Information on the opportunities referred to in para 5(a) of 1/CP.19 [opportunities for actions with high mitigation potential, including those with adaptation and sustainable development co-benefits, with a focus on the implementation of policies, practices and technologies that are substantial, scalable and replicable

Submission by the College of the Atlantic, the Gaia Foundation & Friends of the Earth – England, Wales and Northern Ireland

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INTRODUCTION

At its third session, the ADP invited Parties and admitted observer organizations to submit to the secretariat, by 30 March, information on the opportunities for actions with high mitigation potential, with a focus on implementation of policies, practices, and technologies that are substantial, scalable, and replicable.

There is substantial scope and potential for mitigation in the agriculture sector in developed countries, as well as industrialized systems in developing countries, through policies, practices, and technologies that are scalable and replicable.

In contrast to other sectors, carbon dioxide (CO_2) is not the most important greenhouse gas for mitigation consideration in the agriculture sector. Direct non-CO_2 emissions from agriculture contribute an estimated 10-12% of global emissions. On top of this, although accounted for separately from agriculture, the production of synthetic nitrogen fertilizers is alone responsible for 0.6%-1.2% of global emissions.[1] These contributions are greatest where agriculture is most industrialised. Methane (CH_4) has 24 times the warming effect of CO_2, while nitrous oxide (N_2O) has 298 times the warming effect of CO_2. Effective mitigation strategies must take into consideration the unique character and source of emissions from the agriculture sector in order to effectively reduce sector emissions.

In this submission we outline 3 broad interventions that can have significant results in reducing emissions from agriculture. We also take the opportunity to learn key lessons from the latest scientific knowledge, so as to recommend the most effective strategies for climate and agriculture.[2]

GENERAL DESCRIPTION OF PROPOSED INTERVENTIONS

The production and application of synthetic fertilizer contributes significantly to GHG emissions. The practice is widespread where agriculture is most intensive or industrialised. Although use of synthetic fertilizer is assumed to confer yield benefits, and is often cited as essential to food

[1] Bellarby, et al. 2008. Cool farming: climate impacts of agriculture and mitigation potential. Greenpeace International.
[2] See also the previous 2013 submission to workstream 2 from The Institute for Agriculture and Trade Policy, IDEX, the Gaia Foundation, the Ecumenical Advocacy Alliance, and Misereor.

production, these assumptions should be interrogated, particularly in the context of climate change. A range of alternative strategies to increase soil fertility are proven to be highly effective and easy for farmers to adopt, such as use of nitrogen-fixing cover crops or tree species to biologically-fix new nitrogen.[3] A key strategy for mitigation must therefore be **reduction of synthetic fertilizer use**.

Linked to this issue must be the **promotion of agro-ecological production methods**. Agro-ecological approaches span a range of methodologies (e.g., agroforestry, organic farming, permaculture, integrated pest management, push-pull, and participatory seed breeding). These approaches use ecological principles and consider the impact of agriculture on local ecosystems. Agroecological approaches refrain from, or significantly reduce, the use of synthetic fertilisers or pesticides. By considering agricultural areas as ecosystems, they also aim to increase on-farm biodiversity, including seed and crop diversity, and offer significant benefits for soil health and resilience.

Reduction in meat consumption is a third action within the agriculture sector with high mitigation potential.[4] Intensive livestock production methods cause significant emissions throughout the production chain. There is wide disparity in meat consumption between countries, with developed countries eating far more meat per capita than LDCs and many developing countries. Meat consumption in developed countries is largely dependent on import of both meat and feed from developing countries, with a significant impact on the food security and environment of the exporting countries, as well as impacting on the global climate.

Much discussion about agriculture and climate change in the past has focused on the carbon sequestration potential of soils. However we find that the mitigation potential of the world's soils has been vastly overstated.[5] Strategies that focus on soil carbon sequestration are

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[3] http://www.soilassociation.org/LinkClick.aspx?fileticket=trTYwH9W6Ck%3D&tabid=186; http://www.sciencedaily.com/releases/2009/08/090824182535.htm

[4] Bellarby, J., et al. 2013. Livestock greenhouse gas emissions and mitigation potential in Europe. *Global Change Biology* 19: 3-18; Hedenus, F. et al. 2013. The importance of reduced meat and dairy consumption for meeting stringent climate change targets. *Climatic Change* DOI 10.1007/s10584-014-1104-5; Miller, S.M., et al. 2013. Anthropogenic emissions of methane in the United States. *Proceedings of the National Academy of Sciences* DOI 10.1073/pnas.1314392110; Davidson, E.A. 2012. Representative concentration pathways and mitigation scenarios for nitrous oxide. *Environmental Research Letters* DOI 10.1088/1748-9326/7/2/024005; Garnett, T. 2011. Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy* 36: 523-532; Crews, T.E. and M. B. Peoples. 2004. Legume versus fertilizer sources of nitrogen: ecological tradeoffs and human needs. *Agriculture, Ecosystems and Environment* 102: 279-297; and Garnett, T. 2009. Livestock-related greenhouse gas emissions: impacts and options for policy makers. *Environmental Science and Policy* 12: 491-503.

[5] See for example: Lam, S.K., et al. 2013. The potential for soil carbon sequestration in Australian agricultural soils is technically and economically limited. *Nature Scientific Reports* DOI 10.1038/srep02179; Mackey, B., et al. 2013. Untangling the confusion around land carbon science and climate change mitigation policy. *Nature Climate Change* DOI 10.1038/NCLIMATE1804; Hopkins, F.M., et al. 2012. Warming accelerates decomposition of decades-old carbon in forest soils. *Proceedings of the National Academy of Sciences* DOI 10.1073/pnas.1120603109; Rose, S.K., et al. 2012. Land-based mitigation in climate stabilization. *Energy Economics* 34: 365-380; Knohl, A. and E. Veldkamp. 2011. Indirect feedbacks to rising CO2. *Nature* 475: 177-178; and Powlson, D.S., et al. 2011. Soil carbon sequestration to mitigation climate change: a critical re-examination to identify the true and the false. *European Journal of Soil Science* 62: 42-55.

temporary solutions at best, but are more likely to be ineffective or even counter-productive. In particular, as global temperatures warm, increased metabolic activity in soils may lead to reversals in sequestration, undermining past mitigation and precipitating increased warming. We therefore urge against focusing on highly fallible soil carbon sequestration strategies. **Permanent reduction of emissions in agriculture should be promoted over temporary sequestration efforts**.

CLIMATE BENEFITS:

a) MITIGATION BENEFITS

Reduction in synthetic fertiliser use and **promotion of agroecological production methods** lead to significant reductions in CO_2 and N_2O emissions in a number of ways:

- Manufacture of synthetic nitrogen fertilizers is highly energy intensive, and leads to significant CO_2 and N_2O emissions.
- When applied to soils, synthetic fertilisers release nitrous oxide (N_2O), a highly potent GHG. N_2O makes up 54% of the UK agricultural sector's GHG emissions[6].
- Use of synthetic fertilizer has also been found to cause stable soil organic matter to convert to atmospheric CO_2 emissions[7].

New Zealand's per capita N_2O emissions from agricultural soils in 2010 came to 2.91 tons CO_2-equivalent. Argentina's came to 1.84 t/CO_2e. However the Philippines' N_2O emissions from soils came to 0.09 t/CO_2e in 2010.

The meat industry is estimated to contribute 14.5% of the world's total greenhouse gas emissions[8]. **Reduction in meat consumption** leads to significant reduction in CH_4, CO_2 and N_2O emissions because:

- Production of feed (grains) for industrial livestock is a major driver of deforestation.
- Production of livestock feed is also a major contributor to N_2O emissions from corn and soy fields.
- Industrially-produced meat is estimated to consume ten times as much arable land per calorie of food as grains or vegetables, due to the low conversion rate of feed into meat by livestock. Thus each calorie of meat has led to ten times as much N_2O and CO_2 emissions as a plant-based food.

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6 Committee on Climate Change (2010) *The Fourth Carbon Budget: Reducing emissions through the 2020s,* December 2010.

7 Mulvaney, R.L., Khan, S.A., and Ellsworth, T.R. (2009) 'Synthetic nitrogen fertilisers deplete soil nitrogen: a global dilemma for sustainable cereal production', *Journal of Environmental Quality,* 38, Nov-Dec 2009, p.2295-2314; Khan, S.A., Mulvaney, R.L., Ellsworth, T.R., and Boast, C.W (2007) 'The myth of nitrogen fertilisation for soil carbon sequestration', *Journal of Environmental Quality,* 36, Nov-Dec 2007, p.1821-1832.

8 FAO (2013) Tackling Climate Change through Livestock http://www.fao.org/docrep/018/i3437e/i3437e.pdf

- Enteric fermentation in the stomachs of livestock produces large amounts of the potent GHG methane (CH_4).
- Intensive livestock production leads to large amounts of slurry waste. Slurry stored in large volumes or pools (as is inevitable with large-scale production) leads to greater conversion to CH_4 and thus higher emissions.

In 2010 Australia's per capita meat consumption was 117.6 kg. Brazilians ate on average 80.8 kg of meat that year. However Malawians consumed only 5.1kg of meat per capita in 2010.

Comparative examples of developed and developing country emissions from the agriculture sector

Country	**Non-CO_2 GHG emissions from agriculture in 2010 (Mt CO_2 eq)**	**Per capita non-CO_2 emissions from agriculture (tons CO_2 eq)**	**Per capita N_2O emissions from agricultural soils (tons CO_2 eq)**	**Per capita emissions from livestock (tons CO_2 eq)**	**Per capita meat consumption (kg)**
Argentina	145.4	**3.60**	**1.84**	1.59	88.6
Australia	96.5	**4.33**	0.71	**2.73**	117.6
Brasil	644.1	**3.30**	0.89	1.22	80.8
Canada	69.2	2.03	0.97	0.88	96.3
Egypt	35.1	0.43	0.20	0.16	22.3
France	102.7	1.63	0.86	0.77	88.6
Gambia	0.9	0.52	0.17	0.17	8.7
Germany	60.3	0.73	0.44	0.30	83.3
Ghana	8.7	0.36	0.07	0.08	9.9
India	732.3	0.60	0.18	0.18	5.2
Indonesia	246.8	1.03	0.14	0.12	10.0
Ireland	18.3	**4.10**	**1.59**	**2.51**	100.7
Kenya	26.3	0.65	0.27	0.36	15.4
Malawi	12.8	0.86	0.66	0.09	5.1
New Zealand	37.1	**8.49**	**2.91**	**5.59**	142.1
Philippines	44.0	0.47	0.09	0.20	Not available
South Africa	34.1	0.68	0.15	0.41	46.2
Ukraine	27.2	0.60	0.32	0.26	38.6
United Kingdom	46.2	0.74	0.43	0.31	83.9
United Republic of Tanzania	50.1	1.12	0.21	0.35	9.5
United States	454.9	1.46	0.78	0.64	124.8
Uruguay	25.9	**7.69**	**3.38**	**3.98**	68.4
Viet Nam	72.9	0.83	0.16	0.23	34.9

Sources: US EPA, Non-CO2 Greenhouse Gases: International Emissions and Projections, http://www.epa.gov/climatechange/EPAactivities/economics/nonco2projections.html (emissions data); UNDESA, World Population Prospects: The 2012 Revision, http://esa.un.org/wpp/Excel-Data/population.htm (population data); FAO, The State of Food and Agriculture 2009 (meat consumption data).

b) ADAPTATION BENEFITS

Reduction of synthetic fertilizer use and implementation of agroecological production methods also greatly improve agriculture's chances of adapting to climate change.

- Increasing the organic matter present in soil significantly increases the water-holding capacity of soil, giving crops a greater chance to deal with a range of challenges from drought to flooding.
- Reducing fertilizer use and using agroecological production methods to increase soil health also reduces soil compaction and erosion, and thus improves crop performance, particularly when under climate stress.
- Agroecological production methods that increase seed diversity in the hands of farmers, while preserving and reviving the knowledge systems can ensure farmers' ability to save, breed, adapt, exchange and pass on crops. Agro-ecological crop diversity ensures that farmers can spread risk and increase resilience in the face of unseasonal and unpredictable, weather, and emerging pests and diseases. Such approaches increase farmers' access to a wider range of germplasm and skills with which to breed and adapt new varieties for changing climatic conditions.

Parties may wish to note that at the recent launch of the IPCC's 5th Assessment Report, the panel indicated that the "green revolution" model of agriculture, which uses chemical fertilisers, pesticides and corporate-owned seeds and requires large amounts of water, is likely to fail in the face of temperature extremes and changing rainfall patterns.

IPCC chair Rajenda Pachauri commented that "It's now becoming evident that the so-called 'green revolution" has probably reached a plateau[9]." Pachauri went on to explain how the green revolution is unlikely to benefit the hundreds of millions of farmers dependent on rain-fed agriculture in India, Africa and Latin America.

Michel Jarraud of the World Meteorological Organisation and one of the report's lead authors additionally commented that as a result of the green revolution "Global food production may have increased but this has come at the expense of vulnerability… All the ingredients are there for a new food crisis."

MULTIPLE BENEFITS

[9] The Press Conference of the IPCC Report can be viewed here: http://www.ipcc.ch/news_and_events/press_information.shtml (view from 1:06:50 for discussion of this topic)

There are multiple benefits to these approaches, which can address yields, hunger, development, gender equity, biodiversity and health.

- Beneficial mycorrhizal fungi and soil bacteria break down dead plant material and convert this into nutrients, providing a spongy consistency to soil. These micro-organisms are essential for soil health and natural fertility, but are negatively impacted by synthetic fertilizer application. Thus stopping fertilizer applications and rebuilding organic matter through agroecological methods can allow natural soil fertility and soil health to revive.
- Reducing synthetic fertiliser and pesticide use improves the health of the local environment, farmers and consumers.
- Increased crop diversity associated with agroecological production methods can improve nutrition for rural communities.
- Reduced meat consumption in industrialised countries can confer health benefits.
- Reduced use of the planet's land and water resources for growing feed for consumers in industrialised countries can free up land for feeding the world's hungry and protecting ecosystems such as forests.

Agroecological projects have shown an average crop yield increase of 80% in 57 developing countries, with an average increase of 116% for all African projects. Recent projects conducted in 20 African countries demonstrated a doubling of crop yields over a period of 3-10 years[10].

The UN Special Rapporteur on the Right to Food, Olivier de Schutter says that "To feed 9 billion people in 2050, we urgently need to adopt the most efficient farming techniques available. Today's scientific evidence demonstrates that agroecological methods outperform the use of chemical fertilisers in boosting food production where the hungry live – especially in unfavourable environments."[11]

A meta-analysis of 184 observations from 94 studies has found that on average, organic farms support 34% more plant, animal and insect species ("species richness") than conventional farms. "Organic methods could go some way towards halting loss of diversity in industrialised nations," says Sean Tuck of Oxford University's Department of Plant Sciences, the lead author of the study[12].

Further studies show that when agroecological approaches are compared to modern high-input approaches, farmers earn a greater net income, due to the comparative yields and reduced input costs[13]. It should thus be seriously considered as an approach to combat hunger in the developing world.

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[10] de Schutter (2011) "Agroecology and the Right to food" http://www.srfood.org/en/report-agroecology-and-the-right-to-food
[11] ibid.
[12] Tuck et al, Journal of Applied Ecology (Feb 2014) "Land-Use Intensity and the Effects of Organic Farming on Biodiversity: a hierarchical meta-analysis" http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12219/full
[13] Altieri, Rosset, Thrupp (1998) "The potential of agroecology to combat hunger in the developing world" http://www.twnside.org.sg/title/twr118g.htm

LESSONS LEARNED

Because of the range of activities and gases emitted, there are many different approaches for mitigation in agriculture. One essential means of differentiating between approaches is with regard to the permanence of emission reductions[14]. Mitigation may be:

- Permanent. Approaches that provide permanent emissions reductions are those that prevent emissions: reduction or elimination of synthetic fertilizer, reduction in number of animals, practices that reduce methane emissions from rice production, avoidance of land clearance.
- Temporary. Approaches that provide temporary mitigation, and therefore risk reversals and undermine mitigation, are those that sequester soil carbon through implementing particular practices on cropland and grazing land, recovery of organic soils, and restoration of degraded lands.

Soil carbon sequestration is not a reliable strategy for mitigation in agriculture, although much hope has been placed on its potential, including by the IPCC. Scientific studies conducted since the publication of AR4 strongly indicate that many of the recommended practices, such as reduced tillage, do not in fact increase soil carbon content, but merely prevent more carbon from escaping soils. Estimates provided so far for mitigation potential are far in excess of feasibility, particularly when taking into consideration uncertainties associated with biological processes.[15]

Increasing concentrations of soil carbon are complex undertakings that require increasing inputs of carbon such as manure and compost. These practices must be maintained yearly. Any change in practices can lead to reversal, as could an increase in average temperatures due to global warming. Moreover, as precipitation patterns change, along with soil moisture profiles, the sequestration potential for any given soil type or agricultural ecosystem will likely diminish. For example, an increase in soil moisture will likely increase soil emissions of nitrous oxide and methane, leading to an actual increase in greenhouse gas emissions from soils, rather than sequestration.

Mitigation efforts in agriculture should focus on the main emissions from the sector. As noted earlier, methane and nitrous oxide, rather than carbon dioxide, are the most important GHGs emitted in the agriculture sector. Moreover, agriculture emissions of these non-CO_2 gases are responsible for the bulk of the global emissions of these gases. Methane emissions from agriculture account for 50% of total global methane emissions; nitrous oxide emissions from agriculture account for 75% of the global total. Attention to mitigation of these gases in the agriculture sector is urgent.

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[14] FERN (2014) "Misleading Numbers: The case for separating land and fossil-based carbon emissions" http://www.fern.org/sites/fern.org/files/misleadingnumbers_full%20report.pdf

[15] See also footnote 5 above.