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Koronivia joint work on agriculture

Improved nutrient use and manure management towards sustainable and resilient agricultural systems

Workshop report by the secretariat

Summary

The in-session workshop on improved nutrient use and manure management towards sustainable and resilient agricultural systems was held in conjunction with the fifty-first sessions of the subsidiary bodies. Experts from Parties, international organizations, the private sector, research organizations, civil society and constituted bodies under the Convention as well as farmers presented key opportunities and challenges and engaged in in-depth discussion on the potential and co-benefits of nutrient use and manure management, including on synergies and trade-offs in relation to addressing other pollution resulting from these activities. The workshop provided the opportunity to begin discussing options for increasing synergy and collaboration among stakeholders, while highlighting that farmers must be at the centre of all discussions and decision-making on climate change, agriculture, nutrient use and manure management.

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Contents

Abbreviations and acronyms

AF	Adaptation Fund
COP	Conference of the Parties
EU	European Union
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	greenhouse gas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
KJWA	Koronivia joint work on agriculture
NDC	nationally determined contribution
NGO	non-governmental organization
SB	sessions of the subsidiary bodies
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SRCCL	Intergovernmental Panel on Climate Change Special Report on Climate Change and Land

I. Introduction

A. Mandate

1. The COP requested the SBI and the SBSTA to jointly address issues related to agriculture, including through workshops and expert meetings, working with constituted bodies under the Convention and taking into consideration the vulnerabilities of agriculture to climate change and approaches to addressing food security.[1]

2. The SBI and the SBSTA requested the secretariat, subject to the availability of supplementary resources, to organize six workshops between December 2018 and June 2020 under the KJWA,[2] as outlined in the Koronivia road map.[3] They encouraged admitted observers to participate in these workshops.

3. The SBI and the SBSTA requested the secretariat to organize the fourth workshop in conjunction with SB 51 on the subject of improved nutrient use and manure management towards sustainable and resilient agricultural systems. They also requested the secretariat to prepare a report on the workshop for their consideration at SB 52.[4] They further requested the secretariat to invite representatives of the constituted bodies to contribute to the work and attend the workshops.[5]

4. The SBI and the SBSTA invited Parties and observers to submit via the submission portal[6] their views on the subject of the workshop referred to in paragraph 3 above.[7] They took note of the importance of issues, including but not limited to farmers, gender, youth, local communities and indigenous peoples, and encouraged Parties to take them into consideration when making submissions and during the KJWA workshops.[8]

B. Possible action by the Subsidiary Body for Implementation and the Subsidiary Body for Scientific and Technological Advice

5. The SBI and the SBSTA may wish to consider this report at SB 52 when reviewing the KJWA and preparing a report to COP 26 (November 2020) on the progress and outcomes of the work, including on potential future topics.[9]

II. Proceedings

6. The workshop referred to in paragraph 3 above was organized by the secretariat and held in Madrid on 3 and 4 December 2019. It was open to all Parties and observers attending SB 51.

7. On behalf of the SBI and SBSTA Chairs, the SBSTA Rapporteur, Stella Gama (Malawi), delivered opening remarks and detailed the mandate and objectives of the workshop. She invited Monika Figaj (Poland) and Milagros Sandoval (Peru) to co-facilitate the workshop.

8. The workshop was organized in four sessions:

(a) Country presentations;

[1] Decision 4/CP.23, para. 1.
[2] FCCC/SBI/2018/9, para. 39, and FCCC/SBSTA/2018/4, para. 61.
[3] FCCC/SBI/2018/9, annex I, and FCCC/SBSTA/2018/4, annex I.
[4] FCCC/SBI/2018/9, para. 41, and FCCC/SBSTA/2018/4, para. 63.
[5] FCCC/SBI/2018/9, para. 42, and FCCC/SBSTA/2018/4, para. 64.
[6] https://www4.unfccc.int/sites/submissionsstaging/Pages/Home.aspx.
[7] FCCC/SBI/2018/9, para. 43, and FCCC/SBSTA/2018/4, para. 65.
[8] FCCC/SBI/2018/9, para. 40, and FCCC/SBSTA/2018/4, para. 62.
[9] As mandated in decision 4/CP.23, para. 4.

(b) Presentations on work undertaken by financing entities;

(c) Expert panel discussion;

(d) Plenary discussion.

9. Further information on the workshop, including the agenda, presentations and names of speakers, is available on the UNFCCC website.[10]

III. Summary of presentations

A. Keynote presentations

10. A scientist[11] gave a keynote presentation on the role of nutrient management in agriculture in addressing climate change and related co-benefits. He emphasized that action to address nitrous oxide emissions is essential in order to reach the 1.5 °C goal, requiring system-wide improvement in nitrogen use efficiency. He presented studies that show that nitrogen pollution results in damage costing at least EUR 70 billion/year in the EU alone. Thus, addressing nitrous oxide emissions would offer co-benefits for air, soil and water quality as well as for biodiversity and the ozone layer. He identified 10 key actions for improving nitrogen management, including in relation to agriculture, transport, industry and waste management as well as to societal consumption patterns.

11. The scientist emphasized the need to develop the capability to measure the full nitrogen flux in order to improve nutrient management. Spatial optimization would be important for this, as nitrogen systems may work differently across regions and land uses, and in particular in the case of significant regional imbalances, with some regions experiencing a nutrient surplus and others a nutrient shortage. Nutrient management systems may not react linearly to management interventions. He added that it would be important to consider trade-offs, for example when a management action may improve air quality but reduce water quality.

12. The scientist identified policy fragmentation as a reason for the limited progress in addressing issues relating to nitrogen and phosphorous. He presented some of the goals of the Colombo Declaration on Sustainable Nitrogen Management, which builds on the sustainable nitrogen management resolution that was adopted at the fourth session of the United Nations Environment Assembly. One activity under the Declaration is establishing an inter-convention nitrogen coordination mechanism and secretariat to facilitate communication and coherence in relation to different nitrogen policies, in accordance with the mandates of existing relevant conventions and multilateral environmental agreements. The Declaration states that countries should consider, in line with their national circumstances and where relevant, developing national road maps for sustainable nitrogen management, with the aim of halving nitrogen waste by 2030. The Declaration also states that countries should consider promoting innovative anthropogenic nitrogen use and recycling, emphasizing opportunities for circular economy.

13. An expert[12] from the Food and Agriculture Organization of the United Nations gave another keynote presentation, on improved manure management towards sustainable agrifood systems. He explained the effect of feed on the amount of manure and related emissions produced by various farmed animals; for example, 120 Mt nitrogen in animal feed results in 99.5 Mt nitrogen in manure. The challenge of manure management is increasing because of the continued rise in demand for animal source foods, which has been seen to lead to the rapid and poorly regulated intensification of livestock production. The geographical separation of production units from feed resources results in natural nutrient cycles being broken, which increases the challenges faced as the size and geographical concentration of

[10] https://unfccc.int/event/improved-nutrient-use-and-manure-management-towards-sustainable-and-resilient-agricultural-systems.

[11] Mark Sutton.

[12] Henning Steinfeld.

intensive production units result in large quantities of manure that far exceed the absorptive capacity of the surrounding land.

14. Poor manure management results in the loss and waste of nutrients and energy from the manure management system, leading to opportunity costs as a result of inefficiency and negative effects on GHG balance, ecosystems, and air, soil and water quality. Such effects threatening ecosystem health and biodiversity include the contribution of ammonia gas from manure to acidification, and that of nutrients such as ammonium hydroxide to eutrophication and aquatic toxicity in water bodies. Also, the GHGs emitted as a result of poor manure management contribute to climate change. It was mentioned that the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* contains improved guidance and emission factors for estimating emissions from manure management.

15. The expert concluded that manure management presents a clear opportunity for climate action, but the technical options available must be adapted to provide local and integrated solutions. Activities to improve manure management include improving livestock feeding, using dietary ingredients and feed additives, covering slurry stores, applying appropriate timing and methods of manure application to crops and pasture, extracting biogas, and recycling manure as organic fertilizer. These activities could not only help to reduce emissions but also bring co-benefits for soil health and productivity, water quality, biodiversity, odour reduction, food security and resilience, energy efficiency and human health. Another important measure is spatial planning taking into account feed and land availability, in particular where livestock numbers are increasing. Barriers to these actions could include existing regulations, which often do not facilitate efficient manure management, and the economic feasibility of solutions, requiring stronger efforts to establish an enabling environment and governance partnerships. The expert emphasized the importance of avoiding disadvantageous trade-offs and shifts of burden, such as increasing the emissions of one GHG when decreasing the emissions of another, or shifting burdens from one impact domain to another.

B. Country presentations

16. Five country representatives made presentations, in which they responded to the following questions:

(a) What are your countries' national experiences with improving nutrient use and manure management towards sustainable and resilient agricultural systems?

(b) How did your country address co-benefits and synergies with multiple objectives when improving nutrient use and manure management?

(c) How did your country set goals and measure progress in improving nutrient use and manure management?

(d) Which challenges did your country face in improving nutrient use and manure management, and how can the KJWA and UNFCCC constituted bodies help to address these challenges?

17. A representative of Chile described the country's national agricultural production systems and efforts to reduce emissions and to report them in the national GHG inventory. The agriculture sector accounts for about 11 per cent of its national GHG emissions and Chile is aiming to be carbon neutral by 2050. Activities in the agriculture sector were initially focused on adaptation, but it was recognized over time that many adaptation measures have co-benefits for climate change mitigation and that integrated policies are required at the national level. Chile has recognized co-benefits of improving nutrient use efficiency, such as reduced environmental impact, improved community perception of agriculture, direct economic benefits thanks to cost reduction, and new business and development opportunities. The presenter highlighted the need for further research on improved manure management, in particular on key drivers of GHG emissions, mitigation options and developing updated emission factors. Another challenge is scaling up local research results to guide decision-making at the regional and national level, whereby international collaboration is essential for knowledge exchange and capacity-building, including integrating knowledge from

developed and developing countries and contributing research outcomes to the work of the IPCC.

18. A representative presented the EU's approach to improving nutrient use and manure management towards sustainable and resilient agricultural systems. Policy guidance is included in the EU Common Agricultural Policy, which allows for adaptation to local conditions and for development over time as it is reviewed every seven years. The EU Common Agricultural Policy has nine objectives, including action on climate change, environmental care and increasing competitiveness. It also supports research and innovation, such as through development of the Farm Sustainability Tool for Nutrients to achieve better agricultural output at lower cost by making full use of innovation, digitalization and modernization. In addition, agriculture was to be considered in developing the European Green Deal, including in relation to the mitigation potential of improved nutrient use and manure management.

19. A representative of Ghana described challenges in nutrient use and manure management in his country and in Africa in general. A key challenge identified by him is the low use of fertilizer in Africa (at an average 16 kg/ha compared with over 100 kg/ha in most other regions), which is due, among other reasons, to the cost of fertilizer in Africa, which can be as much as four times more expensive than in Europe because of high transportation costs. As a result of political action such as the Abuja Declaration on Fertilizer for an African Green Revolution, which was adopted in 2006, and related fertilizer subsidy programmes, average fertilizer use increased from 8 to 16 kg/ha by 2015, but did not reach the Declaration's goal of 50 kg/ha. The representative also gave examples of several research results that show that integrated use of fertilizer and manure leads to the highest crop yields and minimizes land degradation and GHG emissions. Integrated plant nutrient management in Ghana would require increasing the percentage of manure applied to soils and reducing the cost of fertilizer, by both significantly increasing production of fertilizer within the region and reducing transportation costs.

20. A representative of Indonesia highlighted the challenges of improving nutrient use and manure management in a country with a large variety of agricultural systems, involving both traditional and modern management systems, a wide range of farm sizes and biophysical conditions, farmers from diverse backgrounds and a geographical distribution across almost 7,000 subdistricts. To address these challenges, Indonesia promotes balanced fertilization and site-specific implementation of recommendations, for example by providing soil test kits that allow laboratory analysis of soil nutrients in the field to ensure that appropriate fertilizers can be recommended. Indonesia develops and updates information tools for farmers, such as an online integrated cropping calendar, which has evolved into a fertilizer and crop variety recommendation package. While Indonesia's goals are to ensure food security and increase farmers' incomes through adaptation measures, it recognizes several co-benefits of improved nutrient use and manure management, such as lower GHG emissions, reduced eutrophication and water pollution, and increased soil carbon stocks and soil biota diversity. The representative explained that increasing the speed and scale of improved nutrient use and manure management will require means of implementation, in particular capacity-building for farmers, regional pilot projects for developing and evaluating improved nutrient use and manure management, and technology exchange, including through South–South cooperation.

21. A representative of Japan presented her country's experience with improving nutrient use and manure management towards sustainable and resilient agricultural systems. She emphasized that the total global warming potential of an activity on the basis of emissions of all GHGs needs to be estimated and analysed, as activities that lead to increased soil carbon sequestration may also lead to increased methane and nitrous oxide emissions, in particular in rice paddies, and additional scientific research is required in this area. She highlighted practical uses of biological nitrogen inhibition, an active plant-mediated natural function, where nitrification inhibitory substances released from plant roots suppress the soil-nitrifying process. Japan is investigating the possibility of automating operations by using advanced technologies, such as robot tractors and a water management system operated by smartphones, which would enable businesses to be scaled up. All these developments require communicating the science involved to the users and beneficiaries of the technologies, in particular to farmers, who bear the operational risk when installing new equipment and

machinery. Farmers should therefore be at the centre of addressing climate change and are key to scaling up proven solutions, while multi-stakeholder exchanges are fundamental to inclusive decision-making and successful adoption of action on the ground.

C. Presentations on work undertaken by financing entities

22. Four experts made presentations on the work of their respective body or organization, guided by the following questions:

(a) What work is your body or organization undertaking to improve nutrient use and manure management towards sustainable and resilient agricultural systems?

(b) How does your body or organization address co-benefits and synergies with multiple objectives when improving nutrient use and manure management?

(c) How does your body or organization set goals and measure progress in improving nutrient use and manure management?

(d) Which challenges did your body or organization face in improving nutrient use and manure management, and how could the KJWA, UNFCCC constituted bodies or other actors help to address these challenges?

23. A representative of the World Bank emphasized that the global efficiency of nutrients added to soils through organic and synthetic fertilizers is only about 50 per cent. Improved nutrient efficiency through better fertilizer application, manure management and nutrient recycling would contribute to increasing the productivity of low-input systems and reducing the emission intensity of high-input systems. This could lead to an increase in production by up to 70 per cent for most crops and make a significant contribution to closing global yield gaps, while reducing emissions by 0.71 gigatonnes of carbon dioxide equivalent annually. Although management practices proven to increase nutrient efficiency exist, more work is needed to enable their implementation at scale, such as by increasing public awareness and technical assistance; prioritizing nutrient use and manure management in NDCs; realigning public and private support for improving nutrient use and manure management; improving the quality of data on soils; and standardizing low-cost monitoring, reporting and verification of nutrient use and manure management.

24. A representative of the AF highlighted that approximately one third of the 100 AF adaptation projects cover agriculture and food security, and this share can be expected to increase owing to the importance of both agriculture and adaptation in developing countries. Specific adaptation action includes climate-smart agriculture, sustainable land management, creating an enabling environment, enhancing food security and conservation agriculture. The AF takes gender and environmental and socioeconomic benefits into consideration in its projects, especially in relation to the most vulnerable. It faces challenges such as the growing demand for adaptation funding and the difficulty of scaling up successful projects, which is not possible with the limited funding available. As the AF works on the basis of country proposals, it also encounters difficulties with projects that integrate the reduction of fertilizer use with manure management as these often require complex interactions and cross-sectoral coordination between the authorities in charge of different aspects of the project.

25. A representative explained that the GEF supports integrated solutions for achieving multiple global environmental benefits but does not have a specific mandate or resources allocated for agriculture projects. Agriculture and food security feature heavily in the climate change adaptation portfolio of the GEF, as agriculture is an important cross-cutting dimension under the conventions for which the GEF serves as a financial mechanism and countries are increasingly addressing agriculture and food security in an integrated manner. Nutrient use and manure management activities can be funded through GEF funding windows other than the climate change window. As a global financing entity with a focus on environmental results, often measured in GHG emissions mitigated or hectares of sustainable land management implemented, the GEF has a limited view of, and influence on, project activities on the ground. The GEF does not have a mandate to fully scale up these interventions, but demonstrates the applicability of approaches, both technical and financial, which can then be scaled up through other means. Finally, the representative explained that

it is easier for the GEF to provide funding for activities that are included in a country's NDC, as its analysis of a project proposal involves checking whether it aligns with COP guidance and contributes to achieving the country's NDC.

26. A representative of the GCF explained that projects relating to sustainable and resilient agricultural systems fall under two mitigation impact areas of the GCF, namely forests and land use, and energy generation and access, but under all four adaptation impact areas, namely health, food and water security; ecosystems and ecosystem services; livelihoods of people and communities; and infrastructure and built environment. About 20 per cent of the committed GCF funds are allocated to agriculture projects. About 75 per cent of projects classified as agriculture projects by the GCF are supported under the adaptation window, with most of the remaining 25 per cent supported as cross-cutting projects involving both mitigation and adaptation and very few supported solely under the mitigation window. The projects are integrated within landscapes and along value chains, include water management and climate information, and focus on impacts on livelihoods and food systems. The GCF monitors environmental and social safeguards during project implementation, for example to avoid negative environmental impacts from fertilizer use. Project success is measured in most cases by the increase in yield and income resulting from improved sustainable and resilient agricultural practices; in few cases, change in soil health, water retention and biomass, or reduction in emissions from manure management is measured, which means the manner of capturing such benefits, especially mitigation benefits, could be improved. The GCF is country-driven and aims to turn country ambition according to NDCs into climate action. Investment is typically in policy reform or implementation, innovative low-emission and resilient approaches and technologies, monitoring and evaluation methods, and measurement, reporting and verification systems. The GCF Readiness and Preparatory Support Programme provides financing for capacity-building, studies, and intersectoral and multi-stakeholder consultation, and the GCF Project Preparation Facility provides financing for data collection and analysis.

D. Presentations by expert panellists

27. The expert panel discussion entailed experts representing non-State actors responding to the following questions:

(a) What are the key challenges and barriers in achieving a transformation in agriculture that leads to improving nutrient use and manure management towards sustainable and resilient agricultural systems?

(b) How can the KJWA and UNFCCC constituted bodies or other actors help to address these challenges?

28. A smallholder farmer shared her experience on a 5 ha farm in Malawi, where she cultivates maize, beans, soy and groundnuts. In the past three years, she and other farmers in her region have experienced extreme weather events such as drought, heatwaves and severe flooding, and have faced new pests, all of which are threatening local livelihoods and food security. Women farmers in Malawi face additional challenges because they cannot own land there, their participation in decision-making processes, where they could communicate their needs, is limited and they are poorly represented in development structures in the country because of their high illiteracy level. They also lack access to agricultural public extension workers. The farmer described her experience of using hybrid seeds and chemical fertilizer, which she found to reduce resilience to climate change, in particular because chemical fertilizer depletes and hardens the soil, reducing the water available to plants and the soil microorganisms. She learned that fertilizer feeds only the crops, while switching to agroecological methods, such as integrated crop and livestock farming, makes use of compost and manure, which feed both the crops and the soil. She emphasized that the needs of smallholder farmers can best be met by promoting agroecology, redirecting fertilizer subsidies to funding training and the hiring of agricultural extension workers, empowering women farmers to own land, and providing government support for community seed banks.

29. A representative of the International Fertilizer Association, presenting on behalf of business and industry NGOs, explained that it is unrealistic to aim for zero emissions from

biologically leaky systems, and that the focus should be on optimizing nutrient uptake by plants while reducing losses to the environment. In order to improve nutrient use efficiency and reduce GHG emissions, it is important to use the right fertilizer, at the right rate, at the right time and in the right place. She noted that a benefit of fertilizers is that farmers have a concentrated, consistent and precise source of nutrients that can be transported and stored easily. Fertilizers would be particularly effective when used in combination with conservation practices, and therefore crop- and site-specific best management practices should be considered under the KJWA, such as integrated plant nutrient management, balanced fertilization, site-specific nutrient management and 'fertigation' (combining fertilizer with irrigation water). The representative added that there are studies that show that mineral fertilizer does not deplete soils.

30. A representative of environmental NGOs highlighted the relevance of the finding contained in the SRCCL[13] that nitrous oxide is increasingly accumulating in the atmosphere, driven primarily by the increase in manure production and synthetic nitrogen fertilizer use since the mid-twentieth century. She added that synthetic fertilizers have a higher GHG emission factor than organic fertilizers and require energy for their production. Furthermore, fertilizer use can lead to air and water pollution, affecting biodiversity and health. IPBES identified fertilizer as the main cause of 400 dead zones (low-oxygen areas) in the ocean covering an area larger than the United Kingdom of Great Britain and Northern Ireland.[14] The volatility of fertilizer prices may increase in line with uncertainty over fossil fuel prices, which may also increase the vulnerability of farmers. The representative emphasized that the adoption of agroecological practices, for example crop rotation with diversified nitrogen-fixing leguminous plants or system approaches that integrate sustainable livestock and mixed crops, should be promoted through adaptation strategies, national adaptation plans, NDCs and farmer extension services. Funds could be reallocated for the agroecological transition by ending subsidies for synthetic fertilizer and fossil fuel projects. She suggested that countries should consider environmental taxation of damage caused by synthetic fertilizer and incentivizing a shift in diet while making sure to consider biodiversity and social dimensions in evaluating agricultural data.

31. A farmer from South Africa and one from Chile, representing farmers and agricultural NGOs, provided an overview of their farming using agroecological practices. The farmer from South Africa is engaging in mixed farming with livestock and crops, and recently added vegetables and beehives for pollination to her farm. The farmer from Chile integrates sheep, grassland, walnut trees and leguminous plants in an agroforestry system. Both emphasized the value of manure for improved nutrient cycling and soil health, reducing the need for expensive inputs. They explained the use of cover crops of legumes and gramineous plants, which produce plenty of biomass, fix nitrogen in the soil, increase soil organic matter, stimulate biological activity in the soil and create a healthy rhizosphere. Healthy soils can produce healthy crops. It was stressed that, although farmers are part of the solution to climate change, organic farming is a very complex science that requires good extension services and adequate research for providing balanced advice to farmers, and there should be opportunities for farmers to learn from farmers. The farmers concluded that investing in farmers, especially young and women farmers, would enhance rural communities and food security while also benefiting the climate.

32. A representative of indigenous peoples organizations emphasized the need for holistic perspectives to be shared, including discussing agriculture and climate change in the context of achieving the Sustainable Development Goals. Traditional techniques and the knowledge of indigenous peoples used over thousands of years have helped in creating the varieties of crops such as rice, maize and potato used today while also helping to preserve the health of the land. The value of learning from each other was emphasized, such as from the attitude

[13] IPCC. 2019. *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems.* PR Shukla, J Skea, E Calvo Buendia, et al. (eds.). Available at https://www.ipcc.ch/report/srccl/.

[14] IPBES. 2019. *Status and trends – drivers of change. Chapter 2.1 of the global assessment report on biodiversity and ecosystem services* (unedited draft version). Bonn: IPBES secretariat. Available at https://ipbes.net/global-assessment.

that indigenous peoples have towards their land and environment and how they produce food. Indigenous peoples need to be involved in efforts to combat climate change.

33. A representative of Colorado State University on behalf of research and independent NGOs identified three action areas in relation to the fundamental challenge of nitrogen management in agricultural systems:

(a) The emphasis on precision nitrogen input management does not take into account all aspects of nitrogen management, as recent research shows that up to 60 per cent of nitrogen uptake comes from sources other than the current year's fertilizer input. A multi-year perspective is required with a view to expanding nitrogen nutrient management frameworks and including soil nitrogen as a key crop nitrogen source. Soil quality frameworks should capture the higher grain uptake of macro- and micronutrients essential for livestock and human health compared with synthetic inputs;

(b) The regional concentration of livestock systems can lead to overapplication of organic amendments to cropland in those regions as a result of their high transportation costs and perverse policy incentives. Frequent rate and high volume of manure application can contribute to nitrogen loss and phosphorous loading. In contrast, infrequently applying large amounts of compost to grazing land demonstrates the potential to increase yield and soil health. Recoupling livestock input and output systems offers enormous potential for reusing nutrients from those systems towards meeting productivity goals, achieving synergies with soil carbon storage and reducing soil degradation;

(c) Robust decision-support tools are needed for measuring and quantifying progress towards nutrient use and manure management related outcomes across agricultural production contexts, such as tools for smallholders for assessing soil health, or free web-based tools that empower food suppliers and companies to quantify the impacts of current agricultural production practices and whole-farm GHG emissions, and to understand how adjusting nutrient use and manure management practices can reduce emissions in key categories.

34. A representative of the women and gender constituency presented the perspectives of those involved in small-scale family farming, in particular women farmers from local communities, a group with limited technological knowledge and access to resources, finance, investment and support for their efforts to build local resilience, food security and sustainable livelihoods. They use permaculture, traditional knowledge and agroecological farming methods and principles to sustain their families and communities. Working with nature to recycle nutrients and energy is beneficial for both gardening and farming because it saves time, energy and money, while also increasing biodiversity, fertility, production and yield. Improving soil condition requires a holistic, integrated approach. Chemical fertilizer can restore soil fertility quickly, but does not improve soil structure or organic matter, and its use and production also have other disadvantages, such as the negative impact on beneficial life in soils. The representative concluded that the KJWA should promote agroecological practices for improving nutrient use and manure management that are gender-responsive, ecosystem-based, community-driven, participatory and fully transparent approaches to climate change adaptation and resilience. The corporatization and intensification of agriculture should be avoided and improper use of heavy agrochemicals by industrial agriculture should be prohibited.

35. A representative of youth NGOs explained that nitrogen leakage from fertilizer affects not only climate change but also water and biodiversity, for example by creating dead zones in the sea. The subsidizing of synthetic, rather than organic, fertilizer use has been at the expense of smallholder farmers and alternative systems, while conflict of interest makes the transition to using improved management techniques difficult. In addition, the specialization of territories has led to monocultures and dissociation of crops and livestock. Poor regulation of and facilities for manure management not only contribute to climate change and the pollution of ecosystems but also threaten human well-being. There is unequal access to resources, scientific knowledge and data, and low-intensity technologies, which particularly affects the most disadvantaged in society, such as rural women, many of whom work in agriculture. Urbanization and the decline in agricultural livelihoods are worrying, in particular the lack of youth participation and leadership in agricultural management. The

representative called for Parties to engage fully in minimizing conflict of interest and for a just transition away from the subsidized use of synthetic fertilizer. First steps would be to acknowledge the SRCCL, promote research into alternatives to the subsidized use of synthetic fertilizer, and reallocate the subsidies and incentives to areas that have proven efficient. Also important is to address social issues such as gender inequality and to establish ambitious programmes for young people to incentivize training, provide resources and promote capacity-building. To address psychological and sociocultural barriers, there is a need for collective bottom-up change through knowledge-sharing and capacity-building between farmers, especially smallholders. The representative emphasized the need for multisectoral, interdisciplinary and participatory approaches to policy and research that simultaneously address the social, climate and ecological crises by implementing systemic changes. She also stressed the importance of considering local realities and context and incorporating traditional and indigenous knowledge and practices as part of the process.

36. A representative of the IPCC presented key findings from the SRCCL. Improved nutrient use is important for both areas with high and those with low non-carbon-dioxide emissions from agriculture because it boosts productivity, restores and maintains soil health, which is key to tackling climate change, and therefore helps in maintaining a balance between land allocated to agriculture and land allocated to other ecosystems. A fundamental issue for agriculture is soil loss, currently occurring 10–100 times faster than soil formation. The solution-oriented SRCCL points out that in many parts of the world nitrogen application can be reduced with little negative effect on yield, while increasing nitrogen application in less productive systems can lead to significant gains in productivity, including the build-up of soil organic matter. Methane emissions from enteric fermentation result from inefficient use of carbon by the animal and can be reduced by improving feed quality. Meanwhile, intensification of agricultural systems increases incentives for expanding those systems across the landscape; therefore, enabling environments and governance are required to keep these economic forces under control and to reduce deforestation, which many countries identified as an aim in their NDCs. The representative recalled the reliance of the IPCC Special Report on Global Warming of 1.5 °C[15] on the expansion of bioenergy with carbon capture and storage for keeping global warming below 1.5 °C, while the SRCCL takes the discussion further by setting out the significant land trade-offs and potential food security trade-offs of energy production in monocultural bioenergy plantations.

IV. Summary of discussions and way forward

A. Summary of discussions

37. The plenary discussions were guided by three questions:

(a) How could the constituted bodies be further involved and synergies be enhanced for improving nutrient use and manure management towards sustainable and resilient agricultural systems?

(b) Which modalities would be useful for the implementation of activities for improving nutrient use and manure management towards sustainable and resilient agricultural systems?

(c) How is improving nutrient use and manure management towards sustainable and resilient agricultural systems linked to other KJWA topics, and how can synergies be achieved?

[15] IPCC. 2018. *Global Warming of 1.5 °C: An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. V Masson-Delmotte, P Zhai, H-O Pörtner, et al. (eds.). Geneva: World Meteorological Organization. Available at https://www.ipcc.ch/sr15/.

1. Practices and approaches

38. Participants agreed that emissions and other pollution result from inefficient use of nutrients, and that multiple benefits would come from all actors committing to implementing measures to avoid nutrient loss. Several practices and approaches were discussed.

39. They discussed the potential of cover crops and intercropping to reduce nitrogen loss and nitrous oxide emissions from cropland by quickly binding nutrients in plant matter. Successful implementation was considered to be site- and system-specific because, once the crop has been ploughed under and decomposes, the nutrients could also quickly be lost.

40. A participant reported on his country's use of biological nitrogen fixation with leguminous species on cropland, which is a robust technology with many environmental and socioeconomic benefits. His country is starting to develop similar approaches for grassland and sugar cane plantations. Another participant mentioned that, since research into using *Azolla* as a nitrogen-fixing companion plant had shown an accompanying accumulation of mercury, the practice was abandoned.

41. Participants discussed biochar application for enhancing soil fertility. There are many practical barriers to its implementation at scale, such as lack of information on any increase in yield or profit and therefore on its cost-effectiveness, and the low market availability of biochar. It is also important to consider other gases and emissions that may result from producing and applying biochar to soil.

42. It was discussed that using coated urea can reduce urea use and related emissions by 15–20 per cent. A representative of one country reported on the experience of implementing mandatory coating of urea. While participants agreed that GHG emissions from coated urea are lower than those from urea without coating, one suggested that the effect of coating on ammonia emissions may require further research. In discussing the impact of different climates on the use of coated urea to improve nitrogen fertilizer technology, one participant noted that the absolute baseline emissions from fertilizer use may vary according to climate, resulting in different absolute effects in terms of emission reduction, but that overall the relative benefit ratio is mostly constant, resulting in comparable relative emission reductions.

43. Many participants emphasized the need to ensure that affordable fertilizer is available to farmers in regions with nutrient deficiency. Both dependence on imported fertilizer and transport costs could be reduced by establishing local or regional fertilizer manufacturing. One participant asked the financing entities about their efforts to address the fertilizer input and knowledge needs of countries aiming to achieve yield and production goals by correctly and sustainably using mineral fertilizer and other cropping system technologies. The GCF representative responded that mineral fertilizer is not directly financed by the GCF but can be co-financed through domestic funds or agriculture finance from multilateral development banks, in particular for large-scale projects. She added that many of those projects focus on smallholder farmers in the least developed countries, small island developing States or African countries, and agroecology has been shown to effectively improve nutrient use. Meanwhile, the GEF representative noted that the GEF does not limit to the use of one technology or another in its projects but requires environmental results.

44. Several participants from African countries highlighted findings in the SRCCL, noting that agricultural production in Africa is most at risk from rising temperatures, heatwaves, more frequent drought and changing rainfall patterns because of its fragile environment and limited financial resources for adaptation. The yield of food crops has been projected to decline by 10–40 per cent in Africa by 2050 without adaptation. Soils with low fertility and low nutrient stocks, high acidity and low holding capacity for water available to plants cover large areas of Africa. Depletion of soil carbon and nutrient stocks also affects large areas of Africa, owing mainly to continuous cropping with little or no replenishment of nutrients by fertilizer, resulting in large gaps between current yields and water-limited yield potential. Therefore, increasing the use of external nutrients would be necessary in Africa to boost productivity and produce food for a growing population. One participant mentioned that African countries are currently 35 kg/ha below the target of applying 50 kg/ha fertilizer, and that it would be important to continue pursuing the agricultural agenda agreed by African Heads of State for food security and poverty-related reasons. Another participant added that

mitigation options related to nitrous oxide are limited in most African countries because of nutrient-poor soils and underuse of fertilizer.

45. Whether organic farming and using organic fertilizer would generally result in lower emissions than using synthetic fertilizer is a complex matter: nitrous oxide emissions are usually lower in organic farming systems, but methane emissions from livestock may be higher. It was emphasized that there are opportunities for all farmers to make improvements. One participant cautioned against focusing on certain terminology, as no single approach can meet the needs of all farmers; rather, an integrated package of locally adapted practices will be required to achieve productive outcomes for nutrition, production and the environment.

46. Participants acknowledged that the integration of livestock and crop production is widespread in traditional agricultural systems, including smallholdings with rubber or oil palms. One participant shared experience of integrating livestock into large plantations, although this is still in a trial phase and the area of adoption is relatively small.

47. Participants discussed how mitigation of GHG emissions from manure management through improved feed can work in extensive grazing systems. Regarding whether this would require supplementation with high-protein feed, and how that would affect productivity and manure quality, manure management depends fundamentally on feeding practices, and improving the digestibility and quality of feed with necessary protein and supplements leads to reduced inefficiencies in digestion, and therefore reduced emissions. The volume of manure would decrease, but its nutrient content would increase.

48. Participants also discussed whether fresh manure could be used as compost and a nutrient source, thereby potentially providing an additional source of income to livestock farmers. One participant noted that this can only be done if the surrounding land can absorb it, which is not the case in modern large-scale units. The concentration of livestock in preferred locations counteracts such direct nutrient cycling but this could be avoided through improved regional planning for new livestock farms that takes into account opportunities for nutrient recycling.

49. One participant noted that, in his experience, farmers are often doubtful as to whether organic resources can replace fertilizer or whether yield will still be satisfactory with reduced fertilizer use. In terms of how farmers could develop trust in such new practices and approaches, it was explained that the effect of using organic resources such as manure depends on other factors such as emissions (uncovered manure may lose nutrient content through emissions) Relevant knowledge is essential, and better availability of related tools and extension services could also be useful. One participant suggested reimagining the role of the farmer, who might no longer be just a food producer but increasingly also a provider of ecosystem services. Another participant highlighted that farmers could strengthen their influence by working in cooperatives, for example to make organic fertilizer available from multiple sources.

50. Participants discussed promoting a ‘demitarian’ diet, where meat consumption is reduced by 50 per cent, in developed countries, while recognizing that in many parts of the world people still require a much better and nutrient-richer diet. According to thought experiment, without considering any associated food waste, this could reduce the amount of land used to produce meat and the free land could then be converted to other land uses. However, it could also increase the production of grains and meat for export, limiting any potential environmental benefits. One participant found the feasibility of changing dietary systems debatable owing to the associated implementation challenges. Some participants noted the lack of comparability of different livestock systems and highlighted that some regions with grassland unsuitable for crop production have experience of low-emission livestock production systems that enhance soil carbon sequestration in grassland. Animal protein was considered essential for health, in particular for children. One participant noted that increasing efficiency of production may lead to lower prices and an increase in meat consumption.

2. Measurement and data

51. Participants acknowledged that, in many cases, upfront investment would be required to obtain better data on soils, in particular activity data for tier 2 emission estimation

approaches, which would also help countries to include specific activities related to more efficient use of fertilizer in their NDCs. A representative of farmers and agricultural NGOs added that it is crucial to have all data available at the farm level.

52. Regarding how the GCF and the GEF quantify the mitigation effect of their programmes and projects, the representatives confirmed that both request project developers to follow the IPCC guidance for GHG inventories. The majority of current GCF projects related to agriculture are in adaptation, and the measurement of mitigation effects depends on various factors, such as country priorities, the capacity of the accredited entity to measure mitigation effects, and previous related work. The GCF representative highlighted that there is space for partners to support accredited entities where quantifying mitigation benefits is a priority for the country.

53. As to whether outcomes of GCF-supported projects would be reported in national GHG inventories, and whether indicators such as soil health and water retention could also be tracked using an appropriate measurement unit, the GCF representative explained that projects that generate significant results would be expected to be captured in countries' GHG inventories, although not necessarily directly, and that capacity-building may be required for this.

54. One participant highlighted the difficulty of considering multiple benefits of projects, especially expected benefits during project planning, and the need to streamline such consideration in order to create enabling conditions for financing the efforts of farmers in the context of climate change.

3. Support

55. Participants agreed that, although agriculture is a private sector activity, it has an important public goods dimension. Individual actors alone cannot transform the global food system; systemic change is required that takes into account that all solutions are local, which is different from in other sectors. One participant presented research showing that, in the majority of cases, it was most appropriate and effective for governments to take the lead on essential actions, adding that, in his experience, the countries that had successfully reduced emissions from agriculture were those that had effective regulations in place.

56. The GCF representative clarified that the GCF will only finance projects where evidence of climate benefits is provided. She added that development benefits are not a problem, and that the GCF uses sustainable development criteria. One participant highlighted that it can be difficult to differentiate between climate and development benefits, particularly in the case of climate benefits related to adaptation.

57. The representatives clarified that the financing entities do not allocate funding on a sectoral basis. Nevertheless, about one third of AF funding goes to the agriculture sector, which is a relatively high proportion given that agriculture is one of 10 sectors.

58. Requested to explain the balance, which should be 50 per cent each, between mitigation and adaptation funding provided by the GCF, the representative confirmed that in nominal terms more GCF funding is allocated to mitigation, but this includes financing instruments other than grants, which are more commonly used for mitigation projects. Adaptation accounts for a slightly higher share of GCF funding when comparing mitigation and adaptation funding in grant-equivalent terms.

59. Participants discussed the lack of funding security of financing entities, in particular the AF and the GEF. The representative of the AF noted that the clean development mechanism share of proceeds under the Kyoto Protocol would not necessarily be replaced directly by a share of proceeds under the mechanisms under Article 6 of the Paris Agreement (the negotiations on this matter are ongoing). Voluntary pledges from Parties have become more important. Acknowledging the slight decrease in funding available to the GEF, the representative added that efforts are being made to increase the effectiveness of funding by using integrated approaches and working with partners.

60. A representative of a group of Parties considered the requirement for co-financing under the GEF to be of particular concern, as it contributes to the number of prerequisites that are difficult to fulfil, in particular in the area of agriculture and food security. Countries

face challenges in aligning their agriculture projects with the rules of the financing entities, which each fund different types of project with different requirements, time frames and on different scales, with the GEF covering agriculture only indirectly when the project aligns with one of the GEF impact programs or focal areas. Concerning whether financing entities are making the most of the current agriculture strategy preparations of the GCF to explore whether they would also benefit from establishing an agriculture strategy and how they could coordinate such efforts with the GCF, the representatives of financing entities responded that there is regular dialogue between the AF, the GCF and the GEF on priorities. They noted that they work on the basis of proposals received from countries and underlined that country focal points must work together to develop project ideas that align with the funding priorities of the three financing entities, in particular where a country has a different national focal point for each financing entity. Countries can receive support for this type of work, for example through the GCF Readiness and Preparatory Support Programme or from organizations such as the NDC Partnership.

61. As to whether there were any impact studies on post-project sustainability of interventions with farmers or on the replication of project models as part of a country's public policy, the AF representative explained that agriculture projects usually have a component of awareness-raising, and that demonstrating the outcomes of projects successfully implemented on the ground can help policymakers to disseminate such practices and policies through a strong enabling environment and to other regions. The GCF representative pointed out that any available results of most GCF projects would be from their midterm evaluation as that is as far as they had advanced so far.

62. Asked for examples of successful project scale-up, and which organization was involved, the AF representative responded that the funds complement each other and that several AF projects had been taken up by the GCF. According to the representative, the GEF is making efforts to analyse systematically how projects can be supported by partners, including by the private sector, and moved from GEF focal areas to focusing on integration and transformation of economic systems. The GCF representative added that the GCF is aiming to implement transformative projects and programmes.

63. A representative of the World Bank explained that financing entities try to leverage best practices in countries on the basis of the latest data available, including by redirecting government subsidies, which are often not used effectively. The World Bank provides annual finance of around USD 7 billion for agriculture, but systemic change will not be achieved as long as governments continue to provide about USD 700 billion annually in largely ineffective subsidies. Ideally, such public support should be repurposed towards implementing more sustainable agriculture and reducing poverty, which could potentially be rewarded by climate finance where climate benefits are achieved.

4. Cooperation and partnerships

64. Several participants highlighted the value of the KJWA in creating an opportunity for countries to learn from each other on matters related to agriculture and climate change. Although solutions need to be local, emphasis was placed on sharing experience across regions, as this could lead to sharing solutions that can be used in other parts of the world. For example, the management and technology options for agriculture on nutrient-poor soils may be useful in regions that have similar soils but different socioeconomic, political, environmental or climatic conditions.

65. The International Nitrogen Management System was introduced, the aim of which is to bring together the scientific community, the private sector and civil society to gather and synthesize evidence that can support international policy development to improve global nitrogen management. It also brings together various technologies used in different climates, while closely considering policy in order to understand barriers to change. Given the multidimensional problems arising from nitrogen pollution, the System is also contributing to the development of an inter-convention nitrogen coordination mechanism with the aim of enhancing the consistency of nitrogen management guidance developed in different international contexts.

B. Way forward

66. Participants noted that crop- and site-specific best management practices for improving nutrient use and manure management should be considered in addressing agriculture and climate change. Loss and waste of nitrogen due to inefficiency need to be reduced, not only because the resulting emissions contribute to climate change, but also because nitrogen inputs are costly and such reduction could have significant co-benefits for air, soil and water quality as well as for biodiversity and the ozone layer. It was recognized that this would not be feasible in all regions and agricultural systems, such as where productivity is low because of nutrient-poor soils and underuse of fertilizer. In such situations, improving nutrient use and manure management could lead to a significant increase in production. Several participants emphasized that the overall effect (taking into account all GHGs and emissions sources) of any intervention needs to be considered in order to avoid disadvantageous trade-offs and shifts of burden. A key intervention would be preventing soil degradation.

67. Participants recognized that work under the KJWA can help to raise ambition in relation to food security and agriculture. However, many participants, including the representatives of financing entities, emphasized that the main constraint is the limited availability of resources. This is particularly important due to the increasing demand for adaptation support and urgent need to increase mitigation efforts, as identified by the IPCC in its reports, both of which will require funding and the effectiveness of that funding to be increased through integrated approaches and effective partnerships. It was suggested that the KJWA could contribute to the development of the agricultural strategies of financing entities, such as that currently being developed by the GCF. Capacity-building may also be required for improving nutrient use and manure management, which could potentially be developed by technical agencies and include guidance on including nutrient management aspects in NDCs, which were seen as a key tool for coordinating activities at the national level and accessing climate finance. Better availability of related tools and extension services could also be beneficial.

68. Participants emphasized that the KJWA could be advanced by connecting science to the broader community and relevant policy processes. Key challenges are making practices transferable and scaling up local research results to guide decision-making at the regional and national level. The KJWA is considered an essential tool for international collaboration, enabling knowledge exchange and capacity-building, including the integration of knowledge from developed and developing countries and contributing research outcomes to the global scientific community, in particular to the IPCC. Another area of work is developing and improving tools and methodologies for the measurement, reporting and verification of nutrient use and manure management. Of particular interest is the cost-effective measurement of the multiple benefits of projects, as many adaptation measures have co-benefits in climate change mitigation and other areas, and vice versa.