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Meeting local/state/national/international climate change mitigation goals

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International Agreements: The need for climate change mitigation

In December 2015, 195 nations committed themselves at the COP21 in Paris to keep global warming well below 2 °C (above preindustrial levels), possibly below 1.5 °C. To achieve this target, emissions will have to be significantly reduced across sector reaching a balance between emissions and removals in the second half of the century. This leaves a cumulative anthropogenic GHG emissions of around 400 – 1,200 $GtCO_2eq$ until 2100 which makes the rapid adoption of stringent mitigation policies indispensable (Friedlingstein et al., 2014; Schellnhuber et al., 2016). Countries submitted “Intended Nationally Distributed Contributions” (INDCs) ahead of the COP21, which specify nationally anticipated GHG mitigation and climate change adaptation policies. However, more mitigation than what is currently proposed by the countries and timely delivery on these proposals will be needed to keep climate change well below 2 °C (den Elzen et al., 2016; Rogelj et al., 2016). As agriculture is one of the biggest emission sources accounting for up to 20% of global GHGs when including emissions from land use change driven by agricultural expansion (Hosonuma et al., 2012), most countries mentioned agriculture and the land use sector in their submitted INDCs. 103 parties have mitigation and adaptation targets in agriculture and 128 include targets related to other land use (forests, degraded land and soil carbon restoration). Yet, the proposed actions are diverse across countries and lack detail, which highlights the need for a shared and ambitious target for land-based mitigation and adaptation (Richards et al., 2015).

Several studies show that the AFOLU sector offers various low-cost opportunities to reduce global emissions by (i) enhancing carbon sinks in soils and biomass, (ii) reducing direct GHG emissions through improved management, and (iii) avoiding conversion of land covers with high carbon stocks (IPCC, 2007; Kindermann et al., 2008; Sohngen et al., 2008; Smith, 2012; Havlík et al., 2014; IPCC, 2014). Measures to increase the land sink through measures such as soil carbon sequestration and afforestation are the only operational negative emissions technologies today. Estimates of the economic mitigation potential in the AFOLU sector on the supply side through carbon sequestration i.e. improved cropland and grassland management, and restoration of cultivated organic soils etc. (Paustian et al., 2016), range between 7.2 and 10.6 GtCO_2 eq/yr at a carbon price of up to 100 USD/tCO_2 eq of which one third could be achieved at a carbon price of 20 USD/tCO_2 eq by 2030 (IPCC, 2014). The '4/1000 Initiative Soils for Food Security and Climate' aims to increase annual SOC stocks by 0.4% through the adoption of improved management practices. Achieving this target would result in a large enhancement of the terrestrial biosphere C sink, that could later be partly associated to Carbon Capture and Sequestration (CCS) when this negative emission technology becomes mature (Smith, 2016). Together with an avoided CO_2 source from halting net land use change emissions, this increased land C sink would allow for an early offsetting of anthropogenic CO_2 emissions. However, turning the ambitious goal of the '4/1000' soil C initiative into social and economic realities is a great challenge.

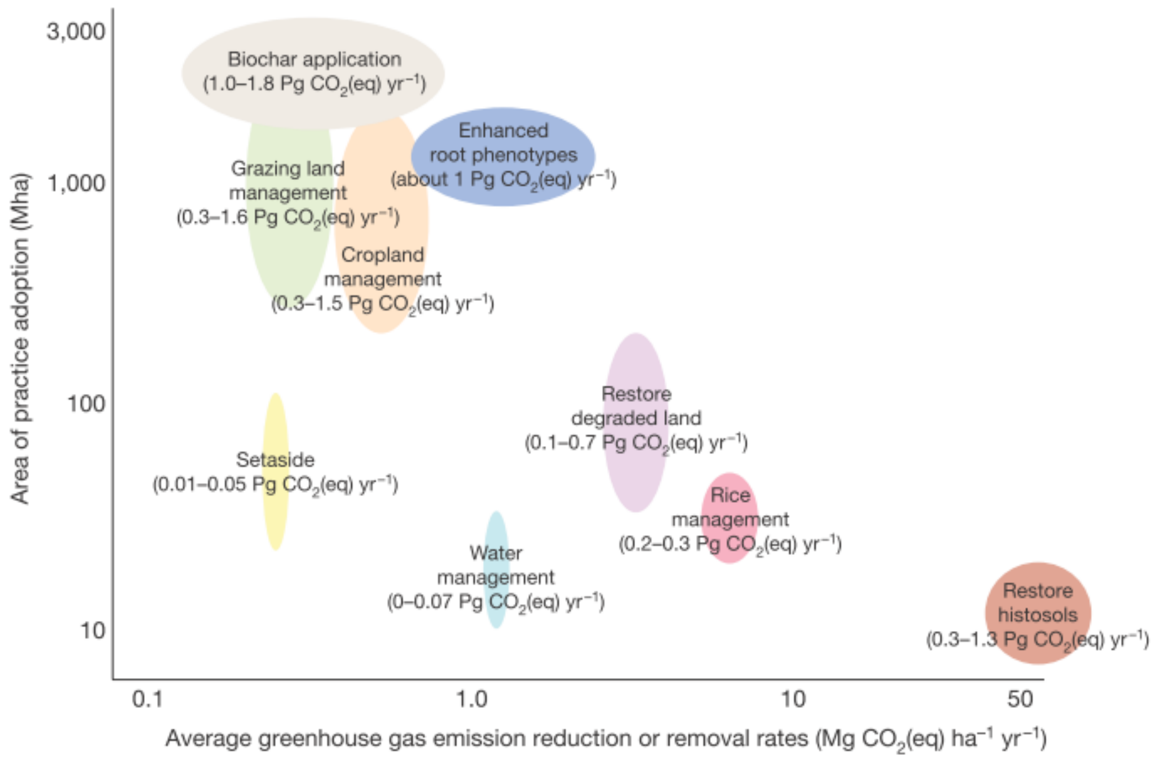

Figure 1. Global potential for agricultural-based GHG mitigation practices. Management categories are arranged according to average per hectare net GHG reduction rates and potential area (in millions of hectares) of adoption (note log-scales) (Paustian et al., 2016).

Integrated assessments: Bringing together top-down and bottom-up estimates

Several studies estimated global and regional mitigation potentials in the land use sector using bottom-up approaches for a (comprehensive) set of technologies (Freibauer et al., 2004; Smith et al., 2008; Henderson et al., 2015; Wollenberg et al., 2016). Estimates for agricultural SOC sequestration potential are around 5 $GtCO_2$/yr (Smith et al., 2008). Restoration of salt affected and desertified lands could add another 3 $GtCO_2$/yr of SOC (Lal, 2010). Significant mitigation potentials from the land use sector for GHG abatement are anticipated in the global integrated assessment model (IAMs) (van Vuuren et al., 2011; IPCC, 2014; Fricko et al., 2016; Riahi et al., 2016). Global climate stabilization scenarios project that current land use related emissions of around 10-12 $GtCO_2$eq/yr are required to drop substantially (IPCC, 2014) as the land use sector needs to become a significant carbon sink. Negative emissions technologies undoing historical emissions from industrialization have become essential to reach ambitious climate targets (Azar et al., 2010; Kriegler et al., 2013; van Vuuren et al., 2013) . However, IAMs did not consider SOC sequestration explicitly despite the significant potential for climate change mitigation (Smith, 2016) and food security (Paustian et al., 2016). Frank et al. (forthcoming) show that if agricultural SOC sequestration options were incentivized under a mitigation policy, the cost-efficient contribution of the AFOLU sector to achieve the 1.5°C target could increase from 8 $GtCO_2$eq/yr to up to 11.5 $GtCO_2$eq/yr by 2050 while at the same time improving food availability in food insecure countries. Taking into account the positive effects of SOC sequestration on crop yields (Lal, 2006), food security could be further improved while maintaining the level of GHG abatement. Hence, win-win mitigation options like soil carbon sequestration are an important option also at global scale could contribute significantly to climate stabilization while at the same time enabling synergies with other Sustainable Development Goals like food security.

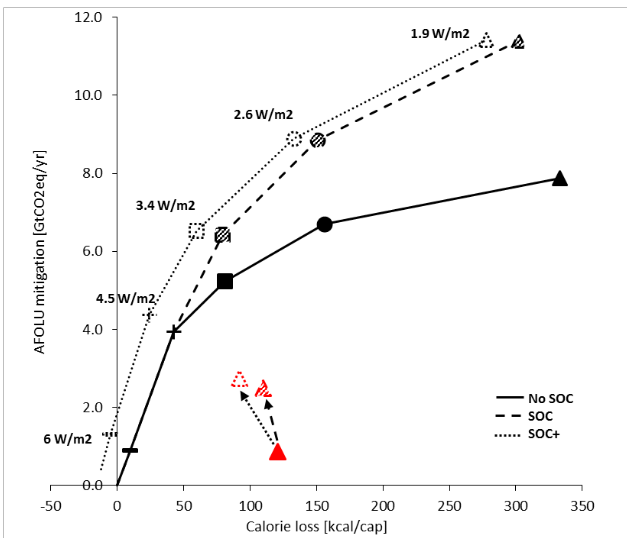

Figure 2. Trade-offs and synergies between annual land sector mitigation and dietary energy consumption by 2050 under a uniform carbon tax. Global annual mitigation potential in $GtCO_2eq$ in 2050 vs. loss in daily dietary energy (kcal per capita) consumption in food insecure regions, compared to a baseline scenario without mitigation efforts. The concave lines represent policies where all countries participate in the mitigation effort assuming three alternative mitigation policies: no SOC sequestration incentives (No SOC, straight line); SOC sequestration incentives without considering associated yield improvements (SOC, dashed line); SOC sequestration incentives considering yield improvements (SOC+, pointed line). For a 1.5°C scenario, implications of a regional mitigation policy are shown for Annex I & China (red). Arrows indicate the impact in the climate policy for the three policy variants (no SOC, filled triangle; SOC – dashed triangle; SOC+, pointed triangle) (source: Frank et al., forthcoming).

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