agKnowledge Spotlight
Shedding light on the concerns of your fields.

The Benefits of Crop Rotation

- Crop rotation can help maximize crop yield potential; there is often a "yield bump" for crops grown in rotation.
- Crop rotation is an important strategy in managing insects, diseases, and weeds.
- Over time, crop rotations can help increase soil organic matter, reduce soil erosion and runoff, and improve soil physical properties.

Risk Management

Crop rotation can help spread the workload during the growing season and mitigate risk from weather events when a variety of crops are planted across the entire farming operation each year. A traditional corn-soybean rotation, in which a portion of the acreage is planted to soybean and part is in corn, allows growers to spread out planting and harvest operations while minimizing the effect on yield potential. The importance of risk management was evident during recent periods of drought. For example, if different crops were subjected to dry conditions at different growth stages, the impact on yield was likely varied and the risk was spread out. If a grower had all of their fields planted to corn and the fields were at approximately the same growth stage when dry conditions occurred, there could be a serious effect on yield potential.

Disease Management

Crop rotation can be an effective disease management tool, particularly if the pathogen has a narrow host range and overwinters in crop residue or soil. Crop rotation can decrease the level of inoculum present by introducing a crop that is not a host to the pathogen. When a non-host crop is planted, the pathogen is unable to reproduce, inoculum in the soil gradually dies, and over time inoculum levels are reduced. In contrast, when the same host plant is grown year after year, the pathogen is able to survive and reproduce, leading to increased inoculum levels in the soil. Brown stem rot, northern corn leaf blight, and Diplodia ear rot are examples of diseases for which crop rotation can be an effective management tool. Soybean cyst nematode populations can be reduced by as much as half when soybean is rotated with corn and wheat.[3] Other diseases such as Stewart's wilt and common rust of corn do not rely on overwintering in soil or debris and are not affected by crop rotation.

Insect Management

Rotating crops is an important management tactic for some insect pests. Crop rotations are most effective against insects that are fairly nonmobile, that feed on a narrow range of crops, and that overwinter in the soil as eggs or larvae. The corn rootworm is an example of an insect that has traditionally been managed by crop rotation. Corn rootworms lay their eggs in existing corn fields during August and September. If fields that were in corn are rotated to a non-host crop such as soybean, corn rootworm larvae emerge and are unable to find a suitable food source. In many areas, crop rotation is still an important management tactic; however, in other areas corn rootworm populations have developed that are resistant to crop rotation. Northern corn rootworms with extended diapause are able to survive a traditional corn-soybean rotation because they have developed a 2-year life cycle.[12] A variant of the western corn rootworm survives crop rotation by laying eggs in soybean fields rather than corn fields. These larvae then emerge in first-year corn fields the following summer. Other insects that crop rotation can help manage include wireworms, white grubs, and some cutworms.[9]

Weed Management

Rotating different types of crops, such as in a corn-soybean rotation, allows growers to diversify their herbicide program and select chemistries with different modes of action. Using herbicide products with different modes of action over the course of several years can lead to better overall weed control and minimize the risk of developing weed resistance. Adding another crop, such as wheat or alfalfa, to the rotation may help further manage weeds.[5] For example, summer annual weeds may fail to germinate under a wheat canopy or they are cut before setting seed when wheat is harvested.

Soil and Nutrient Benefits

Soil physical properties can improve through the use of crop rotation. For example, growing a hay crop in a rotation can result in improved tilth and bulk density due to the soil being protected from the impact of erosive forces such as precipitation and wind, the growth of fine roots in the soil, and the formation of humus from decomposing plant roots.[1] Alternating crops with taproots and fibrous roots can help improve the soil physical, chemical, and biological composition or properties, particularly in no-till systems. Over time improved soil structure leads to an increase in the soil water-holding capacity and the development of macro pores in the soil promotes new root growth in successive crops.[6] In addition, rotating crops with a high carbon to nitrogen ratio (corn, small grains) with low carbon to nitrogen ratio crops (soybeans) helps establish a diverse community of soil micro-organisms.[2] This improvement in soil microbial communities along with improvement in soil tilth can lead to more stable soil structure and a decrease in the susceptibility to soil erosion. Supporting nutrient availability through crop rotation can mean fewer fertilizer inputs and lower costs. For example, adding legumes like soybean or alfalfa to a rotation has the potential to increase the soil nitrogen (N) available for grain crops.[7] The "nitrogen credit" for corn following soybean is likely due to soybean roots and root exudates increasing the pool of easily mineralized organic N.[10] In the Corn Belt, this increased N

The Benefits of Crop Rotation

availability usually occurs at such a time that fertilizer N levels can be reduced. In warmer, more humid climates, N mineralization occurs too early in the growing season for plants use and thus no N credit may be given. Including year-round plantings such as alfalfa can also increase nutrient use efficiency.

Additional Benefits

Crop rotations can balance the production of crop residues when crops that produce durable residue (such as corn) are rotated with crops that produce more fragile residue (such as soybean). This allows for more flexibility when deciding on tillage practices, such as no-till or reduced tillage following soybean. Allelopathy is the suppression of growth of a plant species by another plant species. Autotoxicity is a specific type of allelopathy and occurs when chemicals released from a specific crop, such as corn, affect that same crop. Studies at Iowa State University indicate that autotoxicity can delay corn germination and early season growth. While it is not thought to be a primary cause of yield penalties in corn following corn, it is likely a contributing factor.[8]

The "Yield Bump"

Often a yield bump is seen in crops grown in rotation. Studies show that a 10% or greater yield advantage is seen in both corn and soybean when they are rotated with another crop compared to when grown continuously.[11] Recent research at the University of Wisconsin indicates that the yield bump for these crops may be closer to 19% and that this rotation effect lasts for two years.[11] While the exact mechanism of the rotation effect has not been identified, it is likely due in part to the pest management benefits and soil improvements associated with crop rotation as well as the decrease of typical problems associated with monoculture. Research has also shown that crop rotation is more important for maximizing yield potential in stressful environments.

Summary

Deciding whether to use crop rotation or grow a crop continuously may be determined in part by commodity markets and available equipment. While crop rotation can have many benefits, determining the right crop rotation for a specific field depends on several variables including the disease and insect pests present. Although a corn-soybean rotation may be the most common rotation in many areas, it may not always be the best option. When planning a rotation, consider adding a third crop, like wheat, or planting two years of corn followed by a year of soybean. Experiment with different rotations to find the best fit for each field.

Sources

[1] Roth, G. Crop rotations and conservation tillage. Penn State Extension. http://extension.psu.edu.

[2] Boquet, D. Louisiana conservation tillage handbook. Chapter 1: Crop rotation http://www.lsuagcenter.com.

[3] Kleczewski, N. 2013. Basics to soybean disease management. University of Delaware Cooperative Extension. http://extension.udel.edu.

[4] Nunez, J. 2010. Crop rotation as a method of disease control. http://westernfarmpress.com.

[5] Cavigelli, M., Teasdale, J., and Spargo,J. 2013. Increasing crop rotation diversity improves agronomic, economic, and environmental performance of organic grain cropping systems at the USDA-ARS Beltsville farming systems project. http://www.plantmanagementnetwork.org.

[6] Al-Kaisi, M., Hanna, M., and Tidman, M. 2003. Crop rotation considerations for 2004 management season. Integrated crop management. Iowa State University. http://www.ipm.iastate.edu.

[7] Mallarino, A., and Rueber, P. 2006. Yield of corn, soybean, and oats as affected by crop rotation and nitrogen fertilization for corn. Iowa State University. http://www.agronext.iastate.edu.

[8] Elmore, R. and Abendroth, L. 2007. Allelopathy: a cause for yield penalties in corn following corn? Integrated crop management. Iowa State University. http://www.ipm.iastate.edu.

[9] Teetes, G. and Pendleton, B.B. 1999. Insect Pests of Sorghum: cultural management methods. Department of Entomology. Texas A&M University. http://sorghumipm.tamu.edu.

[10] Murrell, T.S. 2011. The science behind the nitrogen credit for soybeans. International Plant Nutrition Institute. http://www.ipni.net.

[11] Lauer, J. 2010. The natural benefits of crop rotations and the costs of monocultures. University of Wisconsin-Madison. http://www1.extesnion.umn.edu.

[12] Prasifka, P., Tollefson, J., and Rice, M. 2006. Rotation-resistant corn rootworms in Iowa. Integrated Crop Management. Iowa State University. http://www.ipm.iastate.edu. (Web sources verified 11/30/2015).

131030060302