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# *We Can Now Solve the 10,000-Year-Old Problem of Agriculture*

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My beginning fix on native prairie happened during the summer of 1952 when I was sixteen. I worked on a ranch near White River, South Dakota, close to the Rosebud Indian Reservation, and lived in the shack pictured in Figure 1. Years later, I began to grasp the importance of nature's ecosystems. It happened in my own state of Kansas, where we have thousands of acres of prairie ranging from tall to short grass (Figure 2). One June day in 1977, two friends and I visited a tallgrass prairie in the Flint Hills after a drenching rain. On the way home, we saw farmers' fields similar to the one in Figure 3.

On the prairie (Figure 2), nature's ecosystem is resilient and more or less free of damaging erosion, unlike grain agriculture (Figure 3). Why this is so has to do with what lies below the surface. Figure 4 reveals a network of perennial roots of various structures in prairie soil, whereas Figure 5 provides a contrast between perennials and annuals of closely related species, both in monoculture. On the left is perennial wheatgrass, which we have named *Kernza*<sup>™</sup>. On the right is common annual bread wheat.

## HERBACEOUS PERENNIALS

How does a farmer manage herbaceous perennial seed-producing polycultures? We can take a clue from the native prairie, still in existence, as our standard. Nature uses fire as one "management tool" (Figure 6) and grazing as another, as exemplified by bison on The Land Institute prairie (Figure 7).

Since most farmers are disinclined to produce bison, the domestic bovine is a close enough analog (Figure 8, Flint Hills). The domestic alternative, like its wild relative, is a selective grazer.

A non-selective "grazer" is the mowing machine (Figure 9).



Figure 1.



Figure 2.



Figure 3. (courtesy of Andy Larson)



Figure 4. (courtesy of Jim Richardson)

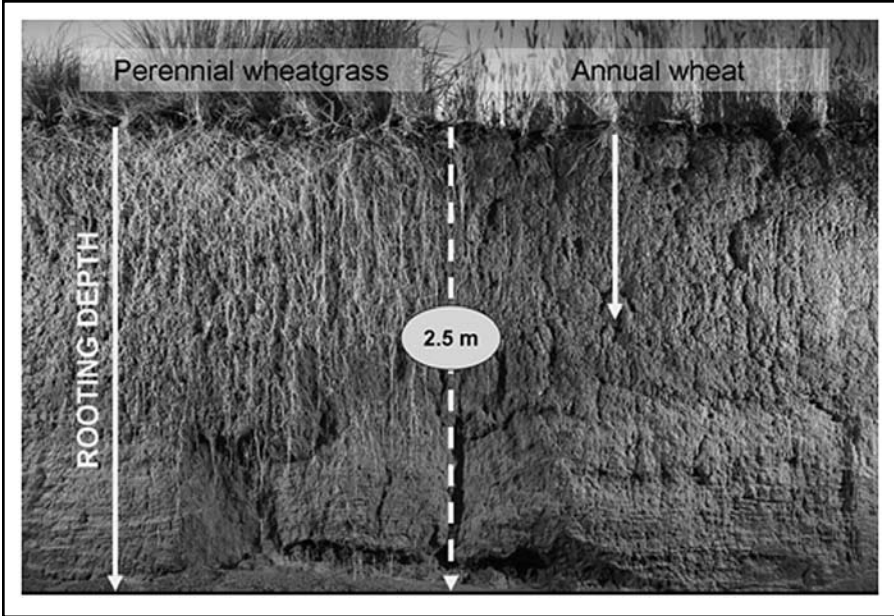


Figure 5.



Figure 6. (courtesy of Jim Richardson)



Figure 7.



Figure 8. (courtesy of Jim Richardson)



Figure 9. (courtesy of *The Draft Horse Journal*)

When we combine fire with selective and non-selective grazers, we see the potential for future management tools.

Such agriculture, admittedly, would be a radical departure from what farmers have done for the past 10,000 years, but the necessity for something different in the way we interact with the land can be seen from various points of view. For example, the Millennium Ecosystem Assessment (2005), sponsored by the United Nations, concluded that agriculture is the “largest threat to biodiversity and ecosystem function of any single human activity.”

But there is promising news. Ecologist Chris Field (2001), writing in *Science*, concluded from a survey of the earth’s ecosystems that, “In most parts of the world, human activities, and agriculture in particular, have resulted in decreases in net primary productivity from the levels that likely existed prior to human management.”

For nearly three and a half decades, The Land Institute has addressed “the problem of agriculture” by mimicking nature’s ecosystems. We do so with herbaceous perennials in mixtures. The first step is to breed perennial grain-producing crops. Dr. Shuwen Wang, a molecular geneticist at The Land Institute is working to develop perennial wheat. Dr. Stan Cox is developing a winter-hardy perennial sorghum. Dr. David Van Tassel is working on perennial sunflowers as well as a perennial legume known as Illinois bundleflower. In addition, The Land Institute provides financial support to Dr. Hu Fengyi, who is developing a perennial upland rice for steep hillsides in China and elsewhere, where soil erosion is extreme. Good progress is being made on all fronts by these breeders.

Once we move our minds to consider perennial polycultures, our imagination then leaps to new possibilities. To help with this leap, consider Figure 10, with the hierarchy reaching from the ecosphere to the atom.

• <b>Ecosphere</b>	—	<b>Whole Earth</b>
• <b>Ecosystem</b>	—	<b>Prairie, Rainforest, etc.</b>
• <b>Organisms</b>	—	<b>Humans, Dogs, etc.</b>
• <b>Organs</b>	—	<b>Liver, Heart, etc.</b>
• <b>Tissues</b>	—	<b>Muscle,</b>
• <b>Cells</b>	—	<b>Any</b>
• <b>Molecules</b>	—	<b>DNA, Protein</b>
• <b>Atoms</b>	—	<b>Carbon, Nitrogen, etc.</b>

Figure 10.

After ecosphere is ecosystem, a slab of space/time that includes both the biotic and the physical. It should be clear to all that countless ecosystem processes that function in the wild are greatly limited in annual monocultures, which is akin to clear-cutting a forest every year; the chance for many processes in the wild to return to the land is greatly reduced. But with perennials on the horizon, what ecologists have been learning over more than a century can begin to be applied to grain production.

This idea is gaining traction. In 1997, an international conference in Australia was devoted to the theme of *Agriculture as a Mimic of Natural Ecosystems* and a proceedings volume was published (Lefroy *et al.*, 1999). Since then, global research to develop perennial grains has expanded. Most of the germplasm derived from our scientists' efforts at The Land Institute is in the hands of researchers in Australia, Canada, Nepal, China and elsewhere in the United States. This spread of interest and research has led to the validation of the desirability of perennial grains by the National Research Council (2010) of the National Academy of Science:

*Perennial plants reduce erosion risks, sequester more carbon, and require less fuel, fertilizer, and pesticides to grow than their annual counterparts.*

And the Royal Society (2009) provided a similar endorsement:

*Perennial crops would store more carbon, maintain better soil and water quality and would be consistent with minimum till practice. These crops would also manage nutrients more conservatively than conventional annual crops, and they would have greater biomass and resource management capacity.*

Conventional thinking leads to saying that if we are to preserve biodiversity, we will have to intensify agriculture. The typical language of dualism says "production at the expense of conservation" or "conservation at the expense of production." Instead, we can now imagine "conservation as a consequence of production."

## PREMINENCE OF GRAINS

On the table for us to consider are not forests or range lands. Nor are vegetables and fruits. On the table are grains, because they are the source of 70% of our calories. Grains have long been central. A 1565 painting by Peter Bruegel (Figure 11) shows that nearly 100% of the agricultural landscape was devoted to grain production. Even the trees—apple and pear here—have their lower limbs removed to allow light through to foster crop growth.

Figure 12 shows the distribution of crops grown in the United States.

## IN SUMMARY

If we are to solve the 10,000-year-old problem of agriculture, the most predominant feature of which has been soil erosion, we will need to develop perennial grains. If we are to adequately manage insects, pathogens and weeds as well as biological nitrogen fixation, we will need polycultures.

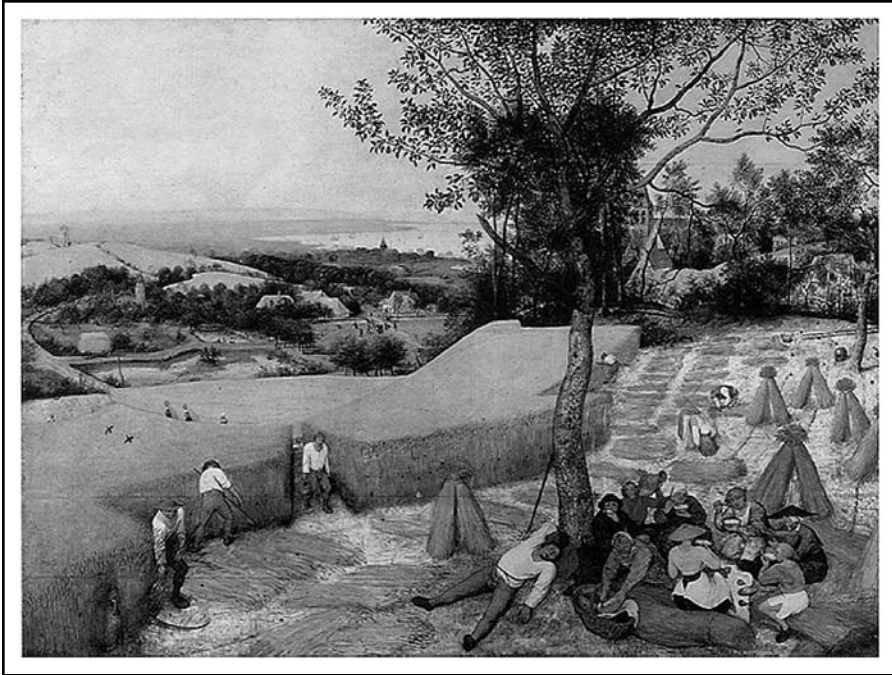


Figure 11

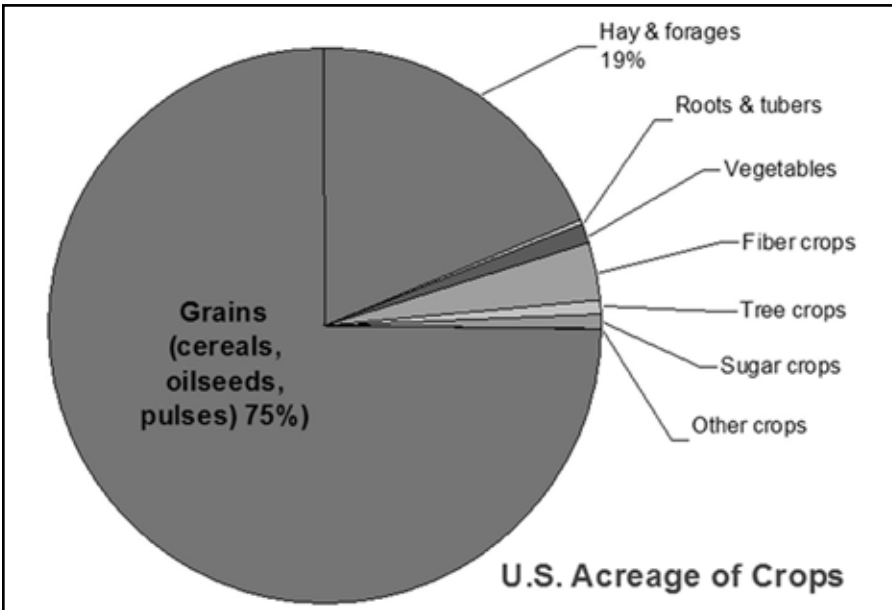


Figure 12.



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**WES JACKSON** earned a BA in biology from Kansas Wesleyan, an MA in botany from the University of Kansas, and a PhD in genetics from North Carolina State University. He established and served as chair of one of the country's first environmental studies programs at California State University-Sacramento and then returned to his native Kansas to found The Land Institute in 1976. *LIFE* magazine named him as one of eighteen individuals they predicted would be among the 100 "important Americans of the 20th century." In 2005, *Smithsonian* named him one of "35 Who Made a Difference," and in 2009 he was included in *Rolling Stone's* "100 Agents of Change." Work of The Land Institute has been featured extensively in the popular media, including *The Atlantic Monthly*, *Audubon*, *National Geographic*, *Time Magazine*, *The MacNeil-Lehrer News Hour*, and *All Things Considered* on National Public Radio. Dr. Jackson is a recipient of the Pew Conservation Scholars award (1990), a MacArthur Fellowship (1992), a Right Livelihood Award (Stockholm)—known as the "Alternative Nobel Prize" (2000)—and the Louis Bromfield Award (2010). His writings include the recent works, *Nature as Measure* (2011) and *Consulting the Genius of the Place: An Ecological Approach to a New Agriculture* (2010).