Grassland Ecosystem Restoration

Successional Brushland & Oak Savanna as an Ecological Model for Permanent Staple Crop Production in North America

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The United States of America is the self-proclaimed "breadbasket of the world." There is no denying the massive quantity of staple food crops (corn, soybeans, wheat, rice) that the United States produces. However, more and more people are coming to realize that there's something moldy in the breadbasket.

There is mounting evidence (with supporting documentation courtesy of the USDA) that annual agriculture, as practiced today, is now one of the most destructive technologies on the planet. What could possibly be more destructive than rendering sterile, with toxic chemicals, one-third of the surface area of a continent? Unless it is turning over the top 16-24 inches of the soil with plows, once or more every single year?

Agriculture kills everything in a given area except the crop, and for up to eight months of the year agriculture leaves the soil exposed, free to blow away in the wind or wash away in the rain. Even when a mature annual crop is in the field, the soil surface is usually bare, exposed to wind and water erosion.

Annual agriculture also contaminates the water supply in many ways, including direct runoff of highly toxic chemicals. Tillage oxidizes organic matter, releasing CO_2 into the atmosphere contributing to the greenhouse effect. Soluble nitrogen fertilizers oxidize; into nitrous oxides; greenhouse gasses that are even more effective at trapping heat than CO_2. American agriculture is claimed to be responsible for up to 17 percent of all greenhouse gas emissions in the form of CO_2, nitrous oxides and methane. Annual agriculture in the Midwest is one of the largest contributors to the collapse of the multi-billion dollar fishery business in the Gulf of Mexico because of sedimentation, over-fertilization, and the creation of the anoxic (lacking oxygen) dead zone that seasonally affects over 10,000 square miles of the Gulf.

As the flaws in our agricultural system become financially apparent, family-scale farmers are going broke as fast as ever. Farm size is increasing. Large, supposedly efficient confinement livestock operations are becoming the rule rather than the exception. Even with greater economic efficiencies, these large farms are in trouble. Their resource base (the soil) is degrading and the cost of equipment, fuel, fertilizers, pesticides, herbicides, fungicides and antibiotics use increasing. The federal government continues to subsidize this unprofitable industry, creating tensions with trading nations because of the inequity this causes in world trade.

Are there any real alternatives to this? Most of us reading this article ate today. You and I are totally dependent upon this economically troubled, ecologically flawed agricultural system. While we're at it, we might as well dispel the illusion that organic agriculture alone will be our saving grace. The above-mentioned flaws in our agriculture apply to organic systems as well, differing only in degree and kind. Annual agriculture is annual agriculture, regardless as to what kind of poisons you use or don't use. What are we going to do about this problem while still remaining fed and while we still have the time?

An organic farmer in Wisconsin harrows his field, with green grass in the foreground and 50-foot-tall trees in the background. No soil blows away and more food is available with less energy expenditure.

AN ECOLOGICAL MODEL

Before the breadbasket of the world was ever farmed using modern industrial agricultural technologies, it was a wilderness comprised of forests, prairies, wetlands and savannas. For millions of rears North America's prime agricultural farmland was maintained in incredible health and vitality by natural processes with no human intervention whatsoever. Human intervention began in North America a mere 14,000 or so years ago. The first 13,700 years of human intervention was rather low-intensity, due to the fact that the inhabitants were not industrially organized, and had not yet developed the tools to go with the industrial/ mechanical worldview.

The appearance of the landscape has radically changed in the past 300 years. The old-growth eastern hardwood forest that once spanned from the Atlantic seaboard to beyond the Mississippi River has been decimated. It really exists only in patchy, cut-over remnants. In its place (aside from cities, suburbs, and highways) are vast tracts of agricultural land separated by ditches, weedy fencelines and highway rights-of-way. The fate was the same for the savannas and prairies. The forest, savanna, and prairie biomes formerly supported life, permanent groundcover, and year-round photosynthesis. The agricultural land that replaced these systems lies barren for eight months of the year and supports little to no life at all. When the season is favorable for plant growth, millions of square miles of this former American wilderness grow only a handful of crop species. The soil is bathed with chemical fertilizers and herbicides. An increasing majority of these staple food crops are genetically modified to tolerate the harsh chemical environment in which they must survive.

The appearance of the landscape may have changed, but the natural processes governing life have not. When farmland from Maine to Florida, from the Jersey Shore to the Rocky Mountains (anywhere on Earth, in fact) is abandoned, a miraculous process occurs; the process of plant succession. Briefly summarized, it is the process by which plant communities and their associated animals change over time. An abandoned cornfield in Ohio, for example, will first be colonized by aggressive, fast-growing annual and biennial weeds. By occupying the site, they change the site conditions providing opportunities for perennial grasses and broad-leaved plants to invade, either by wind and animal-borne seed, or by underground roots or shoots. Dead stems and roots from previous plant populations increase the organic matter content of the soil which becomes the energy source for increasingly diverse populations of soil biota from bacteria and fungi to insects and worms.

Once the bare soil has transformed into perennial grassland ecosystem (perhaps taking as little as three years on rich, moist sites or as many as hundreds of years in sandy, droughty or rocky sites) fire and grazing become significant factors affecting species composition. In addition to the usual seasonal rainfall and temperature changes, fire, grazing and moisture are the most significant factors in the natural maintenance of grassland and shrubland ecosystems worldwide. It is during absences of fire that brambles, shrubs and pioneer trees begin to invade what was once bare soil. Some of the common brambles and shrubs to invade grasslands include raspberries, blackberries, wild plum, crabapple and hazelnut. Of these shrubs, the one with the widest historical distribution in North America is the American hazelnut *(Corylus americana)* with a range from 8,000 feet in the Colorado Rockies to the Atlantic coast; just shy of the tundra in Manitoba to the southern Appalachians west to the Ozarks and Texas.

The first trees to move into the grassland would differ slightly, depending on the region of the country, but on the whole they are the same species for the entire continent east of the Rockies. These first trees into the brushy grasslands (successional brushlands) are the oaks, aspens, cottonwoods, white pines, red cedars, box elders and others. The most common sun-loving, grasslands tolerant tree in North America is the Oak. Oaks are in the genus *Quercus* in the family *Fagacea*.

One of the reasons for oak's wide distribution is its ability to survive fire. During times of frequent fire, young oak seedlings lose their tops then re-sprout. This can occur for decades, if not hundreds of years, with the oak roots remaining in the ground and increasing in size and energy resources. These large topless oak roots were called grubs by the early European settlers, presumably because they had to be "grubbed out" with pick axes and shovels. In the absence of fire, or other catastrophic event, grassy oak savanna will become populated with more and more trees and become an oak forest. This oak forest will in turn be invaded by shade tolerant and fire intolerant trees. The mixed forests of eastern North America are the result of this process of disturbed and undisturbed periods (time) and locations (space) over hundreds and thousands of years.

The above summary is an incredibly brief description of a process that is more complex than humans have been able to fully understand. Plant succession, as described above, is how this law of nature occurs through time. Its occurrence in time is dictated by disturbance. Historically disturbance has meant fire and grazing (locally/regionally significant events such as tornado, hurricane and wind-shear contribute to the disturbance regime as well). How this successional pattern occurs in space (distribution across the continent) has been a function of the frequency and severity of these disturbances. The frequency of these disturbances has been driven to a great degree by climate. In moister regions such as the Atlantic Seaboard, most sites were too moist for frequent fires. In the Great Plains where drought was the norm, fires were frequent events. In moist regions such as the East Coast, drier sites with well-drained, sandy soils saw more frequent fires and hence supported fire and drought-tolerant plant communities (xeric communities). Likewise in arid regions such as the Great Plains, moist zones such as found along streamsides and in poorly drained areas supported fire-intolerant and moisture-loving plant communities. In between these two extremes was a broad, patchy spectrum of successional systems dominated in the east by forest and the Great Plains by prairie.

This middle ground between forest and prairie has been much overlooked by researchers; prairie researchers treat it as a degraded prairie that hasn't been burned enough and foresters treat it as a forest in its establishment phase. Both foresters and prairie ecologists have often overlooked the fact that prior to European colonization, this successional stage or sere, occupied 25 percent or more of the landmass east of the Rocky Mountains. It is primarily due to agriculture and the fact that this biological treasure has escaped our perception, that the savanna has been

New Forest Farm in southwest Wisconsin supports chestnuts, hazelnuts, apples, Nanking cherries, grapes, raspberries allowed to grow semi-wild with livestock rotated through periodically. Annual grops were grown between woody plant rows in the early years as did hay and grazing. A system such as this never stops being productive.

declared the most endangered ecosystem on the continent, occupying less than .1 percent of its original range. The heartland of these savanna systems is, significantly, the heartland of North America: the corn and soybean capital of the world.

Since we know that the savanna was self-replicating and self-maintaining for millennia, it would be prudent to examine this system and use it as an ecological model for a truly sustainable, permanent agriculture If we were to produce our crops in systems that mimic the physical characteristics and ecological functions of savanna systems wouldn't the forces of nature, which maintained the savannas for millennia, also maintain our agricultural savannas?

Cattle graze freely in hazelnut polyculture. Cattle need to be rotated through before they eat all the grass and start eating trees. Hogs (with rings in their noses to prevent rooting) graze wherever they want without damage to trees or shrubs. In woody crops intended for human consumption, livestock are grazed post-harvest; during other times of the years they are in their own silvopasture paddocks.

How could we do this?

The first step would be to identify the actual native savanna and brushland species and identify the ones with promise as food crops. Preferably we would choose species with similar nutritional characteristics as the annual crops that they would be replacing. We would then plant them in such a way as to mimic the savanna system as nearly as possible. We would manage these agricultural savannas much the same way that nature would manage them and attempt to mimic the disturbance regime of the particular savanna subtype appropriate to the location. These associations of plants would, of course, be slightly different between regions and soil types. The basic research identifying the various different savanna sub-types has been accomplished.

What were the most significant species in North American savannas? The following list clearly shows the potential for large-scale agricultural production in savanna systems:

Oak
Crabapple
Wild plum
American hazelnut
Raspberries
Wild grape

(Note: Due to space constraints, less widespread or locally adapted species are not listed here.)

All of these species have naturally occurred in association with one another across North America, managed only by nature for millennia.

The work of creating a savanna agriculture is not ecological restoration in the commonly known sense. We are not saving remnant savannas by restoring them to their pre-settlement condition. The work of restoration has a significant value and should be done by those who feel that it is their mission to do so. To coin a new term, the author argues that those involved in the establishment of agricultural savannas are doing what should now be termed restoration agriculture; farming in nature's image.

Farming is the production of basic commodities for food, livestock feed, industrial ingredients, chemical feedstocks, and fuels such as biomass, biodiesel, methanol and ethanol. Since the majority of farms are not concerned about the fact that their cornfields do not mimic nature and are not concerned about non-native plants (soybeans are not native to North America and currently cover millions of square miles), we are likewise not as concerned as a restorationist might be. A reasonable approximation of a savanna ecosystem, with commercial cultivars of savanna species, is infinitely more diverse, sustainable, and natural than a field of genetically modified soybeans! That aside, let's look at an agriculture that reasonably approximates a successional brushland ecosystem. Moreover, let's design a savanna agriculture to replace corn and soybeans using plants that already exist with markets that also exist.

Corn is high in carbohydrate and relatively low in protein and fat. Soybeans are high in protein and moderately high in oils. Together corn and soybeans are the majority of all food and feeds that are produced in the former savanna biome. Both of these' are easily replaceable with fire-tolerant, woody species.

Soybean is most easily replaced with a natural, native savanna specie. As previously mentioned, *Corylus americana,* American hazelnut was the most common savanna shrub species. In the upper Midwest, hazelnut shrubland was a dominant savanna type. Remnants of the vast hazel shrublands still exist in several states, most notably in the Cedar Creek Natural Area in central Minnesota. Hazels came to dominate a shrubland when fires occurred less frequently than 5-10 years, yet more frequently than 20 years. When fires were more frequent

The author checks hazelnut clusters for ripeness on New Forest Farm. Perennial crops pictured include chestnut, hazelnut, apple, pear, grape, raspberries, currants, elderberries, walnut.

than 5-10 years, hazels weren't able to establish. When less frequent than 20 years, oaks grew to a fire resistant size and dominated. From Virginia to Colorado, Missouri to Manitoba, the author observed hazels and oaks co-existing in degraded savanna remnants

What would an agricultural hazelnut shrubland look like? Hazels would obviously be the dominant woody shrub. They would be planted in high-density plantings, arranged so they could be mechanically planted, maintained and harvested. They would not be planted as orchards, which would require weed, pest and disease control and continual pruning. They would be planted as savannas with many of the plants that would naturally be found in association with them in the wild. When possible, marketable prairie plants are planted between rows of hazels providing yet another yield for the farmer.

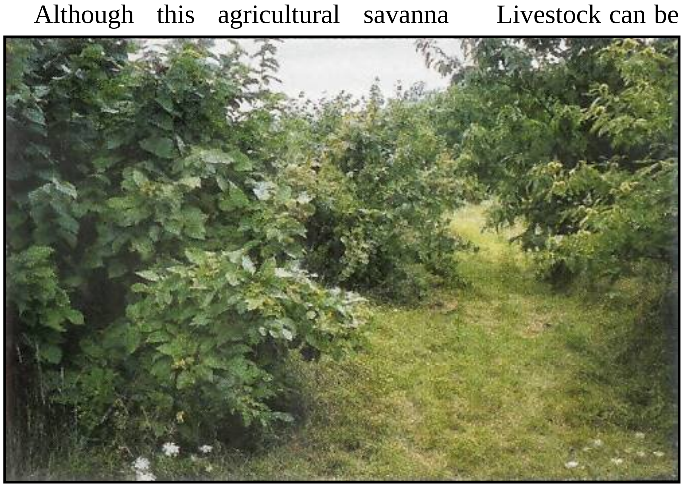
Ecosystem functions such as natural pest and disease suppression which are all but absent in annual crop fields would be intact in a hazelnut shrubland. Pests and predators would be allowed to come into a naturalized equilibrium, which in the long-term, is the lowest cost pest and disease control possible. Annually, seed would be harvested and shells utilized as biomass. Periodic coppice would be used to imitate the rejuvenating effects of fire (removing older and diseased wood and setting back pest populations). The removed wood chips would represent yet another yield to the farmer. In order to mimic natural processes even more closely, a newly coppiced hazelnut field could be burned immediately after coppice or late the following winter.

Although this agricultural savanna technology might sound pie-in-the-sky to some, it is currently being practiced across the upper Midwest by dozens of growers from Ohio to Nebraska. Mechanized planting, maintenance, harvest and post-harvest handling/processing technologies have already been developed. The techniques are mature enough for rapid, widespread adoption. Hybridized hazelnuts have been developed that out yield wild hazels with higher quality kernels and can be rapidly multiplied using stoolbed or tissue culture propagation.

Replacing corn with a similar crop grown in a savanna system requires slightly more intellectual flexibility, in that the dominant savanna tree species, the oaks, would be replaced by a tree not in the same genus, but in the same family, *Fagaceae*. The *Fagaceae* that produces seeds of similar nutritional value as corn is the chestnut, the *Castanea* genus. Traditionally, chestnuts have been grown in an orchard setting. Orchard floors have been mowed, laboriously grafted trees have been pruned, and crops sprayed with fungicides and insecticides. The processes are entirely mechanized. Mature chestnut trees resemble their cousins the oaks in form and in many of their functions. Although fancy, niche market varieties of chestnut may require specific orchard conditions in order to produce satisfactorily, hybridized seedlings, chestnuts have been bred to thrive in savanna systems.

SYSTEMS

Hybrid savanna chestnuts can be grown to tree size or can be managed as a shrub land much like the hazels. Livestock can be grazed beneath an open chestnut canopy in silvopastoral systems, and forage can be harvested between the rows. Chestnuts managed as a shrubland would be coppiced more often precluding timber harvests but allowing for the use of sway-type bush harvesting equipment. Once again, this is not pie-in-the-sky. Growers across the Midwest are successfully growing various species of chestnut in savanna systems.



At New Forest Farm the tallest maturing plants are placed to the north, getting shorter and shorter as the rows are laid out—chestnut being the taller trees on the right, and hazelnut on the left. Additional rows to the left include plums, raspberry and asparagus with grazing and hay between rows.

Once again, with the technology of tissue culture propagation, millions of acres of these savannas could be planted within a few short years. Chestnut savannas and hazelnut shrublands are but two agricultural savanna ecosystems that can be used anywhere in the corn belt of central U.S.A. They both produce crops that are direct nutritional replacements for corn and soybeans. Although current varieties and practices don't quite equal the yield per acre of corn or soybeans, they allow for the growing of other crops in the system. Like the corn and soybeans they would replace, these production systems are completely mechanized. Elimination of annual soil preparation and seed planting would dramatically reduce fossil fuel use on savanna farms. Erosion would be virtually eliminated. The long-term dollar cost savings of a perennial savanna agriculture are nearly incalculable. Plant it once, then manage it for eternity.

The conservation and environmental benefits of these savanna crops cannot be equaled by any annual crop. Long-term carbon sequestration in woody stems and roots is significant in these crops. Unlike the annual crops they would be replacing. Surface runoff would be virtually free of suspended solids. Since herbicides are not needed—used only during establishment, if at all—they would not be able to wash into rivers, streams, and drinking-water wells. Wildlife would find its habitat greatly expanded. Drought and flood tolerance and long-term sustainability of such systems have been proven by the legacy that they have left behind. Despite nearly 200 years of the axe and plow and 60 years of herbicides, we have not been able to eradicate the savanna.

The natural forces that sustain savannas in North America have sustained them for millennia. If we design our agricultural practices to fit in with these natural forces and processes rather than fight or deny them, our agriculture may at long last prove to be as enduring.

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