Agriculture and Climate Change

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In a recent paper published in the journal Science, researchers Michael A. Clark, Nina G. G. Domingo, Kimberly Colgan, Sumil K. Thakrar, David Tilman, John Lynch, Inês L. Azevedo, and Jason D. Hill [Clark] show that greenhouse gas emissions (GHG) from agriculture alone are enough to warm the planet 2 K. In their study, the authors assume that all emissions from other sources such as transportation and the generation of electricity stopped on January 1, 2020, but that emissions from the growing of our food continue unabated until 2100. Agriculture contributes about 30% of total GHG emissions globally [Gütschow]. Therefore, this is equivalent to instantaneously eliminating 70% of all greenhouse gas emissions. This is an important result because plans to cut emissions generally only address electricity generation or transportation and indeed various carbon taxes and other market-friendly schemes tend to exclude the agricultural sector.

Figure 1, from the Clark paper, shows several strategies which might be employed to reduce these emissions, “…*through changes in dietary composition and healthier caloric consumption, through increased crop yields, through decreased food loss and waste, or through increased emissions efficiency of food production, provided that these strategies are adopted individually and gradually such that they are fully adopted by 2050. If all five strategies were to be partially implemented together (50% adoption of each), cumulative emissions through 2100 could be reduced by 63% relative to business-as-usual. Full adoption of all five strategies could result in a food system with marginally negative net cumulative emissions because of lowered emissions and net carbon sequestration on abandoned croplands*.”

I find some of this puzzling. For example, the business-as-usual scenario already includes significantly increased crop yields. Some increases in yields have increased the caloric value of food while reducing its nutrient value, i.e., compromising “healthier caloric consumption”. Further, much of this historic increase in yield also increased emissions through more mechanization, and increased use of petrochemicals and synthetic fertilizers, which calls into question whether possible future increases in yield would not also result in more emissions rather than less. Reducing food loss and waste is problematic because this decreases resiliency. The study does not account for additional losses in production due to worsening weather-related phenomena, which is both forecast and already happening [Gaupp] [Mehrabi]. Since 1980 the number of annual climate related events such as storms, droughts and fires, have more than tripled [MunichRE].

Despite these and other optimistic assumptions [Note], the report is timely and important. And though optimistic, the assumptions are reasonable and well-stated. The conclusion is clear. We cannot meet the Paris Accord objectives unless we reduce emissions from agriculture.

Rodale Press has recently published a white paper by Jeff Moyer, Andrew Smith, Yichao Rui, and Jennifer Hayden [Moyer] which describes strategies for not only eliminating agricultural emissions but converting farmland from a source to a carbon sink. Agriculture policy is well beyond my capabilities but I can appreciate that this conversion is going to need government support. My own experience is an illustrative example.

I have a 1500 square foot garden. Concerned about winter erosion caused by wind and runoff, I asked a local Loudoun County master gardener for advice. She recommended a cover crop of vetch, oats and field peas. I spent $20.00 for enough seeds to cover 500 square feet. These plants fix nitrogen and build soil by adding organic matter. They are a green manure cocktail. With my compost, I don’t need to add chemical fertilizer. This is all good for a hobby garden but for a commercial farm, this would have a cost which is not recoverable. Outside of its soil building qualities, this particular winter cover crop has no commercial value so far as I know.

A few policies are suggested. Perhaps the county or state could subsidize farmers planting winter cover crops. This has multiple advantages to the community including sequestering carbon dioxide from the atmosphere, reducing the need for chemical fertilizer which reduces nitrous oxide emissions, another greenhouse gas, and limiting runoff of soils and fertilizers into the Chesapeake Bay watershed. Since everybody benefits, it is appropriate that this strategy is subsidized by the community. Maryland has such a program so there is precedent.

Other soil management strategies recommended in the Moyer paper for building soil carbon include: diversifying crop rotations; planting cover crops, green manures, and perennials; retaining crop residues; using natural sources of fertilizer, such as compost; employing highly managed grazing and/or integrating crops and livestock; reducing tillage frequency and depth; and eliminating synthetic chemicals. I’m sure there are many local farmers in Western Loudoun who already employ some or all of these strategies. But I imagine they are expensive and the implementation rate would benefit from appropriate subsidy.

Encouraging community gardens and victory gardens taking advantage of local resources like the Master Gardeners to consult and run seminars would be a big help to residents wanting to learn how to garden. I would be at a loss without my master gardener buddies. And of course, the World War II Victory Gardens are a precedent. By 1944, an estimated 20 million victory gardens produced more than 40 percent of all the fresh fruits and vegetables consumed in the United States [Schumm]. Rodale Institute in Kutztown, PA. is also a local resource as are our local universities.

In summary, agriculture represents 30% of all greenhouse gas emissions and there is no way we can keep global warming to less than 2 degrees Kelvin above the pre-industrial level if we don’t reduce these emissions. While this level of warming would be a disaster, it would at least be manageable.

[Note] The study’s conclusions are optimistic in several regards. We didn’t stop all other emissions in January. The study assumes we’ve only warmed the planet 1 degree and the climate is actually 1.2 degrees above the 1880-1910 average already. The study also assumes yields will continue to increase at the current rate. This is not unreasonable but it is optimistic. The study ignores increased production losses due to climate changes which have already been occurring and are forecast to continue to worsen [Gaupp] [Mehrabi]. Like all such studies, transient climate response is used rather than equilibrium climate sensitivity. The best estimate for ECS, between 2.6 and 3.9 K [Sherwood] is entirely based on an Ice Age Climate State and since atmospheric carbon dioxide equivalent is 500 ppmV [NOAA], the Earth is only marginally at best still in this state, i.e., with ice at both poles [Westerhold]. The Arctic Ocean is expected to be ice-free by around 2035 [Guarino]. The reflectivity of open water compared to ice in this ocean adds the equivalent of about 1,000 billion tons of additional atmospheric carbon dioxide to the radiation budget [Pistone]. Emissions from permafrost and methane clathrate decomposition, and increased forest fires, are ignored. A new study estimates that even if all emissions, including those from agriculture cease, future permafrost emissions ensure the climate warms to 2.6 C over 1850 [Randers].



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