SUSTAINABILITY IN SEED PRODUCTION ENTERPRISES – WHAT WE'VE LEARNED

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Introduction

Approximately 25% of the land in the Willamette Valley is devoted to grass seed production and associated rotation crops. In many cases, farms that produce this seed represent Century Farms that have been operated by the same family for 100+ years. The long-term presence of these and other families in the seed production business has required management decisions that ensured economic sustainability and long-term soil quality. In addition to the need to produce profitable crops in a sustainable manner, producers are also faced with societal expectations and state and federal legislations regarding air and water quality.

During the past 18 years, we have conducted long-term studies under contrasting production conditions in the Willamette Valley to quantify the impact of different production practices on economic seed yield, soil quality, and the quality of surface and ground waters adjacent to seed production enterprises. Our more recent research has also quantified earthworm populations present under contrasting production systems because there is evidence that their presence is one indicator (and facilitator) of long-term soil health.

The intent of this report is to summarize what these studies, and the cooperating growers, have taught us. In some cases, this work has uncovered gaps in our knowledge that point to additional studies that are needed to understand how these unique perennial grass seed production systems function and respond to various production practices in western Oregon's unique marine climate.

<u>Soil carbon</u>

There is considerable interest in quantifying the amount of carbon sequestered in the perennial grass seed production systems commonly used in the Pacific Northwest. There may be potential for seed producers to participate in "cap and trade" opportunities, and many producers have interest in the long-term impact of their management approaches on soil carbon as an indicator of soil quality. We know that soil carbon levels can be influenced by tillage and residue management, but these perennial production systems under Willamette Valley climate conditions tend to have more stable soil carbon levels that recover from tillage relatively rapidly. We speculate that this recovery may be due in large part to climatic conditions that favor rapid microbial growth, including that of soil fungi, for much of the year. We believe this because our studies of soil invertebrates showed that the majority of the species found in these production systems were fungivores. Presumably, the nature of the species found is representative of the food sources available to support those populations. Our estimates of soil carbon show approximately 12 to 16 tons of carbon are sequestered per acre each year at a 0 to 6 inch soil depth. We need to conduct further studies to determine how stable this carbon is in Willamette Valley soils (i.e., how long the carbon remains sequestered).

<u>Residue management</u>

We completed a 10-year experiment in western Oregon at three contrasting locations that demonstrated perennial grass seed crops can be economically produced without burning by using minimum tillage in combination with chopping back straw onto fields after harvest. Compared to conventional tillage establishment with straw removed by baling, these conservation practices reduced soil erosion 40 to 77%, shallow ground water nitrate 6-fold, establishment costs $27-162 per acre, and in some cases, increases seed yields.

<u>Surface water quality</u>

The 407 square-mile Calapooia River watershed originates in the Cascade Mountains in Willamette National Forest and drains through mixed-use and agricultural lands into the Willamette River at Albany, OR. Aquatic wildlife habitat is a primary concern of the watershed because of cutthroat trout, steelhead, salmon, and other native fishes and amphibians that use the river. In addition, there are listed concerns for water temperature and bacteria under the Clean Water Act. Since seed production is a major activity within the watershed, this area provides an ideal model system for quantifying the impact of management practices on natural resource quality. Our long-term evaluation of surface water quality in the Calapooia watersheds has been conducted with the assistance of Oregon State University Dept. of Fisheries and Wildlife (F&W), a partnership that enabled us to extend our analyses from the field into the aquatic habitats that provide ecosystem services to the watershed. While we quantified concentrations of nutrients and sediment in streams that drained a variety of land uses in the watershed, our F&W partners actually conducted stream surveys of aquatic organisms, an expertise that was lacking among most of our agricultural science collaborators. Our F&W partners showed that native fish use seasonal streams near grass seed fields during the winter. More than 95% of the aquatic wildlife using seasonal agricultural drainages are native and different assemblages were characteristic of different subwatersheds.

Our own measurements showed that nutrient and sediment concentrations in these drainages were generally less than those reported to adversely affect fish health, and some fish species even used these drainages to reproduce. Also, trees naturally growing in fields along drainages where shown to provide habitat for winter songbirds. University of Massachusetts and ARS scientists showed seventeen-times more birds were found along forested than non-forested drainages, but only 15% of the total land cover was needed to be in trees to maximize songbird diversity. This research shows that in addition to providing farmers income from their crops, the seasonal drainages and vegetation near their fields are providing valuable habitat supporting native fish and bird populations in a landscape that is significantly impacted by cities and towns. Because aquatic wildlife protected under Endangered Species Act can be sensitive to high concentrations of sediment and nutrients found in field runoff, these findings will support landowner applications for conservation program payments under the USDA Farm Bill and help demonstrate compliance with provisions of the Clean Water Act. These studies led to some very targeted research in the Santiam Canal in 2005 when it was suspected that agricultural practices were impacting Albany drinking water quality. The results of our targeted research in the watershed showed that agriculture was not a contributing factor to the issue at hand.

Ground and surface water quality

We demonstrated that in southern Willamette Valley grass seed production landscapes, stream water nitrate, ammonium, sediment, and the herbicide diuron concentrations throughout the year were below those reported to affect the survival, growth, and malformation of frogs that live in Willamette Valley riparian zones. Atypical elevation of shallow groundwater nitrate can occur after plowing or when the field is left fallow. Following these events, short-term shallow ground water nitrate concentrations can exceed 50 ppm during the wet winter months. This is minimized during the first seed-year if a fall crop is planted and growing through the winter. For the most part, grass seed cropping systems, unlike conventional cropping systems are usually left undisturbed for years. Typical in these landscapes and associated valley climatic conditions, local high precipitation causes rapid dilution of shallow ground and surface water chemistries. We see no major area of concern based on data collected thus far.

Riparian area function

During the course of these long-term studies, we conducted two specific projects that focused on how riparian zones adjacent to grass seed production fields functioned in processing nitrogen. The study sites included one at Lake Creek in Linn County and one on the Calapooia River mainstream in Benton County. At both sites we found that water moved from the cropping system to the riparian zones through the slow movement of groundwater and also through the rapid drainage of surface water (i.e., overland flow). These studies showed that there are complex hydrological factors that impact how water moves through these systems, but that both the seed crop and the riparian vegetation were capable of processing nitrogen that was present in shallow groundwater. Typical groundwater nitrate levels measured during this study were in the range of 0.6-1.8 ppm NO_3^- -N, well within the standards generally applied to drinking water.

Future Studies

During the 18 years covered by this study, a number of factors have impacted agricultural production practices used in the Willamette Valley. When we began this study, the seed industry was still in the process of developing new approaches to produce seed crops, largely without the use of open field burning. Recent legislation has reduced the availability of burning even more. Increased labor and fuel prices that growers are faced with today have driven some to adopt production practices that reduce fuel use by field operations including the use of minimum or shallower tillage. Recent market conditions have also prompted interest in alternative crops. As the industry continues to adapt to changing policy and market conditions, there will be a need for new understanding of how production practices impact the productivity of soils in the unique environment of the Willamette Valley. These studies are needed to better understand how these poorly drained soils can be utilized by a diversity of crops that might fit into regional or national niche markets, especially if the demand for grass seed significantly declines with time.

Improvement of minimum tillage/direct seed establishment approaches

Our findings showed that direct seeding could be used successfully in combination with chopped back straw resulting in higher economic seed yields for two-of-three perennial grass seed crops (perennial ryegrass and tall fescue, but not fine fescue). In some cases, however, particularly with small-seeded crops and during years with high numbers of slugs, stand establishment by direct seeding invites more intensive pest management. Future research is needed to extend the advantages of direct seeding to more growers under more challenging field conditions.

Potential for participation in carbon markets based on sequestration in perennial systems

There has been much speculation about the value of grass seed crops competing in the volatile carbon markets of present. Certainly, grass seed crops rank high with regard to sequestering atmospheric carbon. Grass seed crop soils are generally rich in carbon organic matter. Additionally, these perennial systems are conservation rich because they minimize erosion, reduce soil disturbance over conventional crops, have high nutrient absorptive characteristics, and produce large quantities of biomass that can be returned to the soil to enhance sustainability. If however, current carbon market trends continue to base payments on trajectories of improvement in carbon sequestration over a defined short term period, grass seed crops will not show as much gain in trajectory as would a conventional annual crop that is plowed every year. We also need further research to determine how stable carbon sequestration is in grass seed cropping systems. Long-term stability of carbon in the soil is the desired goal of carbon sequestration for carbon credit markets.

Literature

Gohlke, T., Griffith, S.M., and Steiner, J.J. 1999. Effects of crop rotation and no-till crop establishment on grass seed production systems in the Willamette Valley, Oregon. USDA, NRCS Technical Notes, Agronomy Technical Note No. 30, November 1999.