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Climate-smart agriculture, agroecology and soil carbon: towards winning combinations

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Adaptation to climate change and its mitigation are some of the biggest challenges facing agriculture. In the global South, these challenges are associated with the need for food security. The arrival of climate change on the international agenda has prompted the recycling of a multitude of initiatives to address this problem, leading inevitably to the emergence of numerous controversies. However, although the scales and actors targeted may differ, all of these initiatives are trying in one way or another to provide technical, social, economic and political options to increase the climate resilience of agriculture. There is heated debate about three approaches, which focus on these relationships between agriculture and climate: climate-smart agriculture, agroecology and the 4 per 1000 Initiative on soil carbon. Beyond the conceptual differences and the sometimes partisan interpretations of these three approaches, agriculture in the Southern countries needs to take advantage of their potential synergies.

Multifunctional agro-ecological landscape combining crops, trees, agroforests and forests on the slopes of the Empung volcano in Sulawesi, Indonesia.
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Agriculture, food security and climate: a close relationship finally included in international agendas

Agriculture is a victim of climate change. It regularly suffers from extreme variations in temperature and rainfall (shifting seasons, heat waves, a lack or excess of water, changing rainfall patterns). The impacts are direct, for example when plant growth is altered, or indirect, when parasite pressure increases (pests, diseases). Agriculture therefore needs to adapt if it is to continue to fulfil all of the functions to which it contributes, in particular feeding the world.

But agriculture is also jointly responsible for climate change. It produces around 12% of greenhouse gas emissions (methane, nitrous oxide, carbon dioxide), or 24% if we take into account land use changes linked to logging and the agricultural frontiers that follow in its wake. These emissions are due to misuse of inputs, when fossil fuels are used, or to some intensive livestock and wetland rice cultivation practices.

But agriculture can also become one of the solutions to climate change by contributing to its mitigation. With appropriate practices, agricultural greenhouse gas emissions can be reduced and carbon can be stored in the soil and biomass (plants, soil-dwelling organisms, etc.).

Despite these close linkages with the climate, for a long time agriculture was ignored in United Nations Climate Change negotiations, which initially focused on forests.

It was not until the Paris Agreement in 2015 (COP21) that food security appeared for the first time in an official document of the negotiations, whereas the term agriculture still did not feature. Later still, at COP23 in 2017, a recommendation was adopted on the vulnerability of agriculture to climate change and on food security. This recommendation refers to agricultural adaptation, resilience, the role of soil carbon, the importance of soil nutrients, the role of livestock farming, and socio-economic dimensions.

Scientists addressed the joint issue of food security and climate change earlier on, especially in Europe with the FACCE-JPI research programmes (Joint Programming Initiative on Agriculture, Food Security and Climate Change) developed further to the Fourth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change) published in 2007. Then, in 2010, FAO (Food and Agriculture Organization of the United Nations) proposed the concept of climate-smart agriculture, with three simultaneous objectives: feeding the world, adapting to climate change and contributing to its mitigation. Through this concept, FAO focuses in particular on the countries of the South, for which food security and diversity are priorities. In 2016, the "4 per 1000 Initiative: Soils for Food Security and Climate" was presented at COP22 with the goal of associating mitigation and adaptation through an increase in soil carbon levels.

Climate-smart agriculture, relevant but misinterpreted

The planners of climate-smart agriculture work at the interface between science and policy, with the goal of fostering both action on the ground and the mobilisation of financing. In 2010, their founding publication defined climate-smart agriculture as *"agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals"* (page ii of the report: FAO, 2010. "Climate-Smart" Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation).

From there, a community of scientists united around regular international conferences. A global policy process was also established and led in 2014 to the creation of the Global Alliance for Climate-Smart Agriculture (GACSA). In 2014, the approach was further developed by its planners, who proposed four cross-cutting objectives in order to encourage coordinated action between farmers, scientists, private sector, civil society and policymakers:

> obtaining evidence of the impact of climate change on agriculture as well as information on the appropriate responses, whether technical, socio-economic or organisational;

> increasing the efficiency of institutions responsible for these issues, for example research organisations, development agencies and international institutions;

> fostering coherence between climate policies at different levels and public policies on agriculture;

> linking financing for agriculture and finance aimed at helping farmers to adapt to climate change or to mitigate it.

However, these objectives are not accompanied by any suggestions as to how to achieve them, leaving the door open to all types of scientific and political approaches. Hence calls for agroecology exist alongside those for conventional industrial agriculture, with all of them claiming to take a climate-smart approach, when in reality the three goals (feeding the world, adapting to climate change and mitigating it) are rarely met.

From the viewpoint of scientific research, the interdisciplinarity required to study these three goals simultaneously remains difficult to implement. Numerous scientific publications claiming to take a climate-smart agriculture approach focus primarily on adaptation to climate change, considering this to be sufficient. The argument is that once adaptation is underway, food security will follow. However, numerous examples contradict this argument and show that access to food security and diversity is not associated quite so directly with improvements in agricultural production systems. For example, some countries or regions specialise in export agriculture, which provides them with foreign currency without necessarily helping to achieve food security. Moreover, some highly efficient agricultural systems may be completely disconnected from traditional or local food. In some regions, their dissemination reduces the diversity of cultivated plants, which also results in a loss of food habits and nutritional diversity. Likewise, it is not certain that agricultural systems that are adapted to climate change automatically contribute to its mitigation.

The absence of clear linkages between adaptation and food security, the governance of GACSA (seen by some as a vertical approach) and the lack of any mention of the best ways to achieve the objectives of climate-smart agriculture may have been the cause of opportunistic behaviours that sparked criticism. This criticism, whether

Innovating to address climate change

In Honduras and Colombia, the **PIASAC project** is aimed at building the capacities of family farms to adapt to climate change. To achieve this, innovation platforms have been set up in a participatory manner to develop solutions that integrate the three objectives of climate-smart agriculture.

Three issues are explored through this project:

> identifying the most efficient and equitable social and organisational structure;
> strengthening, or launching, a local participatory process that takes into account local knowledge and enables the development of innovative agricultural practices;
> conducting *ex-ante* and *ex-post* evaluations, and identifying whether local institutional changes are needed.

PIASAC project, Innovation platform for improving farmers' adoption of Climate Smart Agriculture technologies: piloting in Honduras and Colombia, https://umr-innovation.cirad.fr/en/projets/fontagro, 2016-2017.

real or implicit, led national and international civil society organisations to publish in September 2015 an open letter condemning climate-smart agriculture as being incompatible with agroecology. Agroecology is defined by a set of agricultural practices applicable from the plot to the landscape and based on ecological principles. Its goal is to reduce pressure on the environment, to protect natural resources while using them efficiently, and to use as few synthetic inputs as possible. It also pursues the objective of sustainably feeding the human population. According to some definitions, agroecology refocuses agriculture on the use of local resources to the benefit of people living near production areas. Even if its primary goal is not to meet the challenges of climate change, this localised, multifunctional approach is more likely to propose climate-smart solutions than an industrial approach. The latter is specialised and transferable, and is therefore less able to take account of multiple functions, over and above immediate profits. Simultaneity between adaptation, mitigation and food security appears more achievable with the principles of agroecology than with those of industrial agriculture.

After eight years of existence, the concept of climate-smart agriculture therefore needs to be redefined and given more solid scientific foundations. The three objectives must be tackled head-on: this is what should be clarified by the signatories to GACSA and the agricultural stakeholders, including scientific research, involved in the process. It is also important that GACSA proposes reliable indicators to qualify actions and initiatives that are consistent with the three objectives.

Beyond initial opposition, fostering synergies with agroecology and promoting the key role of soil carbon

Agroecology and climate-smart agriculture share the goals of adaptation to climate change and food security. Agroecology refers to the ecological and agronomic sciences to design and steer sustainable agricultural systems, and to the economic and social sciences to accompany their deployment through appropriate public policies. This scientific research, whether implemented at the landscape, farm or plot level, involves adaptation and food security, either in combination or individually. Agroecology thus advances climate-smart agriculture on the ground.

There is also a conceptual linkage between climate-smart agriculture and the 4 per 1000 Initiative on soil carbon, launched in 2015. The assumption is the following: increasing by 4‰ (0.4%) per year soil organic carbon stocks throughout the world would make it possible to offset annual global greenhouse gas emissions. The carbon targeted is that contained in the organic matter in the top 30-40 cm of soil. This calculation nevertheless includes one condition, which is halting deforestation in tropical regions. Even if this objective is very ambitious and raises numerous scientific questions regarding the sustainable increase in soil carbon levels, it has the merit of setting targets and a framework for action in which soils, the fundamental living substrate for agricultural production, play a central role.

More carbon in the soil means more organic matter, which is an essential element of soil fertility, as well as being a key factor in the capacity of soil to retain water and to resist degradation. In other words, it means soil that is better adapted to climate events and more resilient. The 4 per 1000 Initiative, for which mitigation is the main priority, may therefore coincide with agroecology and climate-smart agriculture on adaptation and food security.

Assisted natural regeneration of trees in Niger

Since the 1980s, a number of development projects have been supporting a traditional practice well known to farmers in Niger, consisting in fostering the regrowth of trees present in fields from stump sprouts. The transfer of property rights for trees from the state to farmers has contributed to reviving this practice.
In just a few years, the density of trees in fields has increased dramatically. This has radically altered the agricultural landscape, with tangible ecological and agronomic impacts. The results include improved microclimates and soil fertility in these fields (adaptation), increased plant biomass (mitigation), and higher incomes and living standards for farming families. This is a good example of climate-smart agriculture, which is also agroecological.

Sendzimir J., Reij C. P., Magnuszewski P., 2011. Rebuilding Resilience in the Sahel: Regreening in the Maradi and Zinder Regions of Niger. *Ecology and Society* 16(3): 1.
http://dx.doi.org/10.5751/ES-04198-160301.

Encouraging the adoption of good practices

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The Pigeon Pea is one of the host species for lac insects.

In Laos, the **EFICAS project** supports the emergence of climate-smart agricultural systems in upland areas through a territorial approach to agroecology associating four components:

> participatory planning involving the whole village community in the definition of land-use plans;
> the promotion of diversified, more resilient agricultural landscapes;
> an integrated approach combining planning, the promotion of innovative agroecological practices, the negotiation of regulations on the use of resources and the marketing of agricultural products resulting from these innovative practices, such as organic coffee, stick lac, or cardamom;
> learning loops, with regular negotiations of these plans by the whole community in order to adapt to unforeseen events.

EFICAS project, Eco-Friendly Intensification and Climate Resilient Agricultural Systems, www.eficas-laos.net/, 2014-2017, Laos.

A judicious combination for the countries of the South

Climate-smart agriculture seeks to meet the food and agricultural challenges of the 21st century in both the North and the South. This approach is particularly appropriate for the countries of the South, which are facing the challenges of food security and climate change in a context of complex, unprecedented population growth.

The three objectives of climate-smart agriculture (feeding people, adapting to climate change and mitigating it) can thus be integrated into any research or development project in the South (see boxes p. 2 and 3).

For the countries of the South, the combination of climate smart agriculture + agroecology + 4 per 1000 can therefore increase the probability of simultaneously achieving these three objectives by inventing appropriate pathways that differ from those implemented by industrial agriculture. ■

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This research has resulted in the following publications:

Saj S., Torquebiau E., Hainzelin E., Pages J., Maraux F., 2017. The way forward: An agroecological perspective for Climate-Smart Agriculture. *Agriculture, Ecosystems and Environment* 250: 20-24. http://dx.doi.org/10.1016/j.agee.2017.09.003.

Torquebiau E., 2017. Climate-smart agriculture : pour une agriculture climato-compatible. *Cahiers Agricultures* 26 (6): 66001. https://doi.org/10.1051/cagri/2017048.

Torquebiau E., 2017. Le changement climatique, un défi pour la recherche : l'exemple de l'initiative « 4 ‰ ». *OCL* 24 (1): D108. https://doi.org/10.1051/ocl/2016054.

Torquebiau E., Rosenzweig C., Chatrchyan A. M., Andrieu N., Khosla R., 2018. Identifying Climate-smart agriculture research needs. *Cahiers Agricultures* 27: 26001. https://doi.org/10.1051/cagri/2018010.

Soussana J.-F., Lutfalla S., Ehrhardt F., Rosenstock T., Lamanna C., Havlík P., Richards M., Wollenberg E., Chotte J.-L., Torquebiau E., Ciais P., Smith P., Lal R., 2017 (*in press*). Matching policy and science: Rationale for the '4 per 1000 - soils for food security and climate' initiative. *Soil and Tillage Research*. https://doi.org/10.1016/j.still.2017.12.002.

Some links

Climate-smart agriculture concerns. Open letter signed by international and national organisations: "*Don't be fooled! Civil society says NO to "Climate Smart Agriculture" and urges decision-makers to support agroecology*", September 2015. www.climatesmartagconcerns.info/english1.html.

Climate-Smart Agriculture. Global Science Conference 15-18 May 2015, Montpellier, France, organised by CIRAD and its partners. http://csa2015.cirad.fr/.

COP (Conferences of the Parties). https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop.

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FAO, 2010. "Climate-Smart" Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation. FAO, Rome. www.fao.org/docrep/013/i1881e/i1881e00.htm.

GACSA (Global Alliance on Climate-Smart Agriculture). www.fao.org/gacsa/en/.

IPCC (Intergovernmental Panel on Climate Change). www.ipcc.ch/.

International initiative "4 per 1000". Soils for food security and climate. www.4p1000.org/.

UNFCCC (United Nations Framework Convention on Climate Change). https://unfccc.int/.

A few words about...

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