doi:10.2489/jswc.70.6.141A

VIEWPOINT

Cover cropping and the "4 per Thousand" proposal

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Climate change, caused by anthropogenic emissions through fossil fuel combustion and land use conversion including deforestation, is a major global issue of the twenty-first century. Estimates of anthropogenic emissions for 2014 include about 10 Pg (11 billion tn) of carbon (C) through fossil fuel combustion and ~1 Pg (1 billion tn) C from deforestation and land use conversion. Cumulative emissions of carbon dioxide (CO_2) for the period of 144 years from 1870 to 2014 is estimated at 545 ± 55 Pg C (600 ± 61 billion tn C; 2,000 ± 200 Pg CO_2 [2,200 ± 220 billion tn CO_2]), about 75% from fossil fuel combustion and about 25% from land use change (Le Quéré et al. 2014). Agricultural activities contribute, both directly and indirectly, about 30% of the total anthropogenic emissions (IPCC 2014). Therefore, agriculture must be integral to any agenda to mitigate the climate change.

National commitments made thus far to reduce gaseous emissions may allow global temperatures to increase by 3°C (5.4°F) by 2100 ("How much warming" 2015), which far exceeds the 2°C (3.6°F) limit accepted by the Group of Eight (G-8) nations as per the L'Aquila Accord in 2009 (Reuters 2009). Therefore, there is an urgent need to explore other options to mitigate the climate change.

Among several initiatives to mitigate climate change (Kintisch 2014), the "4 per Thousand" proposal of the French government at the Conference of Parties (COP21) in Paris, France, in December of 2015 is aimed at making agriculture a solution in addressing climate change while also advancing food and nutritional security. Specifically, the "4 per Thousand" proposal is based on the premise of sequestering atmospheric C in world soils at the rate of 0.4% y^{-1}. Cover cropping, the focus of this issue of the *Journal of Soil and Water Conservation*, is an important option for soil C sequestration.

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A cover crop is a transition crop between two production crops. While not a cash crop, it is grown for ecologic benefits and provides numerous ecosystem services (e.g., creation of a protective ground cover for erosion control, production of biomass, sequestration of C in soil, fixation of nitrogen (N) and recycling of nutrients, and enhancement of activity and species diversity of flora and fauna). Therefore, a cover crop enhances the climate resilience of an agroecosystem (Lal 2015a, 2015c).

World soils are the largest terrestrial reservoir of C, comprising soil organic C (SOC) and soil inorganic C (SIC) pools. The SOC pool is estimated at 684 to 724 Pg C (753 to 798 billion tn C; average of 704 Pg [776 billion tn]) in the 0 to 30 cm (0 to 12 in) depth and 1,462 to 1,548 Pg C (1,611 to 1,706 billion tn C; average of 1,505 Pg [1,659 billion tn]) in the 0 to 100 cm (0 to 39.4 in) depth (Batjes 1996). The "4 per Thousand" proposal neither specifies the soil depth to which the SOC pool must be increased by 0.4% y^{-1} nor the type of C (SOC or SIC). Assuming that the proposal refers only to the increase in SOC pool and to the top 30 cm depth, it implies a global C sequestration increase of 2.8 Pg C y^{-1} (3 billion tn C yr^{-1}; 704 Pg × 0.4% yr^{-1} = 2.8 Pg C y^{-1}).

Therefore, under the best case scenario, the technical potential of SOC sequestration through the implementation of the "4 per Thousand" proposal can offset about 25% of the anthropogenic emissions (2.8 Pg [3 billion tn] out of the total emissions of 11 Pg [12 billion tn] in 2014). Because of its potential to sequester SOC (Lal 2015b), cover cropping can play an important role in implementation of the "4 per Thousand" proposal. With a sequestration rate of 0.5 to 0.9 Mg C ha^{-1} y^{-1} (0.22 to 0.40 tn ac^{-1} yr^{-1}) to the 75 cm (29.5 in) depth (Olson et al. 2014), the technical potential of cover cropping on 1.5 billion ha (3.71 billion ac) is 0.4 to 0.8 Pg C y^{-1} (0.41 to 0.82 billion tn yr^{-1}) (Lal 2015c). To harness full benefits, however, cover cropping must be practiced in conjunction with conservation agriculture following a system approach (Lal 2015a, 2015b).

Mitigation of climate change is a complex and a challenging issue. It necessitates a critical and an objective appraisal of all options. There is neither a silver bullet nor a panacea. Furthermore, the "4 per Thousand" proposal may cause only a modest reduction or drawdown of atmospheric CO_2, with a technical potential of offsetting about 10% to 15% of anthropogenic emissions through C sequestration in soils of managed agroecosystems. Nonetheless, the proposal merits a serious consideration because it has numerous co-benefits (e.g., advancing food and nutritional security and improving water quality). Besides, it is also a cost-effective option. By itself, the "4 per Thousand" proposal cannot mitigate climate change. When implemented in conjunction with other options, however, it can make an important incremental contribution and also produce several co-benefits.

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