The Oil Drum: Campfire

Discussions about Energy and Our Future

The 50-year farm bill

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This is an article by Wes Jackson that was previously published by Solutions Journal. We have included a few Campfire questions at the end.

The Trouble with Agriculture

Across the farmlands of the U.S. and the world, climate change overshadows an ecological and cultural crisis of unequaled scale: soil erosion, loss of wild biodiversity, poisoned land and water, salinization, expanding dead zones, and the demise of rural communities. The Millennium Ecosystem Assessment (MEA) concludes that agriculture is the "largest threat to biodiversity and ecosystem function of any single human activity."[1] Up to 40 percent of global croplands are experiencing soil erosion, reduced fertility, or overgrazing.[2] It is likely that agricultural acreage worldwide will expand over the next two to three decades, especially as the human population increases to eight to 10 billion people. The same thing that drives climate change helps drive the agricultural crisis—cheap fossil fuel.

In the U.S., commodity subsidies that focus on bushels per acre, an industrial model that much of the world wants to imitate, continue to drive this increasingly unsustainable agricultural economy. Over the past century, the number of farms in the U.S. has declined as the average farm size has increased. At the same time, the number of commodities per farm—such as corn, wheat, barley, soybeans, alfalfa, tobacco, potatoes, pigs, and chickens—has decreased from an average of five to just one product.[3] American agriculture is guided by five-year farm bills and heavily entrenched subsidies. Export policy is the driver designed to offset our nation's balance of payments deficit, which includes the purchase of foreign oil.

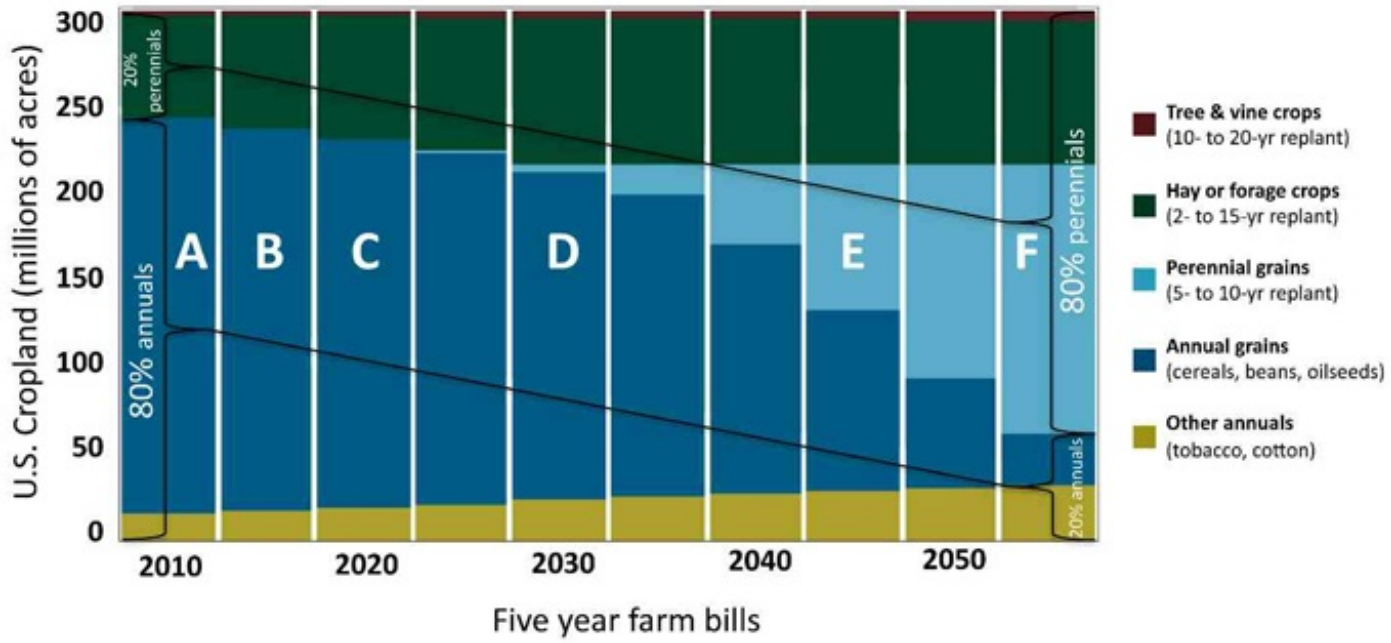
We need a long-term, conserving vision to counteract these trends. Five-year farm bills should be mileposts in a 50-year journey to end degradation of our agricultural capital. Where do we begin? The United States is a big country, and the ecological mosaic is daunting. There are the soils of the upper Midwest, deep and rich in nutrients from the Pleistocene's scouring ice and watered by the moisture favorably blown from the Gulf of Mexico. What have we done with this land? Soil erosion, nitrogen fertilizer, and pesticides have seriously degraded this gift of good land, the best contiguous stretch in the world. In California, rich valleys and reliable snow pack in a Mediterranean environment lessen the problem of soil erosion. But there is spraying, salinization, accumulation of toxins in the delta, and loss of farmland to sprawl.

One could continue the inventory, but the point is that each region has its own problems and opportunities. We must acknowledge that all successful corrections will be local. And that plays to an often-overlooked point: The decline of fossil fuels will require a higher eyes-to-acre ratio,

which means more farmers on the land. Cultural and ecological adaptation become one subject.

Looking broadly, the USDA and the secretary of agriculture should see that our first order of business should be to prevent our soils from eroding and declining in quality—they are the source of most of the nutrients that feed us. If our soils are protected, the water falling on them can be protected and properly used on its trip to the atmosphere, ocean, or aquifer. The United States has about 400 million acres of cropland, with around 36 million acres placed in the Conservation Reserve Program.[4,5] The secretary of agriculture must look at the aggregate use of these croplands. At any one time, 80 percent of that land grows annual crops. The other 20 percent is in perennials, such as pastures or hay, although, to be clear, sometimes in a rotation with annuals such as corn or sorghum.

Such an overview quickly draws one's attention to the core of what might be called "the problem of agriculture": essentially all of the high-yield crops that feed humanity—including rice, wheat, corn, soybeans, and peanuts—are annuals. With cropping of annuals, alive just part of the year and weakly rooted even then, comes more loss of precious soil, nutrients, and water.



The Land Institute

Summary of the possible. Protecting our soils with perennials.

A. 2010: Hay or grazing operations will continue as they exist. Preparations for subsidy changes begin.

B. 2015: Subsidies become incentive to substitute perennial grass in rotations for feed grain in meat, egg, and milk production.

C. 2020: The first perennial wheat, Kernza™, will be farmer-ready for limited acreage.

D. 2030: Educate farmers and consumers about new perennial grain crops.

E. 2045: New perennial grain varieties will be ready for expanded geographical range. Also potential for grazing and hay.

F. 2055: High-value annual crops are mainly grown on the least erodible fields as short rotations between perennial crops.

But the problem of agriculture is about more than the annual condition. It is also about growing crops in vast, unnatural monocultures. This makes harvest easy, but there is *only one kind* of root architecture in any given field; the living roots are not there year-round, and therefore, manage nutrients and water poorly. Waste of both is the rule.

The trouble with agriculture is not a recent development. Soil erosion and soil salting brought down civilizations long before the industrial and chemical era. Why the crisis now? Simply, a surge in human population—which has doubled from about 3.3 billion in 1965 to almost 7 billion now—with land lost to sprawl and the remainder used far more intensively, and the accumulation of large dead zones in our oceans.

What is the alternative? Prudence requires one to first look to nature, the ultimate source of our food and production, no matter how independent we feel we have become. If we look at essentially all of the natural land ecosystems within the ecosphere, from alpine meadows to rainforests, we see that mixtures of perennial plants rule.[6] Annuals are opportunists that sprout, reproduce, throw seeds, and die. Perennials hold on for the long haul, protect the soil, and manage nutrients and water to a fine degree. In this regard perennials are superior to annuals, whether in polyculture or monoculture. The Land Institute's long-standing mission has been to perennialize several major crops, such as wheat, sorghum, and sunflower, and domesticate a few wild perennial species to produce food like their annual analogs. The goal is to grow them in various mixtures according to what the landscape requires. With the pre-agricultural ecosystem as the standard, the institute is attempting to bring as many processes of the wild to the farm as possible, below as well as above the surface.

A 50-Year Vision - A Brief Summary

Five-year farm bills address:

- Exports
- Commodities
- Subsidies
- Some soil conservation measures
- Food programs

A 50-Year Farm Bill would be a program using these bills as mileposts, adding larger, more sustainable goals to existing programs:

- Protect soil from erosion
- Cut fossil-fuel dependence to zero
- Sequester carbon
- Reduce toxics in soil and water
- Manage nitrogen carefully

- Reduce dead zones
- Cut wasteful water use
- Preserve or rebuild farm communities.

Because these perennial crops will not begin to be ready for the farmer on any appreciable scale for another quarter-century, we must make do by perennializing the landscape in other ways. A first step should be to increase the number of pastures and have fewer livestock in the feedlot by phasing out subsidies for production-oriented grain commodities, that industry's lifeblood. Saving the soil and allowing water to improve is more important than having too much meat or corn sugar.

What about California and elsewhere across the mosaic, where soil erosion is less serious? First, perennials are superior for managing nutrients and water.[7] Second, species mixtures can form barriers to outbreaks of insects and epidemics of disease. So nature's example can be referred to no matter where the landscape. This will start what Wendell Berry calls a "conversation with nature," which begins with three questions: What was here? What will nature require of us here? And what will nature help us do here?

To address these issues, the following proposal for a 50-Year Farm Bill is offered for action.

A 50-Year Plan for Change

Current USDA planning uses five-year plans that are really just instruments for protecting our current failing system. They address exports—designed to offset the nation's deficit, including the purchase of foreign oil—commodity subsidies that focus on bushels per acre, subsidies, food programs, and some soil measures. We suggest using the five-year increments to build a radically different type of agriculture: a 50-year vision of perennial, low-impact agriculture.

In the short run, this plan will encourage farmers to increase the use of perennial grasses and legumes in crop rotations. This will help protect our soils and reduce the need for fertilizer, while preparing farms for the use of perennial grains.

Pastures and perennial forage crops are already available in permanent stands and rotations. We propose incentives that would maintain the present perennial acres and increase their presence in rotations. When perennial grains become available, they will require no financial subsidy, since they will represent a compelling alternative.

As more of our acreage switches to perennial agriculture, and with the 50 years of concerted investment in research, education, and incentives envisaged in the plan, we can expect to see perennial crops increase from 20 to 80 percent of the land.

American agriculture is widely used as a model for the rest of the world. Although a U.S. perennial program would not solve all agricultural problems, it could be helpful around the world: Some perennialized grains could be planted elsewhere. Many techniques developed to perennialize U.S. agriculture could be applied to native plants in other countries. American expertise could be exported much as it is today, to help with the sustainability problems of agriculture elsewhere. In other words, the same American approach to improving agriculture that led to the first worldwide Green Revolution could lead to a sustainable green revolution.

At the Heart of the Plan

We recognize that breeding perenniality into a broad spectrum of grain crops will take time. Even so, prototypes have thrived for several years in Kansas.[8] As their yields increase, they will replace their annual relatives—one prototype in as few as 10 years. Initially, these crops will be released on a limited scale, and researchers will work with farmers on agronomic problems, such as seeding density and planting time, as they arise.

Wheat has been hybridized with several different perennial species to produce viable, fertile offspring. We have produced thousands of such plants. Many rounds of crossing, testing, and selection will be necessary before perennial wheat varieties are available for use on the farm. Kernza™ is our trademark name for Intermediate Wheatgrass, *Thinopyrum intermedium*, a perennial relative of wheat. Using parental strains from the USDA and other sources, we have established genetically diverse populations. In 2009, we harvested 30 acres and planted an additional 126. The overall nutritional quality is superior to that of annual wheat.

Grain Sorghum is a drought-hardy feed grain in North America and a staple human food crop in Asia and Africa, where it provides reliable harvests in places where hunger is always a threat. It can be hybridized with the perennial species *Sorghum halepense*. We have produced large plant populations from hundreds of such hybrids and have selected perennial strains with seed size and grain yields up to 50 percent of those of annual grain sorghum.

Illinois Bundleflower, *Desmanthus illinoiensis*, is a native prairie legume that fixes atmospheric nitrogen and produces abundant protein-rich seed. It is one of our strongest candidates for domestication as a crop. We have assembled a large collection of seed from a wide geographical area and have a breeding program. We see this plant as a partial substitute for the soybean.

Sunflower is another annual crop that we have hybridized with perennial species in its genus, including *Helianthus maximiliani*, *H. rigidus*, and *H. tuberosus* (commonly known as Jerusalem Artichoke). Breeding work has turned out strongly perennial plants. Genetic stabilization will improve their seed production.

Upland fields of annual rice are highly vulnerable to erosion, yet millions of people in Asia depend on them. In the 1990s, the International Rice Research Institute achieved significant progress toward breeding a **perennial upland rice** using crosses between the annual *Oryza sativa* and two wild perennial species, *Oryza rufipogon* and *O. longistaminata*.[9] The project was terminated in 2001, but the breeding and genetic populations were transferred to the Yunnan Academy of Agricultural Sciences in southwestern China, where work has been continued with funding support from The Land Institute. The focus is now on the more difficult work with the distantly related *O. longistaminata*, which, when crossed with rice, produces plants with underground stems called rhizomes.[10] In recent breakthroughs, a small number of perennial plants with good seed production have been produced.

Corn and **soybeans** are two species that, more than any other crop, we need to perennialize. **Corn** is a top carbohydrate producer, typically grown on more than 70 million acres annually.[4] Until soybean acreage increased, corn caused the greatest amount of soil erosion in the United States. It will be a challenge to perennialize this crop, but serious consideration is being given to doing so by exploring two main paths. 1) We could obtain genes from a few distant relatives of

corn that are in the genus *Tripsicum*. All are perennial and at least one is winter hardy. 2.) The other, more likely route would be to cross with two much closer perennial relatives of corn. Unfortunately, both species, *Zea perennis* and *Z. diploperennis,* are tropical and not winter hardy. Further research is clearly necessary before we can replace traditional corn.

Several Australian species of the **soybean** genus *Glycine* are perennial; they are difficult to breed with soybean but are potential targets for direct domestication, without crossing with soybean. Our exploration of perennializing soybeans has been very limited. For now, we are working to make Illinois Bundleflower a satisfying substitute.

To mimic a natural ecosystem will require some degree of crop diversity, and there is potential for many more perennial grains, including rosinseed, Eastern Gamagrass, chickpea, millet, flax, and a range of native plants. We have elected not to wait until perennial grain crops are fully developed to gain experience with the ecological context in which they will grow. At The Land Institute we have established long-term ecological plots of close analogs in which to compare methods of perennial crop management. Our perennial-grain prototypes, including Kernza™ and bundleflower, allow us to initiate long-term ecological and production research in these plots. For other crops we are forced to use analogs, but eventually, true perennial grain mixtures will replace them. Additionally, ongoing studies of natural ecosystems, such as tallgrass prairie, provide insight into the functioning of natural plant communities. The prairie is now, and will always be, a valued teacher.

Who Will Pay?

We propose that, over an eight-year period, federal funding would sponsor 80 plant breeders and geneticists who would develop perennial grain, legume, and oilseed crops, and 30 agricultural and ecological scientists who would develop the necessary agronomic systems. They would work on six to eight major crop species at diverse locations. Budgeting $400,000 per scientist per year for salaries and research costs would add less than $50 million annually. This is less than 10 percent of the amount that the public and private sectors have been spending on plant breeding research in recent years.

Implementation will depend on endorsement by the secretary of agriculture, the president, Congress, nonprofit organizations, corporations, and citizens. The Land Institute will offer free germplasm and more than three decades of experience with perennials to the project.

Conclusion

Essentially all of nature's ecosystems feature perennial plants growing in species mixtures, systems that build soil. Agriculture reversed that process nearly everywhere by substituting annual monocultures. As a result, ecosystem services—including soil fertility—have been degraded. Most land available for new production is of marginal quality that declines quickly. The resulting biodiversity loss gets deserved attention, soil erosion less.

Perennialization of the 70 percent of cropland now growing grains has the potential to extend the productive life of our soils from the current tens or hundreds of years to thousands or tens of thousands. New perennial crops, like their wild relatives, seem certain to be more resilient to climate change. Without a doubt, they will increase sequestration of carbon. They will reduce the land runoff that is creating coastal dead zones and affecting fisheries and maintain the quality of

scarce surface and ground water. American food security will improve. It won't be easy to overturn 45 years of American policy and centuries of turning to annuals. There are entrenched interests that can slow change—just look at the recent battle over healthcare in the U.S. Congress—but the social stability and ecological sustainability resulting from secure perennial food supplies make the fight worthwhile. A 50-Year Farm Bill will buy time to confront the intersecting issues of climate, population, water, and biodiversity.

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Questions

1, Does starting this kind of a 50-year plan now make sense?

2. If it such a plan might work, what secondary benefits do you see? For example, might some of the biomass be helpful for heating?

3. Can you think of any modifications to this plan, that might make it easier or faster to implement in a low carbon world?

4. Are there drawbacks to such a plan?