LETTER

Organic farming gives no climate change benefit through soil carbon sequestration

Agricultural management strongly affects soil organic carbon (C), as shown by numerous long-term experiments (1). Practices known to increase soil C include adding organic manures and including grassland in crop rotations. Their effect on C is related to the net primary productivity of the agroecosystem and the fraction of organic matter remaining in the field or returned as residues.

According to Gattinger et al. in a recent issue of PNAS (2), organic farming (OF) promotes soil C increase relative to conventional farming (CF). They evaluated datasets from 74 studies and found that soils under OF had significantly higher C stocks, concentrations, and rates of C increase than those under CF and attributed these differences to the intrinsically higher C inputs in OF. In their analysis, OF received, on average, much higher external (manure, slurry, compost) C inputs (1.20 Mg C ha^{-1} y^{-1}) than CF (0.29 Mg C ha^{-1} y^{-1}). Higher soil C concentrations in OF have been attributed previously to high and often disproportionate external inputs (3); therefore, the authors also analyzed a subset of data comprising only organic trials with productivity that would support an external C input equivalent to a maximum stocking density of 1 European livestock unit (ELU) per hectare. They state that even within this reduced dataset, OF outperforms CF in terms of soil C.

Here, we argue that their interpretation is biased. In the study by Gattinger, 92% of the organic systems received external C inputs compared with only 27% of the conventional (2). The average external C input to OF was 4.14 times that of CF for the full dataset and yet still 2.12 times higher for systems supporting $\leq$1 ELU·ha^{-1} (average annual external C input to: OF, 0.60 Mg C ha^{-1}; CF, 0.28 Mg C ha^{-1}). This bias mainly lies in a nonrepresentative selection of CF. Gattinger et al. compared systems with high stocking densities and C inputs to systems with low stocking densities and C return, which they called "organic" vs. "nonorganic" but which actually represent mixed farming vs. almost stockless systems, respectively. However, CF is not typically characterized by low stocking but by greater separation of arable and livestock systems.

In addition to this unbalanced comparison, Gattinger et al. ignore important aspects of the assessment of climate change mitigation through soil C sequestration (2). First, in most situations, manure would be applied somewhere anyhow, unless used for other purposes. Hence, an increase in soil C in one field (whether in an OF or CF system) is not a net transfer of C from atmosphere to land but a movement of C from one site to another (4). Second, OF generally gives lower crop yields than CF (5), so any expansion of OF would imply either decreased global food production or additional conversion of land with a high soil C content to cropland, leading to additional C emissions. Thus, the interpretation of Gattinger et al. that practices central to OF can mitigate climate change through C sequestration in soils is misleading.

Jens Leifeld[a,1], Denis A. Angers[b], Claire Chenu[c], Jürg Fuhrer[a], Thomas Kätterer[d], and David S. Powlson[e]

[a]*Air Pollution/Climate Group, Agroscope Reckenholz-Tänikon Research Station, 8046 Zurich, Switzerland;* [b]*Agriculture and Agri-Food Canada, Québec City, QC Canada G1V 2J3;* [c]*AgroParisTech, Unité Mixte de Recherche Bioemco (UPMC, Centre National de la Recherche Scientifique, UPEC, Ecole Normale Supérieur, AgroParisTech, Institut National de la Recherche Agronomique, INRA), 78850 Thiverval Grignon, France;* [d]*Department of Soil and Environment, Swedish University of Agricultural Sciences, SE-75007 Uppsala, Sweden; and* [e]*Department of Sustainable Soils and Grassland Systems, Rothamsted Research, Harpenden AL5 2JQ, United Kingdom*

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2 Gattinger A, et al. (2012) Enhanced top soil carbon stocks under organic farming. *Proc Natl Acad Sci USA* 109(44): 18226–18231.

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[1]To whom correspondence should be addressed. E-mail: jens.leifeld@art.admin.ch.