the high-value economic crops/livestock are not covered in public agriculture insurance though climate

	Submitter: Japan (Swiss Reinsurance Company Ltd)		I	(4)	change has brought increased agriculture loss. By introducing weather index based insurance, farmers are able to get quick payment after extreme weather events, and recover.
33	Smart sampling and Sowing failure assessment in India Submitter: Japan (Swiss Reinsurance Company Ltd)	R	B F I	(1) (3)	Swiss Re, in collaboration with local Government and insurance company in India, piloted a smart sampling technology for yield determination. International Rice Research Institute, GIZ (Germany) and SDC (Switzerland) and Swiss Re collaborates to conduct a sowing failure assessment for national yield index insurance, by using satellite sensing technology and rice crop model.
34	Introduction of solar sharing system in Chiba, Japan Submitter: Japan (Patagonia)	M	B F	(3) (4)	An agricultural solar power station (solar panel) is established in abandoned farmland. The generated electricity is used by the Patagonia company. Organic cultivation of soybean, by no-till farming has started under the panel to promote soil carbon sequestration.
35	Introduction of a recently published social experiment Submitter: Japan (Dr: Hiroki Sasaki)	A	―	(5)	A social experiment conducted to study whether a capacity building workshop are effective in permanently changing farmers behavior, using Randomized Controlled Trial (RCT) method.
36	N2O mitigation in Japanese Tea production Submitter: Japan (Shiga Pref, Japan)	M	F	(1)	With mechanization of tea cultivation, there has been increase in pruned branches being accumulated between hedges. Because nitrogen fertilizer is applied over those pruning remains, N absorption by the root is reduced, and nitrous oxide emission is increased. As a countermeasure, Below-crown fertilization technique was developed, and introduced and disseminated together with a technique to return the pruned branches to soil, which is effective in carbon sequestration in tea fields. By adopting these techniques, farmers can benefit by reduced amount of N fertilizer.

37	Dam in the Paddies Submitter: Japan (NARO, Niigata University)	A	P B F	(1) (3) (4)	Agriculture adaptation measure to reduce flood damage because the Intensity and frequency of flood damage in lowland areas is increasing due to climate change. A paddy flood management device called "Rice paddy dam" is installed in rice paddies Iwamisawa City of Hokkaido in 2018, using public direct payment. By this device, rain water is temporarily stored in the paddy and gradually drained. Research organizations provide technical basis and impact assessment.
38	A social experiment for collective auction to encourage farmers to reduce the use of irrigation water collectively Submitter: Japan (Dr. Mikitaro Shobayashi)	A	F	(1) (4)	A social experiment carried out to identify issues associated with promoting "collective auction" to farmers. The study provides empirical evidence that use of pre-existing local communities' abilities to organize collective actions can reduce transaction costs for establishing a competitive environment to prevent possible collusion, thus facilitating compatibility between cost-effective conservation owing to auction and local resource conservation by collective action.

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