



Editorial

Implementation of the Paris Agreement: Consequences for Agricultural Practices Worldwide



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There are two revolutionary goals in the Paris Agreement (PA) of the United Nations Framework Convention on Climate Change (UNFCCC), signed on December 12th, 2015 and enacted on November 4th, 2016. First, the central goal in Paragraph 2a sets an upper limit to global warming by the enhanced greenhouse effect of the atmosphere with the following text:

Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

Second, the goal in Paragraph 4 forces all parties of

the UNFCCC (195 countries and the European Union) to reach greenhouse neutrality:

To achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

Both goals implicitly postulate that remaining fossil fuels have to stay in the Earth's crust (which experts say is about 80% of total, preindustrial reserves), and carbon dioxide has to be actively removed from the atmosphere if – for example – greenhouse gas emissions from agriculture caused by animal husbandry (primarily cattle) and nitrogen fertilization



of cropland and pastures continue. When reading the full paragraph 2 of the PA, it becomes clear that food security was seen as an important side condition during the negotiations. The central goal continues by stating:

Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production.

Agriculture is both extremely challenged by a successful implementation of the PA and critical to its enactment. In order to show the intimate connection between climate and agriculture, we have to compare the carbon reservoirs in the atmosphere, vegetation, soils and ocean as well as the fluxes of anthropogenic carbon between them and their recent trends. At present, the atmosphere contains about 830 Gigatonnes of Carbon (GtC), vegetation contains 450 to 650 GtC, soils contain 1500 to 2300 GtC, and the ocean contains about 38000 GtC. Only in 1970 had the total fossil fuel emissions of carbon containing compounds like carbon dioxide and methane into the atmosphere reached the same level as those resulting from changed land use (mostly stemming from deforestation, but also from agriculture). However, at present, fossil fuel emissions are about 9 GtC (roughly ten times) higher than emissions resulting from land-use change. This has led to carbon dioxide levels above 400 parts per million by volume (ppmv), an increase of more than 40 percent in comparison to the preindustrial level of 280 ppmv in 1750. *Homo sapiens* have never before lived under such high carbon dioxide levels. The concentration increase is, however, equivalent to only about half of the emissions into the atmosphere by human activities. Where did the other half go? Not only into the world's oceans, but also the still intact parts of the terrestrial biosphere! The presently increased storage of carbon on land is, with high probability, larger than the oceanic one: 3.0 ± 0.8 GtC per year versus 2.6 ± 0.5 GtC per year averaged over the decade from 2005 to 2014 (which together, represent slightly more than half of the total anthropogenic emissions), according to the Global Carbon Project (GCP) of the Earth System Science Partnership (ESSP), jointly supported by globally coordinated environmental science pro-

grammes. However, major research questions remain. Will the sink of anthropogenic carbon in the terrestrial biosphere keep its strength or even turn into a carbon source as climate change continues? Will the reduction of the pH-value of ocean water (often exaggerated as ocean acidification) affect the oceanic biosphere so strongly that food from the sea – already overexploited in many ocean basins and marginal seas – declines further?

What are the major consequences of the Paris Agreement, the new scientific findings and open questions for agriculture and food?

1. Food security is less threatened on the global scale if the PA is implemented. A strengthened PA (a re-discussion of climate policy measures is stipulated every 5 years) is helpful for food production and food security in comparison to weaker or no climate policy measures.
2. Investigations into future agricultural yields based on climate change scenarios find more often increased yields in the high mid-latitudes than in lower latitudes, and more often considerably reduced yields in lower latitudes, especially in the absence of globally coordinated climate policy.
3. The goal in Paragraph 4 of the PA (greenhouse gas neutrality) can only be reached if renewable energy becomes really dominant by around 2050 and agricultural practices are changed worldwide. Strong greenhouse gas emission reductions are needed in the animal husbandry sector, especially methane emissions from cattle, and nitrous oxide emissions as a consequence of nitrogen fertilization must also be reduced.
4. Carbon storage in agricultural soils must be augmented, which has the potential to turn agriculture into a sink for anthropogenic carbon. In other words, more bio-farming is needed.
5. Change in human diets and a strong reduction in the amount of food wasted along the entire food chain is required. Both changes can strongly reduce the greenhouse gas burden to the atmosphere from the food sector.
6. Reforestation is needed on abandoned, degraded agricultural soils.



The above points and measures call for a joint implementation of all three major environmental conventions. I would like to urge the new Secretary General of the United Nations to help in this process to make the UNFCCC, the Convention on Biological Diversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD) jointly a stronghold for promoting food security, thus also easing the implementation of the other UN Sustainable Development Goals.

The Federation of German Scientists (VDW) has established a Study Group called "Erdgestaltung" discussing the human activities needed in order to keep the Earth inside sustainable planetary boundaries. We would like to contribute to this endeavor of a joint implementation of these conventions.

With these ideas in mind, I now welcome the readers of the Future of Food: Journal on Food, Agriculture and Society to the Volume 4, Number 3 issue dedicated to the topic "Climate Change Mitigation and Adaptation in Agriculture and Food Systems." The selected research articles, book reviews, and reports tackle climate change and its implications for agriculture and food on the local, regional, and national level. A diverse array of mitigation and adaptation strategies is presented, ranging from changing management practices, to technical advances, to policy adjustments, to improving access to finance, and learning from the resiliency already existing in rural communities. I hope you enjoy the reading and wish you a happy holiday season!