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Opinion Paper

The way forward: An agroecological perspective for Climate-Smart Agriculture

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ABSTRACT

The concept of Climate-Smart Agriculture (CSA) has consistently been positioned between science and policy. CSA has given rise to a lively debate in both the scientific community and civil society although it addresses the pressing need for an efficient strategy to manage agriculture and food systems facing climate change (CC). CSA formally targets the simultaneous fulfilment of three criteria: (i) CC mitigation, (ii) adaptation to CC and (iii) food security. Yet, the review of scientific literature on CSA displays a clear discrepancy between these three objectives, underlining the fact that CSA is regularly perceived as addressing only adaptation, and not mitigation and food security. On the other hand, research on agroecology (AE) reveals an extensive knowledge about food security and adaptation, often at scales which can be considered complementary to those of CSA. A better use by CSA of AE research results may help CSA focus on two currently overlooked dimensions, i.e. (i) mitigation and (ii) trade-offs and synergies between the three criteria. CSA does not have a specific blueprint for climate-smart practices and has rather a strong focus on policies, institutions and financing. Hence AE actually responds to the needs of CSA in terms of site-specificity and potential for adoption by farmers because it is strongly based on local practices. We argue that an eco- and socio-logical approach to CSA represents a *sine qua non* condition if CSA is to promote inclusive development and participate to collective efforts to manage agriculture and food systems under climate change.

1. CSA scope and early years of research

Climate-smart agriculture (CSA) is a recent concept, initially proposed by FAO in 2010 at The Hague Conference on Agriculture, Food Security and Climate Change (CC), to address the need for a strategy to manage agriculture and food systems under climate change. The latest definition of CSA by its original proponents (FAO, 2013; Lipper et al., 2014) describes the three objectives of CSA as follows: (1) sustainably increasing agricultural productivity to support equitable increases in incomes, food security and development; (2) adapting and building resilience to climate change from the farm to national levels; and (3) developing opportunities to reduce GHG emissions from agriculture compared with past trends. Since then, these three objectives (in short food security, adaptation and mitigation) are designated as the three "pillars" (or criteria) of CSA within the agricultural science and development communities. CSA was developed to help different stakeholders incorporate CC concerns in planning and investment processes. It lies at the interface between science and policy-making and strives to foster action on the ground and mobilize financing. Hence, following the meeting in The Hague, two processes developed in parallel. On the one hand, a policy process was launched, leading to the creation of the Global Alliance for Climate Smart Agriculture (GACSA) during the 2014 UN Summit on Climate Change (http://www.fao.org/gacsa/en/). On the other hand, a scientific process was engaged through the organization of international conferences on CSA (Wageningen, The Netherlands, 2011, http://www.gscsa2011.org/; University of California Davis, USA, 2013, http://climatesmart.ucdavis.edu/; Montpellier, France, 2015, http://csa2015.cirad.fr/). However, to date, research on CSA exhibits a narrow base of literature in terms of formal conceptual work.

The concept of CSA quickly aroused both interest and controversy. The main debate lies in the fact that CSA is perceived by some as "business as usual", both in terms of agriculture and/or development schemes, as underlined in an open letter published by several NGOs and farmer organizations after the launch of GACSA (Climatesmartagricultureconcerns.info, 2014a). CSA has also been discussed against the concepts of agroecology, i.e. "the integrative study of the ecology of the entire food system, encompassing ecological,

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economic and social dimensions" (FAO, 2015). Some opposed CSA to agroecology (Pimbert, 2015), on the basis that CSA does not exclude agricultural practices and management schemes that rely on industrial inputs, patents on seeds, the commodification of carbon, etc. Such a debate is partly understandable given the following observations.

First of all, the term "climate-smart" is short and "catchy" and is thus sometimes used in other contexts than that of its original definition. Typically, initiatives aiming at introducing genetic material that is well adapted to future climates are occasionally called "climate-smart" (e.g. Xiong et al., 2014; Yang et al., 2015) although they make no reference to the concept of "climate-smart agriculture". This has led to misinterpretations where "climate-smart" is used for initiatives addressing solely one of the three criteria of the CSA definition. Such misinterpretations may be dated from the very early times of CSA as illustrated in the first editorial about CSA published in a peer-reviewed scientific journal (Siedenburg et al., 2012). Indeed, while these authors clearly discuss the putative benefits of combining CSA's three criteria, their paper can also be interpreted as setting up adaptation as the main criteria to be dealt with and, for instance, a prerequisite to reach food security for small-scale farmers.

Second, the analysis of all currently available research papers (n = 74, consultation done in April 2017; Web of Science™) and of the 434 abstracts from the last CSA conference (2015) further underlines a common absence of simultaneousness between the three CSA criteria (Table 1) and the prevalence of the term adaptation over the terms food security and mitigation. During the 2015 CSA conference, the term "CSA" is often coalesced to adaptation and, in many cases, mitigation and food security are put forward as "positive externalities" of adaptation. This is unfortunate since keynote abstracts showed a different profile, at least in terms of speech, underlining the original will of the original CSA proponents (Table 1). Similar observations can be made for other scientific meetings, such as the Agri-Chains & Sustainable Development International Conference held in December 2016 (eg. session 3 "Climate smart cocoa"; Bunn, 2016; Gilmour, 2016). Furthermore, mitigation is understated in CSA publications (Table 1). This bias probably reflects the poor knowledge of the potential of agricultural systems to decrease emissions or sequester carbon, although carbon markets have been operating for some time (Alexander et al., 2015) and recent literature has highlighted the role of agricultural soils for carbon sequestration (Lal et al., 2015) as illustrated by the 4‰ initiative (Minasny et al., 2017). Unfortunately, this situation leads to CSA opponents arguing that mitigation is purposely avoided because some private companies which "support" CSA wish to minimize their responsibility for reducing their own GHG emissions (e.g. fertilizer companies) while offering "climate-smart" solutions (Climatesmartagricultureconcerns.info, 2014b).

It is clear that the current available research publications on CSA do not exhibit an appropriate equilibrium between the three CSA criteria. Given the low proportion of papers where the three CSA criteria are taken into account, it appears that many publications which claim to focus on CSA actually do not. The same probably applies to many grey literature documents or CSA development projects (Lamanna et al., 2016; Rosenstock et al., 2016). Such an observation underlines the clear need to clarify and/or (re)assert CSA's concept borders if it is to reach its objectives and respond to growing criticisms.

Table 1
Occurrence of "adaptation", "mitigation" and "food security" terms in the abstracts from the 2015 Climate-Smart Agriculture international conference. S = session; CS = climate-smart.

		Abstracts	Word count		
			adaptation	food security	mitigation
CSA 2015	Keynote speakers	*10*	*29*	*46*	*31*
	S1 – regional dimensions	*101*	149	83	79
	S2 – CS strategies	*193*	254	116	149
	S3 – CS solutions	*130*	253	132	77
	total	434	685	377	336

A first step to reply to criticism would be to consistently insist on the simultaneousness of the three criteria in CSA research and development projects. The CSA research community can certainly play a role here, for instance by informing all climate change and agriculture scientific journal editors about the precise CSA definition. Similarly, it is hoped that abstracts for the next CSA international conference (Johannesburg, November 2017) will be carefully screened with these conditions in mind. But this will however not be sufficient. A key challenge that CSA must address is the fact that adaptation refers to a private (local) good while mitigation refers to a public good (Steenwerth et al., 2014). For that matter, food security may be seen as a private good by a farmer but as a public good by a government. This implies that CSA research must go further than the simultaneous, but potentially unconnected, evaluation of the three CSA criteria: it specifically needs to search for synergistic interactions (positive feedbacks) or "least worse" trade-offs between mitigation and one or two of the other criteria. To do so, CSA leading institutions and researchers must develop a research framework that leads to a better understanding and characterization of the interactions between the three pillars and better metrics for the different pillars in order to provide their audience with more balanced and/or comprehensive results. For example, feedback of adaptation on mitigation can be achieved when innovative practices designed for soil fertility management (e.g. compost, reduced tillage, intercropping with legumes) lead to increased soil organic carbon and a reduction in N_2O emissions linked to lower fertilizer use (Soane et al., 2012; Plaza-Bonilla et al., 2015). Conversely, feedback of mitigation on adaptation can be achieved when a reduction in GES emissions (e.g. substitution of mineral fertilizer by organic amendment, alternate wetting and drying in paddy fields to decrease methane emissions) or soil carbon sequestration (e.g. introduction of agroforestry trees in cropland, reduced burning) leads to benefits in terms of soil properties and greater resilience to climatic stress, resulting in improved farmers' livelihoods. Also, positive feedbacks can be achieved between food security and mitigation. For instance, afforestation of savannahs/grasslands with agroforestry systems can lead to higher C sequestration in tree biomass while trees can protect crops/cattle from drought and promote diversification of agricultural systems (Abbas et al., 2017).

2. The case for agroecological CSA

There is no single definition for the term "agroecology" (AE). Since its first use in the scientific community in the 70′s, it has been regularly (re)defined and used idiosyncratically by the many actors from the agricultural socioecosystem (Altieri, 1995; Dalgaard et al., 2003; Francis et al., 2003; Gliessman, 2015). Yet, even though points of view may still differ, one can acknowledge that AE evolved through different phases as underlined by Wezel et al. (2009). At first, AE supporters were willing to develop agricultural practices to protect the environment and to promote the use of ecological theory to favor "eco-friendly" ways to produce agricultural commodities. Until the beginning of the 90′s, most agroecological research was published with this understanding and focused on the use of ecology and local management knowledge at field level (Wezel et al., 2009). AE then moved deeper into societal concerns (especially in South America, cf. Altieri and Toledo, 2011; Guzman and Woodgate, 2013). Since the mid 80′s AE is flagged as a social movement that arose against agribusiness industries' "radical monopolies" (*sensu* Pimbert, 2015) and which advocates for local population food sovereignty. The AE research agenda took this evolution into account and grew larger in the 90′s to embrace social, economic and political sciences while partly spreading from the field to the food system (Dalgaard et al., 2003). This evolution of the AE paradigm progressively led to the inclusion of food security at the global level as an objective. With