Central Coast Climate Science Education
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Agriculture and the Green New Deal

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Two resolutions introduced simultaneously in the House and Senate in February 2019 have generated considerable controversy. These two resolutions are referred to as the "Green New Deal" (GND), evoking the "New Deal" President Roosevelt introduced during the Great Depression. This modern GND sets goals for the U.S. to move to zero greenhouse gas emissions from electrical power generation by 2030, have a carbon neutral economy by 2050, and proposes several complementary environmental and progressive economic and social programs similar to those of the New Deal.

But a couple of little-discussed portions of the GND are often overlooked and have ramifications that include, but go beyond, dealing with climate change. These portions advocate "*working collaboratively with farmers and ranchers in the United States to remove…greenhouse gas emissions from the agricultural sector…by investing in sustainable farming and land use practices that increase soil health*," and "*removing greenhouse gases from the atmosphere… through proven low-tech solutions that increase soil carbon storage*."

Why we need to achieve these objectives on a global scale

The following considerations make such an agricultural and soil program urgent on a global, not just national, scale:

A recent (2019) global population analysis, by the U.N. Department of Economic and Social Affairs, projects growth from a 2019 population of 7.7 billion to an average estimate of 9.7 billion by 2050, (amounting to a 26 percent increase.) A further but less rapid increase, to 10.9 billion is projected by 2100, a total increase of 42 percent since 2019. This places obvious demands on accessibility to water

and food and there are several factors that pose significant challenges to meeting these demands.

Climate change is already bringing increasingly severe heat waves and droughts, interspersed with flooding, along with severe storms and wildfires, all affecting food production. Glaciers are melting, which have served as major sources of fresh water.

While climate change may bring longer growing seasons in northern latitudes, most of the population growth will occur in India, Pakistan and sub-Saharan Africa—just the locations where the impact of climate change on food production will be most severe. Throughout much of the heavily populated parts of the world, ground water depletion is affecting water supply for both irrigation and drinking.

Food shortages lead to civil unrest, especially from the mass migrations that are already occurring and that are driven partly from food insecurity. This civil unrest in turn causes further food insecurity.

Loss of Top Soil and the Degradation of Soil Health: An urgent problem

In addition, there is a little-noted but severe problem with the loss and deteriorating health of much of the world's top soil.[1] The loss and deterioration of soil can take several forms. Water and wind erosion--recall the 'dust bowl' of the great plains--is one main cause. "Desertification", the possibly irreversible conversion of arable land in dry climates to non-arable desert, is another. The combination of climate change and over-harvesting of crops, especially in the Sahel, (the region between the Sahara Desert and the tropical rainy areas of equatorial Africa), is causing the Saharan desert to spread southward.

Even without actual soil loss, soil can become unproductive in terms of yields or nutrition. It can become too salty or too acidic, and the microscopic organisms necessary for producing healthy and abundant crops can be destroyed or imbalanced.

The impacts of improper care of the soil are not limited to the soil itself, since soil washed away results in silt buildup and degradation of streams and rivers.

All of these impacts are largely the result of poor agricultural practices—overgrazing of livestock, overuse of pesticides or artificial fertilizers (resulting in algae blooms), failure to rotate crops, and inadequate use of cover grasses.

If this were all there were to say about soil health it would be discouraging, to say the least. But, through some chance encounters, I have learned that there are positive developments and opportunities for achieving the soil objectives of the Green New Deal noted above.

I happened to hear about an organization called "Farmers and Ranchers for a Green New Deal", (FRGND) formed under the auspices of a global organization called "Regeneration International."[2] There are now about 10,000 FRGND members in the U.S., two of whom, I discovered, are in San Luis Obispo County. Another chance encounter led to my meeting Dr. Timothy LaSalle, professor emeritus at Cal Poly State University and Adjunct Professor at Cal State Chico.

Through these contacts here is a little bit of what I have learned.

Regenerative Farming and

Biologically Enhanced Agricultural Management ("BEAM")

Dr. LaSalle, and a colleague of his, Dr. David Johnson (New Mexico State University), are proponents and practitioners of what they call BEAM: Biologically Enhanced Agricultural Management. The basic ideas of BEAM are described in the link in footnote three[3] and summarized here.

Proper balance between fungal and bacterial components of the soil:

Although some might think of soil as nothing more than 'dirt', healthy soil in fact teems with microorganisms. Generally, the mass of bacterial organisms is substantially larger than the fungal mass, whereas what BEAM strives for is a fungal-to-bacterial ratio of somewhat greater than one.

Frequent planting and harvesting, re-planting and re-harvesting, of cover grasses:

These provide organic matter for the soil and reduce evaporation and runoff.

Application of a thin layer of compost using a new type of 'no-turn bioreactor' (composter):

Use of this compost, together with the other BEAM principles, leads to the desired fungal/bacterial ratio. The design and use of this bioreactor is given in the link in this footnote.[4] (The bioreactor described in the link to footnote four is fairly large; Dr. LaSalle is experimenting with a smaller one.)

Figure 1. The Johnson-Su bioreactor, designed by Dr. David Johnson and his wife Hui-Chun Su. A video describing in detail how to build and use the bioreactor can be accessed through the link given in footnote 4.

No-tillage farming:

The following description of the rationale and benefits of no-till farming is an excerpt from the longer account in the link to this footnote.[5]

> From a soil perspective, the benefits of no-till farming far outnumber those of tillage-based systems. No-till practices allow the soil structure to stay intact and also protect the soil by leaving crop residue on the soil surface. Improved soil structure and soil cover increase the soil's ability to absorb and infiltrate water, which in turn reduces soil erosion and runoff and prevents pollution from entering nearby water sources. No-till practices also slow evaporation, which not only means better absorption of rainwater, but it also increases irrigation efficiency, ultimately leading to higher yields, especially during hot and dry weather. Soil microorganisms, fungi and bacteria, critical to soil health, also benefit from no-till practices. When soil is left undisturbed, beneficial soil organisms can establish

> their communities and feed off of the soil's organic matter. A healthy soil biome is important for nutrient cycling and suppressing plant diseases. As soil organic matter improves, so does the soil's internal structure—increasing the soil's capacity to grow more nutrient-dense crops.

Avoidance of synthetic fertilizers, pesticides and herbicides:

This is an appropriate place to emphasize that BEAM is not simply 'organic farming', but involves much more. However, if the above practices are followed it has been found that synthetic fertilizers, pesticides and herbicides need not, and should not, be used. In fact, they are damaging and undesirable. Fertilizers are costly and energy-intensive to produce and the runoff into waterways and the ocean produces dead-zones and harmful algae blooms. Pesticides and herbicides destroy the very mix of organisms that BEAM produces.

"Regenerative Grazing":

I suspect that I was not alone among my environmentally-aware friends in the belief that all livestock production is bad. But, as described in the Oklahoma musical, I am learning that there is a case to be made that "the farmers and the ranch hands should be friends"—*provided* the ranchers practice what is termed 'regenerative grazing'. The larger question of whether we as individuals and human society worldwide would be better off if no meat were raised or eaten is a much larger topic. In this section I will simply summarize what is described as 'regenerative grazing'.

The following is excerpted from the discussion given in the link in footnote 7:

> Low-labor, industrial grazing is typified by low-density animal stocking occupying the same land area over long periods of time …[whereas what is desirable is] regenerative grazing, which builds soil and grows the healthiest animals. When a large number of densely packed, heavy animals moves through a landscape quickly, occupying that landscape just once or twice a season, the following soil-building events tend to occur: Tall grasses, with correspondingly deep roots, are grazed down to within a foot of the ground *but not completely down to the ground*; grazing to the putting green level damages the plant's ability to rebound. The deeper the roots have penetrated, the deeper into the soil this organic deposition occurs. Densely packed animals provide nitrogen in the form of urine manure as they graze. They also turn up clods of sod, allowing access for rainwater to bring the newly deposited nitrogen and biological activity (microbes in the manure) into the soil. Grasses left standing six to twelve inches by the quickly moving herd rebound rapidly and are allowed to grow to hip height or taller before the herd is brought back again.

These practices mimic the naturally occurring situation of the thriving prairie grasses of the Great Plains where herds of bison roamed before their extinction. There are arguments to be made that bison are preferable to cattle from the point of view of both soil management and nutrition,[6] though there are differences of opinion about this. For more discussion about regenerative grazing see the link given in this footnote.[7]

Results from BEAM Practices

I must confess that when I first encountered these ideas I was skeptical. Like all suggestions that run counter to 'conventional wisdom' they encounter criticism and must be subjected to convincing experimental verification. This convincing evidence seems to me to exist though there is certainly more research to be carried out over a wide variety of crops, soils and climate.

The following discussion on CO2 sequestration is taken from the paper by Dr. Johnson referred to in footnote eight.[8]

CO2 sequestration with BEAM:

Climate scientists are becoming increasingly convinced that not only must we rapidly reduce carbon emissions, but if the worst effects of a warming climate are to be avoided, we must in addition find ways to remove ("sequester") some of the carbon dioxide we have added to the atmosphere. Research into technical procedures aimed at sequestration of carbon at the source of electricity generation (e.g. that emitted from gas-fired turbines) or removing it directly from the atmosphere into the ocean or land are underway. At present, however, these procedures are very expensive and will be difficult to scale up to the level needed.

Vegetation and forests remove CO2 from the atmosphere via photosynthesis and so one proposal aims at planting vast numbers of trees on land already cleared for crop production, in order to absorb some of the CO2. However, as discussed in the paper referenced in footnote 8, this approach is not as attractive as one might think. First, it is not particularly efficient, and studies show that it removes about a quarter of a ton of carbon per hectare per year. (A hectare is a metric system measure of area and is equal to about 2.5 acres.) Second, as the climate warms and droughts become more frequent, wildfires have become more intense as the horrible fire season in Australia showed. The sequestered carbon is then released

right back into the atmosphere as a consequence. Third, it reduces the amount of land available for agricultural production which will be needed for securing food for a growing population.

The experiments conducted thus far using BEAM practices suggest a huge increase in the amount of carbon that can be sequestered in the soil compared to the forest program, by up to as much as 10 times for range lands and 20-40 times for farmland soils.

The beauty of the soil management sequestration described is that it is very inexpensive, a tiny fraction of the cost of the more technical approaches. Additionally, it is equally applicable in both developed nations and in the developing world. Dr. LaSalle has regularly visited developing nations in Africa to teach BEAM practices. Here are two photos from one of his Africa visits.

Figure 2. Colleagues from Africa helping to implement BEAM practices posing with a new bioreactor in Kenya.

Figure 3. A sorghum crop being grown in revitalized soil using BEAM practices in Africa.

In addition to the carbon sequestration achieved by means of BEAM soil management, there are several additional important benefits: Crop yields are significantly improved. The nutritional value of the crops is improved. Costly use of fertilizers is avoided along with avoidance of the health risks from herbicides and pesticides. And, especially important in drought or flood-prone areas: better soil retention of moisture and avoidance of flood-causing runoff with heavy rains.

I often hear claims of advances that sound 'too good to be true', and therefore usually aren't true! But the evidence has persuaded me that following these agricultural practices can have transformative and hugely beneficial global consequences.

[1] See https://www.worldwildlife.org/threats/soil-erosion-and-degradation as well as https://www.globalagriculture.org/report-topics/soil-fertility-and-erosion.html for more comprehensive discussion of top soil loss and degradation

[2] See https://regenerationinternational.org/farmers-ranchers-green-new-deal/ for information about FRGND and https://regenerationinternational.org/about-us/ about Regeneration International.

[3] The basic tenets of BEAM are described here: https://www.csuchico.edu/regenerativeagriculture/bioreactor/david-johnson.shtml

[4] Here is a description of the Johnson-Su bioreactor:https://www.csuchico.edu/regenerativeagriculture/bioreactor/bioreactor-instructions.shtml.

[5] See here for a longer account of no-till farming: https://regenerationinternational.org/2018/06/24/no-till-farming/

[6] The following link is to the audio and transcript of the virtues of bison over cattle from a segment from the program “Living on Earth”: https://www.loe.org/shows/segments.html?programID=19-P13-00040&segmentID=5

[7] See https://www.motherearthnews.com/homesteading-and-livestock/sustainable-farming/regenerative-grazing-ze0z1409zhur for a summary of regenerative grazing.

[8] This paper describes and documents the very substantial gains in soil sequestration of CO2 from the atmosphere resulting from BEAM practices: https://www.csuchico.edu/regenerativeagriculture/_assets/documents/research-david-johnson-atmospheric-co2-reduction-final.pdf