Climate change mitigation and adaptationproduction

J. Climate change mitigation and adaptation

Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked within the development and climate change challenges of the twenty-first century (Tubiello, 2012). Rapidly rising concentrations of greenhouse gases, higher land and sea temperatures and increased frequency and magnitude of extreme weather events and wildfires pose enormous risks to agriculture, soil, and freshwater availability, and affect the livelihood and food security of billions of people around the world, especially in developing countries.

Agriculture is not only a fundamental human activity put at risk by climate change. It is also a major driver of environmental and climate change itself, as it has the largest human impact on land and water resources (FAO, 2016). About 1.6 billion hectares of arable land (around 12.5% of total ice-free land) are used for crop cultivation, and an additional 2.5 billion hectares are used for pasture. Roughly four billion hectares are forested land, 5% of which is used for plantation forestry (FAOStat, 2015a). In addition to land resources, agriculture is a major user of water. By 2010, over 300 million hectares of arable land was under irrigation, utilizing 2500 billion m^3 of water annually, representing roughly 70% of freshwater resources withdrawn from aquifers, lakes, and rivers by human activity (FAO, 2011). Finally, significant quantities of chemical inputs are applied to achieve high yields in intensive production systems including about 109 million annual tons of nitrogen, leading to significant regional pollution (FAOStat, 2015b).

As a result of these large-scale activities, agriculture is a significant contributor to land degradation, deforestation, and biodiversity loss, and a major emitter of greenhouse gases. It emits 13-15 billion tons of carbon dioxide per year into the atmosphere, about one-third of the total amount caused by human activities. Overall, agriculture is responsible for 25% of carbon dioxide (largely from deforestation), 50% of methane (rice and enteric fermentation), and more than 75% of nitrous oxide emissions (largely from fertilizer application) annually produced by human activities (Tubiello, 2012).

Nevertheless, agriculture is one of the few sectors that can both contribute to greenhouse gas emissions and to the mitigation and sequestration of carbon emissions. With growing concerns regarding the decline of non-renewable energy sources and the degradation of the natural environment, it is indisputable that sustainable agriculture is seen as an important goal throughout the world (FAO, 2016b).

SAN's sustainable agriculture approach is distributed along all sections of the SAN-SAF and focuses on building resilient agroecosystems and reducing the carbon footprint of agricultural and livestock activities, by:

- promoting agriculture and conservation practices that restore and increase natural and artificial carbon sinks;
- offering solutions to minimize and compensate greenhouse gas emissions, by implementing responsible fertilizer and pesticide management, reducing the use of fossil fuels and their by-products, and incorporating renewable energies into production systems;
- promoting the diversification of agroecosystems to improve their adaptability to changing climate patterns;
- encouraging soil management practices that contribute to productivity while lowering the pressure of agricultural activities over soil resources;
- improving water efficiency through better management practices that reduce vulnerability to variable conditions of water availability;
- promoting the use of weather monitoring systems and trends analysis to reduce the risks associated to climate variability; and
- assessing livestock management practices to enable adaptation and a reduction of the systems' vulnerability to climate variability.

J.1. Sustainability goal: Climate change mitigation

Outcomes	ID	Performance Indicators /Best practices
Natural and artificial carbon sinks are restored and increased.	J101	Operations implement practices to increase and conserve soil carbon (organic matter): – permanent ground covers or cover crops; – crop rotation; – reduced tillage or no-tillage methods; – use of organic fertilizers and low toxicity substances; – crop and pasture residue mulching; and/or – management of nitrogen inputs to favor biomass humification.
	J102	Operations implement practices for increased biomass production: – intercropping, – crop rotation; – agroforestry systems; and/or – live fences.
	J103	Operations conserve and restore natural carbon sinks: – forests; – coastal marine lands; – peatlands; and – grasslands.

Outcomes	ID	Performance Indicators /Best practices
Greenhouse gas emissions are minimized and compensated.	J104	Operations do not use production methods that require permanent flooding.
	J105	Operations compost organic waste or use any other method to reintegrate it into their productive systems.
Fertilization practices minimize nutrient losses and GHG emissions	J106	Operations implement nutrition management practices that are based on the assessment of crop/pasture needs, soil fertility and environmental conditions. Crop/pasture needs assessments can be done by using indicator plots, plant tissue analysis, application of fertilizer according Maximum return to Rate (MRNT) or Agronomically Optimum Rate (AONR) calculations, or any other effective mechanisms.
	J107	Operations implement practices to enhance Nitrogen fertilizer efficiency and reduce losses by leaching: - splitting Nitrogen applications; - use of slow, controlled release and stabilized fertilizers; - use of urease and nitrification inhibitors; - use of non-nitrate-based fertilizers during early applications (right before or after sowing); and/or - incorporation of nitrogen-fertilizers into the soil (especially in steep slopes).
Fertilization practices are improved to minimize nutrient losses and GHG emissions.	J108	Operations use different nutrient sources, to avoid excessive reliance on petroleum-based fertilizers.
	J109	Operations implement practices to enhance soil nitrogen fixation, such as: planting of nitrogen-fixing ground covers or cover crops; and application of compost, mulch, and green manures.
Use of fossil fuels and by-products is reduced.	J110	Operations invest in energy-efficient farm equipment and vehicles to reduce oil consumption.
	J111	Operations manage their providers and give preference to local inputs to optimize conveyance and reduce oil consumption.
	J112	Operations minimize the purchase or use of inputs that generate waste and emissions.
	J113	Operations evaluate if service providers minimize waste generation & fossil fuel use.
Renewable energies are incorporated into the productive systems.	J114	Operations develop and implement an energy efficiency plan including: – data of quantity and type of energy sources and uses; – practices for increasing energy efficiency; and – targets for reducing dependency on non-renewable energy sources.
	J115	Operations demonstrate, based on record keeping, reductions in overall energy use or non-renewable energy use per unit of grown or processed product.
	J116	Operations invest in renewable energy generation technologies: biogas and biomass energy from crop residues and manure; solar, wind and/or hydroelectric energy.

J.2. Sustainability goal: Adaptation to climate change

Outcomes	ID	Performance Indicators /Best practices
Productive systems are diversified and adapted to local conditions, reducing their vulnerability to climate variability.	J201	Operations only grow crops and graze livestock where soils and climate conditions are proven to be suitable for that crop/breed.
	J202	Operations give preference to locally adapted species and phenotypes.
	J203	Operations invest in the selection of crop and livestock species and phenotypes that have higher yield potentials under the operations' environmental conditions.
	J204	Operations grow drought, heat, and salinity tolerant crops through the implementation of artificial selection techniques.
	J205	Operations diversify and integrate different productive systems.
Soil management practices contribute to higher yields and agroecosystems' resilience.	J206	Operations increase and manage soil carbon (organic matter) using organic fertilizers and low toxicity substances.
Water use efficiency and agroecosystems resilience are improved.	J207	Operations manage river basins to prevent water logging, erosion, and nutrient leaching.
	J208	Operations adjust irrigation timing and mechanisms according to climate data and trends.
	J209	Operations implement or consult weather monitoring systems to collect climate data; and adapt their productive systems accordingly.
Use of weather monitoring systems and trends analysis reduce the risks associated to climate variability.	J210	Operations schedule farm management practices (such as irrigation and nutrient application) to better match altered phenological cycles and precipitation regimes.
	J211	Operations are aware and have access to early warning systems that allow them to prepare and face climate variability and extreme weather events.
	J212	Livestock operations implement intensive production systems and grasslands.