Submission by the North America Climate Smart Agriculture Alliance

In Response to Decision 4/CP.23

Koronivia Joint Work on Agriculture

Topic 2(d)

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

September 26, 2019

The North America Climate Smart Agriculture Alliance welcomes the opportunity to submit its views and recommendations regarding topic 2(d) “Improved nutrient use and manure management towards sustainable and resilient agricultural systems” under the Koronivia Joint Work on Agriculture.

The North America Climate Smart Agriculture Alliance (NACSAA) is a farmer-led platform for inspiring, educating, and equipping agricultural partners to innovate effective local adaptations that sustain productivity, enhance climate resilience, and contribute to the local and global goals for sustainable development. NACSAA reflects and embraces all scales of agriculture in Canada, Mexico and the United States, ranging from small landholders to midsize and large-scale producers. NACSAA encourages the use of climate smart agriculture (CSA) practices to enhance the adaptive capacity of North American agriculture to changing climate conditions, and works to achieve this goal through three complementary strategies: 1) sustainably increasing agricultural productivity and livelihoods (i.e. sustainable intensification); 2) enhancing adaptive capacity and improving resilience; and 3) delivering ecosystem services, sequestering carbon, and reducing and/or avoiding greenhouse gas emissions.

Climate change will have profound negative impacts on agricultural systems across the globe. While some regions will experience disruptions requiring transformational change in what and how food is produced, all continents and regions will experience food and nutrition security challenges. At the same time these challenges create new opportunities for agricultural landscapes to deliver high value climate change and other ecosystem services. With the right enabling policies, technical support and market signals, farmers can sustainably increase agricultural productivity and livelihoods; enhance adaptive capacity and improve resilience; and simultaneously deliver ecosystem services, sequester carbon, and reduce and/or avoid greenhouse gas emissions. Efforts such as these should be encouraged and supported in all regions of the world, and we welcome the opportunity to contribute to the ongoing Koronivia Joint Work on Agriculture.

Guiding Principles for KJWA

As we have previously recommended, the Koronivia Joint Work on Agriculture must be shaped by guiding principles that establish a framework for expected behavior and decision-making. NACSAA recommends that the following guiding principles be embraced and used in the formation of the KJWA:

- As affirmed in the communique from the 8th Meeting of G20 Agricultural Chief Scientists (MACS), science-based decision making should be the foundation for the adoption of climate smart technologies and practices for sustainable agriculture and global food production[1].
- Production and production efficiency per unit of land must increase going forward to meet the food needs of the future while incurring no net environmental cost[2,3].
- As reflected in the Sustainable Development Goals (SDGs) of the United Nations, outcomes (rather than means) applicable to any scale of enterprise must be emphasized, without predetermining technologies, production type or design components[3].
- Adaptation strategies must be recognized to require system approaches[4] that utilize a combination of improved efficiency, substitution (e.g. new crop varieties and breeds), and redesign/system transformation to reflexively respond to continuous short- and long-term changes in climate's impacts on cultivated and natural ecosystem conditions.
- Peer reviewed academic, business and farmer climate smart agriculture research and knowledge sharing recommendations outside of the UNFCCC should be considered by the SBI and SBSTA and integrated into the final KJWA report.
- There is no silver bullet solution for enhancing the resilience of agriculture: KJWA must embrace a systems approach that recognizes the tremendous diversity of agricultural landscapes and ecosystems and enables producers to utilize the systems and practices that best support their farming operations.
- Farmers must be at the center of all discussions and decision-making; significant input will be needed from a wide range of agricultural stakeholders, including technical agricultural experts drawn from farmer organizations, academia, industry, and international and regional organizations, especially those outside of the UNFCCC structure.
- Context-specific priorities and solutions must be aligned with national policies and priorities, be determined based on the social, economic, and environmental conditions at site (including the diversity in type and scale of agricultural activity), and be subject to evaluation of potential synergies, tradeoffs, and net benefits[5].

Nutrient Use and Management

Agricultural productivity for several major crops in the United States has doubled since 1980 through agricultural intensification and adoption of new, innovative technologies[6]. With 40-60% of global food production attributable to fertilizer[7], the necessity of intensification creates nutrient loss challenges and complexities to be addressed with the creative application of co-beneficial input systems[8]. In order to sustainably meet the corresponding increased demand for food, feed, and fiber, agricultural productivity must focus on increased efficiency and decreased environmental losses. Within the U.S., as crop productivity has increased, fertilizer use efficiency has also increased[9]. These increases have been achieved through the adoption of improved agricultural technology, including crop breeding advancements, the availability of pesticides, innovations in farm machinery design, and precision agricultural methods[10].

Greater concentrations of nutrients can be present in areas where agriculture is a significant land use and soil fertility is needed for food production. Whether from organic or commercial fertilizers, nutrient losses can impact both air and water quality and contribute to nitrous oxide (N_2O) loss. Improving nutrient use efficiency of both nitrogen (N) and phosphorus (P) can have positive impacts for both agriculture and the environment. Increased rainfall frequency and intensity as a result of climate change has the potential to increase N and P loss in agricultural systems, creating an even greater need to focus on improving nutrient use efficiency in conjunction with optimized productivity. To better manage environmental losses from the use of both organic and commercial fertilizers, it has become increasingly clear that there is no single solution, technology, or action that in and of itself leads to agronomically and environmentally optimized nutrient management. Instead, it is through the combined effects of 4R Nutrient Stewardship, in coordination with new innovations, whole cropping system management and other sound soil and water conservation practices, that the greatest gains in improved crop and soil nutrient recovery and environmental loss reduction will occur[11].

4R Nutrient Stewardship to improve nutrient use is defined as applying the right nutrient source (either organic or commercial fertilizers) at the right rate, the right time and in the right place. This strategy can have positive impacts on crop yields, farmer profitability, soil fertility, and system productivity (e.g., soil organic matter and soil organic N). Regarding N which is linked to the greenhouse gas (GHG) N_2O, reductions in losses of N to the environment via reduced ammonia volatilization, reduced leaching/drainage/runoff losses of nitrate-N (NO_3-N) and reduced gaseous emissions of nitrous oxide (N_2O) and di-nitrogen (N_2) from wet or waterlogged/saturated soils can be achieved[12].

Numerous adaptation strategies are available to cope with adverse impacts of climate change in agriculture. Relative to improving nutrient use to reduce N_2O emissions, the 2018 Fourth National U.S. Climate Assessment[13] notes strategies could include altering what is produced in a region, modifying the inputs used for production, adopting new technologies, and adjusting management strategies. Specifically, crop management strategies to reduce emissions should include selection of crop varieties/species that are adapted to changes in growing degree days and changes in requirements for fertilizer rates, timing, and placement to match plant requirements (or in other words, 4R Nutrient Stewardship). Adaptation strategies also include changes in crop rotation, cover crops, and irrigation management.

Agricultural intensification reduces the need for land clearing to meet a growing demand on the food supply. Investments towards sustainable agricultural intensification to improve crop yields per unit of existing land area should be at the forefront globally. Increasing nutrient use efficiency (NUE) is a key component of sustainable agricultural intensification[11]. While the highest NUE can be achieved by utilizing the lowest quantity of nutrient input, that approach would significantly restrict productivity in the food supply. The greatest challenge is therefore to improve the NUE to achieve reduced N_2O emissions while also achieving greater nutrient use effectiveness in crop and livestock production. The 4R Nutrient Stewardship approach to nutrient use places significant emphasis on the ability of suites of 4R practices to optimize the selection and application of nutrients resulting in improved NUE, crop productivity and soil health[11].

NACSAA encourages policymakers to take into consideration their countries' specificities in terms of soils, crops and climate, and to tailor their plant nutrient recommendations according to these. Site-specific nutrient management based on the 4Rs, including a balanced use of all essential crop nutrients is key to achieve sustainable and resilient agricultural systems, as it allows to match the nutrient supply with crop requirements, minimizing losses to the environment while optimizing yields.

Managing Animal Manure to Help Mitigate the Effects of Climate Change

An important strategy for addressing and mitigating the impacts of changing climates resides in the management of animal manure and its components. The elements of the contribution are numerous and interactive, intersecting with virtually every aspect of the role of agriculture in general – and animal agriculture specifically – in mitigating changing climates and the production of food. It is important to consider animal manure not as a waste product, but as a resource and contributor to solutions for changing climates.

The USDA Natural Resource Service's Field Office Technical Guides, handbooks and planning design tools are valuable resources that include practice standards and specifications for manure and nutrient management[14]. NACSAA recommends that these resources be included among the tools in the KJWA resource library.

A. Manure emanating from pasture raised ruminants and open lot raised pigs and poultry:

- Virtually all species of food animals consume diets that are partially or entirely made up of ingredients that are either human inedible or unacceptable with undigested, incompletely utilized or end products of metabolism excreted as manure (here referred to as fecal and urinary components). These ingredients may change with climate and growing conditions, but they will remain incredibly valuable in the solutions to changing climatic conditions and feeding an increasing world population[15,16,17,18,19,20,21].

- Ruminants are especially unique (others to a lesser degree) in that their microbially dominant digestive system can utilize cellulose and hemicellulose energy sources, enabling them to utilize grasslands for grazing (in the U.S., at about 3.1 million sq. mi.), predominantly unsuited for tillage[1616,17].

- Manure produced during grazing/non-confinement vegetative space, under best management practices, is immediately distributed consistent with the grazing patterns of animals, and thus in proximity to the growing plants and their nutrient needs[166,22,23]. Also, the urine that is produced is immediately incorporated into the soil, reducing the chance for loss of critical nutrients such as nitrogen and other soluble nutrients[188,222,24]. In grazing areas that can be traversed by devices to spread and further distribute dropped solid manure, the impact is even greater, and in grass-fed systems it helps maintain healthy productive grasslands that sequester carbon.

- Manure produced by all species must be used as efficiently as possible to supply plant nutrients to produce food or feed for both humans and animals as a routine practice, and grazing animals will continue to contribute. This is also extremely important in organic food production of all types, and in many organic operations is a deciding factor on whether or not the operation is viable. Improved manure nutrient conservation using new and/or existing technologies is essential[25,26,27,28].

- Manure management to contain or prevent discharge of nutrients from production systems that use open lots or grazing areas plus feedlots for cattle (open pig or poultry production lots usually have little or no vegetation) is important regardless of location or climate change. Relocation based on changing climates may be necessary, and will allow and possibly require adaptation of new technologies [244,255,277,288].

- Animal agriculture contributes to sustainable/renewable energy production by recovering energy from (and reusing) animal manure and other organic wastes resulting from livestock production/processing; it is important for all types of production systems. Such practices help offset the use of fossil fuels and reduce removal of fossil carbon stored in the earth, and are important contributions of animal production[16,22,23,24,25].

- Enhancement of soil health and sustainability, productivity, and quality through carbon sequestration from manure organic matter is an important attribute of proper manure management, and directly applied to the land by grazing or "free-range" systems. Improved soil water management and moderation of soil water release, plus recycling of carbon and essential plant nutrients through grazing, are also important benefits. Improved nutrient retention (especially nitrogen) in stored manure in all forms and systems, as well as sound, environmentally friendly land application practices, are essential in optimizing manure as a fertilizer in crop production[1616,22,26,27].

- For a variety of reasons, organic matter content of many soils has declined. Manure can play an important part in building soil organic matter and can provide both macro- and micronutrients, adding an additional economic value to animal agriculture and the sustainability of food production. It is also compatible with the current increased use of cover crops, which can serve to sequester manure nutrients for use by subsequent plantings[16,27]. Research has suggested that in systems which use manure compost as a nutrient input and where soil carbon is simultaneously sequestered via cover crops, greenhouse gas mitigation effects are possible, and this management technique should be encouraged with knowledge sharing and incentive-based policies and programs[29].

- For each 1% increase in soil organic matter, soil water holding capacity can be forecasted to increase by 20,000 gal/acre or more based on soil compaction and other factors[30]; use of manure is important to build said healthy soil structures[33]**Error! Bookmark not defined.**.

- Availability of products such as biochar on a commercially economical basis may enhance efficiency of soil retention of nutrients in grazing or "free-range" conditions, as well as reduce the need for, or enhance the efficacy of, chemicals and chemical fertilizers under all growing systems[30].

B. Manure management in confinement production facilities:

- Adoption of new technologies for conserving stored nutrients (especially nitrogen) in manure, as well as improved methods for managing nutrient levels (particularly phosphorus) are critical. New developments also suggest that these management practices may have many benefits. In addition, formulation of animal diets for confined production periods that optimize utilization of critical nutrients is essential. Technologies currently available for diet formulation and treatment of stored manure allow for the proper balance between nitrogen and especially phosphorus, in many areas, to produce critical crops such as corn using only manure while still meeting regulations for application of those nutrients. An example of this is a series of tests conducted in Ohio with confinement hog production using deep pit manure storage. Treatment of pit manure with a proprietary enzymatic/microbial product resulted in enough increase in nitrogen retention to balance the phosphorus content in the manure to the requirements for corn production; this met the limitations set for application of phosphorus on those soils, while meeting the nitrogen and phosphorus requirements for corn production[2626]. Much more work is needed to verify this process, but it offers the opportunity to make optimal manure management an economically important part of crop production as part of the solution to addressing changing climate.

- Use of manure to recover renewable energy (most often by recovering methane by anaerobic digestion, with generation of electricity, as an example), is well established and is recommended wherever possible, contributing to reduction in methane (GHG) emissions. Ammonia emissions are also reduced through use of anaerobic digestion. Many successful systems are available for use, and can add to the profitability of the animal production operation as well as help reduce GHG emissions – important contributions to addressing climate change[16,17,25].

- Livestock are often incorrectly cited as major contributors to global GHG increases. Usually these accusations are made as comparisons that ignore the fact that water vapor (with its very high heat capacity) constitutes well over 90 percent of the GHGs present in the atmosphere and CO2, which is the common reference point, makes up only about 4 percent of GHGs; while U.S. agriculture contributes about 9 percent of GHG in total, with manure and enteric fermentation from beef cattle at 2 percent, from dairy cattle at less than 1 percent, and from hogs at about 0.46 percent[16,17,31]. There is also evidence that the methane emitted as a GHG, part of which comes from domestic and wild ruminants, may be degraded in the atmosphere to CO2[32] with lower heat capacity, thus suggesting that with current populations of cattle the contribution to GHG will remain static.

- In North America, animals such as pigs and poultry spend the vast majority, if not all, of their lives in confinement operations, as do a large proportion of dairy cattle, whereas meat ruminants (cattle, sheep and goats) spend only a short time in "finishing" or confinement facilities. Manure management in confinement facilities is more complex, and often labor as well as capital intensive, involving storage (increasingly to minimize escape of odors, greenhouse gases such as methane and nitrogen compounds and microbial pathogens, and prevention of contamination of water bodies). As facilities increase in size, the complexity of the manure management (and often, processing) increases as well. Manure from storage in these facilities must be moved/transported to land for use in meeting the nutrient requirements of crops growing on that land. Regulation of manure management systems has increased, with the goal of protecting air and water quality, and this trend will continue[22,23,27,28].

- Programs for mitigating environmental impact, including extracting nutrients of fertilizer value (especially nitrogen and phosphorus), as well as renewable energy, have been evaluated programmatically, with the most comprehensive supported by the pig industry at North Carolina State University[25]. Similar evaluations of animal manures have been conducted at other land grant universities including but not limited to Iowa State, Texas A&M, Cornell, Minnesota, Kansas State and Perdue, and by Premium Standard Farms in Missouri. Use of fertilizer nutrients in blends with chemical fertilizer has been evaluated and is possible. The fact that large quantities of phosphorus are contained in agricultural soils, especially in the eastern US due to long time application of excessive amounts in manure, suggests that manure may be an excellent source of extractable phosphorus for more efficient use. All the evaluations by North Carolina State University[25] required demonstration of technologies for phosphorus recovery and separation. If cropping systems relocate in response to changing climates, critical fertilizer nutrients such as phosphorus may need to be re-evaluated in terms of supply and level of soil application to support relocated crops.

Role of Animal Agriculture in Meeting Climate and Other Sustainable Development Goals

Animals play irreplaceable roles in human society. While the most recognized is as a source of human food containing high-quality protein and other essential nutrients, there are many other contributions.

During the production of human food, byproduct resources, here called manure, are produced. These resources are essential to the production of foods and feeds that animals consume in a recycling process to produce food again. In addition, the composition of manure is critically important to soil structure, health, and organic matter retention (especially water holding capacity) as a basis for all of food production and dealing with climate change extremes[33]. Relative to solutions for changing climates, animal manure provides an opportunity to reduce atmospheric carbon increases by enabling sequestration of that carbon in soils (for recycling and thus sparing fossil carbon, as noted above).

Animals can convert feedstocks which cannot be used by humans into human food, and especially on grazing land that is not otherwise useful for cultivation. Without animal engagement the production of food from those lands would be significantly reduced, if not eliminated. Efforts to replace foods of animal origin with alternatives made from plant sources must contend with the removal of those otherwise unusable lands from food production and an expanded need for tilled acres, creating the unintended consequence of potentially expanding the footprint of agriculture and endangering high value natural ecosystems.

Perhaps most importantly, when climate change results in crop failures in one geographical area, the flexibility provided by animal use of otherwise unproductive agricultural lands is a source of food security and mobility, important functions to a large portion of the global population.

Other points that reinforce the critical role that animals can play in achieving climate and food security goals follow:

- As the current interest in trade agreement policies highlights, food production is a globally interactive enterprise. Production of human food of animal origin involves the conversion of non-competitive, generally human-inedible/unacceptable feeds/foods and by-products, often produced on land not suitable for tillage, into high quality, natural human food, and especially protein of the highest biological value[17,18,22,23,24,27,28].
- Ruminants, whether meat or milk producers, over the course of their lives consume diets in which forage (grasses and other cellulose-containing, non-human competitive materials) predominates. Meat animals only consume grains in competition with human use during a relatively short "finishing" stage prior to processing. Monogastric animals (pigs, poultry, and some farm raised aquatic species) depend more on foods/feeds that compete with those for humans, a situation which will be improved with further dietary advances[15,18].
- Reduction in the contributions of foods of animal origin to feeding the world will inevitably result in more serious food supply issues than at present, especially with the expected growth in population, and exacerbated by changing climates[16,17,1819,21,22,23,23].
- On a global basis, people in many areas of limited rainfall incorporate animals (often ruminants) in their food production system not only to meet daily dietary needs, but also as an element of short or medium food security at times of failure of plant food sources (usually drought), thus preventing starvation. This process carries the people through periods of weather-related crisis, as well as other needs for survival[15,18].
- Changing climates may result in changing migration patterns for food security among people who would find it very difficult to relocate if animals were not part of their food cycle as well as their transportation process. This is an often underrecognized but critical benefit from animals in the food chain[15,18].
- Adaptation to changing climates will require significant changes in animal production, including possible relocation, different housing and handling systems, adaptation to different feeds, and careful consideration of the impacts of, especially, changing temperature on animal diseases and their management (including insects and parasites)[16,17,22,23,25,27].

It is important to recognize that the substitution of plant proteins for animal proteins does not consider the critical difference in biological value (BV). BV is a way to compare one protein with another in terms of its similarity with the essential (meaning needed in the diet) amino acid profile of animal, and thus by implication human, body protein. Proteins of animal origin have very high BV (92 percent or higher) while those of plant origin may only have a BV of 50 to 70 percent[34]. What this means is that in diets based on only plant proteins or meat substitutes using plant proteins, between 1.3-2 times as much total protein might be necessary to equal the nutritional value of a meat-based source. Essential amino acids of special importance from animal foods include lysine, methionine and B-complex vitamins (especially B-12); zinc, selenium phosphorus and iron are also critical. Other nutrients such as tryptophan, which is found in animal-based foods, may play a metabolic role in preventing such neurological conditions as Alzheimer's, Huntington's, Parkinson's diseases and dementia, as well as maintaining a healthy central nervous system[19,2020,21].

As noted above, animals of all species convert lower BV plant proteins into higher BV proteins and perform the necessary conversion as they form their own body proteins or the proteins in their produced products (milk and eggs). The excess nitrogen excreted by the animals in manure can be recycled to produce animal foods that are reconverted to high BV protein[16].

North America Climate Smart Agriculture Alliance Partners
September 2019

- 25x'25 Alliance
- Advanced Biofuels USA
- Agricultural Retailers Association
- American Coalition for Ethanol
- American Farm Bureau Federation
- American Farmland Trust
- American Seed Trade Association
- American Society of Agricultural and Biological Engineers
- American Society of Agronomy
- American Soybean Association
- Association of Equipment Manufacturers
- Association of Public and Land-Grant Universities
- Bayer
- BIO
- Business for Social Responsibility
- Canadian Federation of Agriculture
- Canadian Forage and Grassland Association
- CAST
- Cater Communications
- Center for Climate and Energy Solutions
- Conservation Technology Information Center
- Cornell Institute for Climate Smart Solutions
- Crop Science Society of America
- CropLife America
- EcoAgriculture Partners
- Environmental and Energy Study Institute
- Environmental Defense Fund
- Farmers Conservation Alliance
- Family Farm Alliance
- Farm Foundation
- Farm Journal Foundation
- Farm Management Canada
- Fertilizer Canada
- Field to Market
- Florida Climate Institute (FCI)
- Genscape Inc. Un of Illinois Chicago

- ILSI Research Foundation
- Innovation Center for U.S. Dairy
- Iowa Soybean Association
- Iowa State University
- Irrigation Association
- Kellogg Company
- National Association of Conservation Districts
- National Corn Growers Association
- National Farmers Union
- National FFA Foundation
- National Pork Producers Council
- Native Pollinators in Agriculture Project
- OCP North America, Inc.
- Ontario Federation of Agriculture
- Soil Science Society of America
- Soil and Water Conservation Society
- Soil Health Institute
- Solutions from the Land
- Southeast Climate Consortium (SECC)
- Sustainable Corn Coordinated Agriculture Project
- Syngenta
- The Fertilizer Institute
- The Mosaic Company
- The Samuel Smith Noble Foundation
- The Toro Company
- United Soybean Board
- University of Florida
- U.S. Department of Agriculture
- U.S. Farmers & Ranchers Alliance
- Western Growers Association
- World Business Council for Sustainable Development
- World Wildlife Fund

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- University of Florida
- U.S. Department of Agriculture
- Western Growers Association
- World Business Council for Sustainable Development
- World Wildlife Fund

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