Integrating crops and livestock:
A return to the Past or moving into the Future?

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Until the latter half of the 20th Century, mixed crop and livestock operations were the norm across most of the US and much of the temperate world. Only the areas of intensive vegetable production and rice farming excluded livestock from their fields. In the semi-arid rangelands of the American West where rainfall limited crop production, the landscape was left exclusively to grazing livestock. Almost everywhere else, the typical farm grew several types of row crops and small grains as well as cattle, sheep, hogs, and several types of fowl.

The Great Depression of the 1930s and the Dust Bowl droughts forced many farmers and ranchers, both small and large, off the land and into the cities. The industrial demand of World War II drew more manpower into the cities and away from the land. Increased mechanization of agriculture allowed us to get by with fewer farmers and ranchers. Worldwide demand for grains in the postwar era led to more specialization of grain production. The advent of chemical fertilizers and pesticides, another byproduct of the war industries, reduced the need for farm-produced manure and soil building crop rotations.

By the 1970s we had developed into a segmented industry of production specialists. Corn farmers grew corn. Cattle feeders fed corn purchased from corn farmers in feedlots. Concentrated hog production facilities only needed the minimum amount of land required for waste disposal. The fence rows came out. We all became familiar with the CAFO terminology. We were producing lots and lots of stuff. We were touted as being the most efficient farmers in the world. We were proud to be farmers and ranchers. Wasn't life just Grand!

So, what's the problem?

The real question is where do we even begin to start to answer that question.

We have had record high prices for most commodities over the last few years, but those have come with record high production costs. Return on assets for most farms have been stagnant for the last decade.

Soil erosion and water pollution are still significant problems across the country. The dead zones in the Gulf of Mexico and Chesapeake Bay continue to grow, as does the State of Louisiana being built with the topsoil of the entire Mississippi River Basin.

The average age of American farmers and ranchers continues to advance each year as we fail with recruitment of young people into this business. As an industry we are unhealthy and facing potential extinction.

USDA insists we have the safest food supply in the world yet we have one of the unhealthiest populations in the world. The overwhelming evidence is that virtually all of our chronic ailments are the direct product of our so-called 'safest' food supply.

As serious as the above problems are, they are far from being the most serious problem facing our industrial agriculture system. The real problem and the greatest threat to our survival as a civilized society is profoundly overlooked by most of our family, friends, neighbors, strangers, and our leaders.

Very simply, our soil broken.

I like to think of the soil as a three-legged stool that supports the farm. Those three legs are the physical, chemical, and biological components of the soil. All three are closely linked and what we do to one component will affect both of the others. If one leg is shorter than the other two, the stool tilts and the farm slides out of balance. One way to fix the problem is to raise that leg back to the height of the other two. The sad reality of our industry is we are much more prone to shortening the other two legs.

Just as our production systems have become more specialized and narrow in focus, so has our support research. When the first Land Grant Universities were established in the1860s, all of agriculture teaching, research, and extension was housed in the same building. Sometimes one professor would have balanced knowledge of soil, plants, and livestock. It was an amazing thing and one of the best ideas that helped make America great.

As more funding came into the system, the universities built more buildings. Animal scientists went to a different place than agronomists. The agronomy departments split into different building housing plant and soil scientists in different areas. They quit talking to each other and focused more and more narrowly on their specialized areas of interest. Soon we were managing individual aspects of soil chemistry rather than looking at the whole plant-soil-animal interface. Eventually the Land Grant system devolved into a huge population of individual researchers who know more and more about less and less.

So, what does that have to do with the soil being broken? Compartmentalized, reductionist science has led us to ignore the complex interrelationships throughout our agricultural ecosystems. Everything is connected and the ripple effects of our actions are infinite beyond our comprehension. Removing livestock from our farming operations was one of those seemingly logical moves when the value of specialization was being touted by leaders of the ag industries. What they forgot is we still live and work within a biological, biophysical, and biochemical workplace, not a sterile lab or factory.

I grew up farming in the era when we thought if you took a soil test and applied N-P-K fertilizer, we were taking care of the soil. We found out there is more to it than just that. The USDA soil scientists tramped all over our fields and created the Soil Survey. Another one of the very best things USDA ever did. We have an abundance of information on the physical characteristics of the soil. I use that

information a lot in my consulting business and am thankful to have it at my fingertips, but there is still another missing piece.

The most ignored aspect of the soil has been the biological life within it and that is the leg that is too often being shortened and throwing the farm out of whack. If we consider the first half of the 20th Century as when soil chemistry came into its own and the second half as when soil physics and hydrology rose to prominence, I hope we can look at the start of the 21st Century as the time soil biology finally comes to the forefront as the critical component of agricultural sustainability.

The real breakdown of our farming systems has been the collapse of biological life in the soil and I believe the separation of crops from livestock on the landscape is a primary culprit. Many of my friends in the organic arena will likely point their fingers at chemical pesticides and fertilizers as the downfall of soil biology, but may fail to consider the reason we have fertilizers and pesticides goes back to crop monocultures. Those unnatural inputs are the result of separating the livestock from our farm fields.

Tillage is the enemy of organic matter and the leading cause of collapse of soil structure. Tillage is the enemy of biological life in the soil. There have been many studies confirming not only greater microbial biomass but greater diversity of microbial life in pastures compared to tilled crop fields. No-till farming supports much more microbial life than do clean-tilled fields, but not as much as pasture.

The long crop rotations that were practiced prior to the 1950s consisting of three years of crops and four or more years of perennial forage seeding were in fact very productive on a per acre basis. Those few farmers around who still practice long crop rotations with modern crop varieties and appropriate fertilization generally churn out very impressive crop yields. Yes, it does take a much higher level of management to maintain and manage such a crop rotation compared to continuous row cropping, but the long term payoff has been documented repeatedly.

When I was growing up, the general thought regarding the higher productivity of crop rotations was simply the nitrogen the green manure crop put into the soil. Plowing down a grass-legume sod was thought to provide a slow release of N for about three years. Hence the need for returning to sod after the third crop and then four years of sod to rebuild the N level again. We now know it is not quite that simple.

The newly developed interest in soil quality and health and the explosion of information since the turn of the century has given us a broader insight into what really happens with crop rotations. It is far more complex than the timing of N mineralization. Remember my earlier comment that pasture and rangeland support more microbial biomass and diversity than farmland? That is where the answer to the benefit of long crop rotations may truly lie.

Perennial sods allow the development of a much broader community of soil bacteria, fungi, protozoa, and arthropods. All of these organisms play a role in the mineralization and plant uptake processes. Mycorrhizal fungi enhance a plant's ability to take up essential minerals in otherwise mineral deficient soils. The natural checks and balances of diverse soil microorganisms keeps plant diseases

in check. Predatory soil insects and arthropods help regulate parasitic nematodes. The need for pesticides to support crop production is a symptom of destroying soil life.

What crop rotations really do is allow the recharge of biological life in the soil. Tillage depletes life, grasslands restore life. There is only so much tillage the soil can take before it falls beyond a tipping point of biological life, particularly when it comes to microbial diversity. What modern continuous cropping has done is push the soil ecosystem beyond the tipping point for healthy soils. Can crop rotations incorporating grazing livestock bring it back? There is good evidence that grassland rotations can in time restore the land to a more healthy state.

Recent studies have shown a rapid increase in soil microbial biomass within two to four years of seeding a perennial sod. Not only is total biomass being increased, but the diversity of classes and species of organisms is increasing. Reestablishment of native grass mycorrhiza has been observed within five years of seeding down crop land in some environments while in other situations there has been no natural reappearance of these essential soil fungi. Soil inoculants can be used to accelerate the process.

It is clear that long crop rotations have real value for improving soil health and subsequent crop yields. The next question becomes how to use the forage grown on those acres.

For many crop farmers with limited or no livestock experience, there is likely a strong temptation to make and sell hay during the sod years of the rotation. While hay prices are very high right now and some hay producers may actually be turning a profit, there is a very dark side to hay marketing. It is called soil mining.

A ton of hay contains about 40 lbs N, 6 lbs P, 50 lbs K, along with a wide array of micro-minerals. At today's price for commercial N-P-K and micros, a ton of hay contains $80-$85/ton of soil nutrient value. When you sell hay off your property, that is what you're giving away as well. With today's hay price around $200/ton, that might not look so bad, but when hay prices drop to $60/ton, it is downright scary.

If livestock graze those rotation acres, they will be returning the vast majority of those nutrients to the soil. In almost all instances, over 90% of the minerals consumed at the front end of a cow come out the back end of the cow. Unless there is clinical mineral deficiency, rarely is more than 10% of any mineral consumed retained in the animal's tissue to be sold off the farm. More often than not, the retention levels are less than 3%.

How you manage the grazing on those acres will have profound bearing on where those recycled minerals end up. Set stocking at low stock density allows the livestock to transport much of the mineral to a few concentration points such as shade, stock water, or other preferred lounging areas. This pattern of redistribution still creates a mining effect within the field. Short grazing periods at high stock density results in much more uniform manure distributions thus creating a more dynamic mineral cycle.

What class of livestock you choose to have utilize your rotation acres will largely determine the relative profitability of those acres. A grazing dairy typically has very high return potential through the rotation pastures. Basic cow-calf production will likely have the lowest per acre return while pasture-finishing beef or lamb will generate much higher returns. Just like the crop rotation needs to have a long term strategy, so do your livestock enterprises.

As we advance our understanding of the often neglected biological leg of that three-legged stool, we can do an ever increasingly better job of managing our soils and bringing them back to life. I firmly believe that long crop rotations are not a nostalgic piece of our farming history, but rather they are a key component of our sustainable future.

Good Luck & Good Grazing!