Lecture 17 Crop rotations

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Crop rotations

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Introduction

- Crop rotation is a system of designing how to cycle a piece of land through various crops, reducing the reliance on chemical fertilisers, pesticides and herbicides.
- It is how successful farmers nurtured their land over generations, and remains vitally important for farmers today wanting to nourish their local environment whilst growing good, healthy food.

- The practice of crop rotation dates back to antiquity.
- Roman agronomists 2000 years ago thus recommended the practice of alternating legumes and cereals in a rotation, including the use of legumes as green manure.
- This is also a valuable practice in current organic farming systems.

CROP ROTATION?

- Crop rotation refers to the cultivation of different crops on a particular piece of land over time. The succession of crops to be grown is carefully designed to ensure soil nutrients are sustained, pest populations are controlled, weeds are suppressed and soil health is built.
- A crop rotation will cycle through cash crops (such as vegetables), cover crops (grasses and cereals) and green manures (often legumes). The exact sequence of crops will vary depending on local circumstances, with the critical design element being an understanding what each crop contributes and takes from the soil.
- For instance, nitrogen depleting crop should be preceded by a nitrogen fixing crop.

- The central idea is to have the crops themselves sustain soil health, rather than planting the same crop year in, year out, and then repairing soil health through fertilisers, pesticides and herbicides.

Need of crop rotation

- Crop rotation, planting a different crop on a particular piece of land each growing season, is required in organic crop production because it is such a useful tool in preventing soil diseases, insect pests, weed problems, and for building healthy soils.
- Plants exude a spectrum of photosynthates into the soil that are unique to each plant species, and these root exudates influence the soil microbial biodiversity, which, in turn, supports soil function and plant health
- Crop rotations must fit with the farm's production system, equipment, labor, and market demand for the farm's crops.

General Principles to Guide Crop Rotations

1) Follow a legume crop with a high-nitrogen-demanding crop.
2) Grow less-nitrogen-demanding crops…in the second or third year after a legume sod.
3) Grow annual crops for only one year in a particular location
4) Don't follow one crop with another closely related species.
5) Use crop sequences that promote healthier crops.
6) Use crop sequences that aid in controlling weeds.
7) Use longer periods of perennial crops on sloping land.
8) Try to grow a deep-rooted crop…as part of the rotation.
9) Grow some crops that will leave a significant amount of residue.
10) When growing a wide mix of crops…try grouping into blocks according to plant family, timing of crops, (all early season crops together, for example), type of crop (root vs. fruit vs. leaf), nutrient needs, or crops with similar cultural practices.

ADVANTAGES OF CROP ROTATION

A well designed crop rotation makes land both more productive and more environmentally sustainable. It improves the financial viability of a farm by increasing productivity whilst reducing chemical input costs. Key advantages of crop rotation are:

- Improved soil fertility and structure
- Disease control
- Pest control
- Weed control
- Increased Soil Organic Matter
- Erosion control
- Improved biodiversity
- Increased yield
- Reduced commercial risk

IMPROVED SOIL FERTILITY AND STRUCTURE

- Crop rotation improves the physical and chemical conditions of soil and thus improves the overall fertility.
- Nitrogen-fixing legumes such as soybeans and alfalfa in crop rotations fix atmospheric N2 into the soil through root nodules. This nitrogen is then available for subsequent crops.
- Deep rooted cover crops can draw up nutrients such as potassium and phosphorus from deep in the soil profile, making these nutrients available for subsequent shallow rooted cash crops.
- Growing a hay crop in a rotation can result in improved tilth and bulk density. When a hay crop is ploughed in, the soil will be loose and have a good granular structure and tilth. These improved properties result from the soil being protected from raindrops, the network of fine roots in the soil, and the formation of humus from decomposing plant roots.

DISEASE CONTROL

- Crop rotation helps to control common root and stem diseases that affect row crops.
- Crop rotation is highly effective against diseases whose pathogens have a small host range and require soil or crop residue to overwinter. For such diseases, rotating a non-host crop immediately after a host crop prevents the pathogen from reproducing.
- The pathogen inoculum, ordinarily preserved in crop debris, does not have the necessary conditions for its survival and the disease spread is controlled. For example, soybean cyst nematode populations can be cut in half by rotating soybean with wheat and corn.
- In the absence of crop rotation, growing the same crop on a particular land year after year gives pathogens continued optimal conditions, and their population will increase rapidly.

PEST CONTROL

- Crop rotation can be used as a tool to manage those insects which are non-mobile, whose larvae or eggs overwinter in soil and which have a narrow range of crops to feed on.
- For instance, corn rootworms can be managed effectively with crop rotation. These insects lay eggs in the corn fields they live on, and emerge to damage subsequent crops. Rotating a non-host crop immediately after a corn crop means that emerging larvae starve due to scarcity of food. Note that this practice is ineffective in some areas where rootworm populations have developed mechanisms to survive crop rotation.

WEED CONTROL

- Including cover crops into crop rotation systems provides greater competitions to the weeds for their basic needs such as nutrients, space and light.
- Cover crops ultimately crowd out the weeds, slowing down weed growth and proliferation for a reduced weed population in subsequent crops.

INCREASED SOIL ORGANIC MATTER

- Crop rotation will add more crop residues, green manures and other plant debris to the soil. Crop rotation also requires less intensive tillage, which means that soil organic matter does not degrade as quickly.
- Increased soil organic matter improves soil infiltration and water holding capacity, which enables water to be absorbed into the soil. Furthermore, increased soil organic matter improves overall soil structure and the chemical and biological properties of the soil.

EROSION CONTROL

- Crop rotation helps control the erosion of soil from water and wind by improving the soil structure and reducing the amount of soil that is exposed to water and wind. Crop rotation also supports reduced or no-till farming, which ensures even better protection against erosion.
- Cover crops are effective in reducing raindrop impact, reducing sediment detachment and transport, slowing surface runoff, and so reducing soil loss.
- To maximise the results of erosion control efforts, the crop rotation should be designed to reflect climatic conditions. For example, rigid crop rotations give good crop growth along with effective soil cover under consistent climatic conditions of fairly predictable annual rainfall and temperature. More flexible rotations should be used in regions that are susceptible to unseasonal rains or drought.

IMPROVED BIODIVERSITY

- Crop rotation helps improve soil biodiversity by changing crop residue and rooting patterns.
- Different crops benefit different species, and so a range of crops will lead to a more diverse and healthy soil microbial community.
- Similarly, the microbial community is supported by rotating crops with a high C:N (such as corn) with low C:N crops (such as soybeans).

INCREASED YIELD

- Crop rotation can help increase yield. Corn and soybean that is rotated with another crop yields 10% more than when the same crop is grown continuously.
- The increased yield is the result of all of the individual soil and plant health benefits from crop rotation

REDUCED COMMERCIAL RISK

- Different crops have resistance capacities against different adverse climatic conditions. For instance, some crops have good tolerance against flooding conditions while some others have improved drought resistance. Growing different crops in rotation minimizes the impact of crop failure due to adverse weather.
- Crop rotation also requires growing and harvesting crops at different times, helping farmers to spread their workload evenly and allow them to cultivate more land with same amount of equipment and labour.

The beneficial effect of crop rotation is due to:

1. Impact of nutrients fixed/released by first crop on subsequent crop.
2. Impact of underground residues left by first crop on subsequent crop.
3. Impact of organic practices of first crop on subsequent crop due to slow nature of availability of nutrients.

In harnessing the benefits of crop rotation, the selection of crop should be such that preceding crop helps in making available nutrients to succeeding crops.

SELECTING THE RIGHT CROPS FOR YOUR SYSTEM

A successful crop rotation requires the selection of the right crops for your farm. Different crops have different light, water, nutrient, air and temperature requirements, and so a crop rotation must be designed to ensure that each crop will get all the basic needs sufficiently.

The following factors should be considered when designed a crop rotation for your farm:

- First of all, what crops do you want from your farm, and what can you sell. You may want to crop vegetables, grains, hay or other crops.
- The availability of the necessary inputs. Choose crops for which you can easily manage the seeds, sowing and harvesting equipment and other inputs.

- The types of crops: a crop rotation should be designed using crop types which complement each other. For example, cereals are complemented by legumes. The benefits from crop rotation will not be as strong if different crops of the same type are grown in succession (for example, growing two different cereals in rotation).
- The type of crop roots: Some crops have strong roots capable of penetrating deep into the soils. These crops are great to grow on compacted soils as their roots improve the soil structures, porosity and other physical properties. They also draw up nutrients from deep in the soil profile, making them available for subsequent shallow rooted crops.

- The need to improve the soil fertility. Legumes fix nitrogen in the soil, making it available for subsequent crops. Nitrogen fixing crops are ideal to precede nitrogen demanding crops, or to rebuild nitrogen levels after nitrogen demanding crops.
- The need to protect your land against erosion. Cover crops will protect the land from erosion between crops, and will improve soil structure and suppress weeds.
- The soil and climatic factors of your land, such as the soil physical, chemical and biological characteristics, overall soil fertility, rainfall, temperature and presence of pests. A good crop rotation will work with the natural conditions of the land.

HOW TO INTRODUCE A SUCCESSFUL CROP ROTATION

Though different farms have their own climatic and management constraints to deal with, some general rules for rotation are below:

- ✓ In all things, strike a balance between cash and non-cash crops. This creates a profitable and sustainable crop rotation system.
- ✓ Deep-rooted plants should be grown alternately with shallow-rooted crops. This type of rotation combination improves soil structure and drainage capacity. For example, the alternate combination of corn with cabbage is a good rotation combination for the physical properties of the soil.

- ✓ Nitrogen-demanding crops should be grown immediately after nitrogen-fixing plants. For example soybeans should be followed by maize.
- ✓ Plants with high biomass of roots can be grown alternately with plants with low biomass of roots. Legumes such as red clover and orchard grass having high root biomass can be grown alternately with low root biomass crops such as soybeans and maize.
- ✓ Very fast-growing crops like buck-wheat, sun hemp and radishes should be grown alternately with slow-growing crops like winter wheat and red clover.

- ✓ Slow-growing crops are more vulnerable to weeds. Therefore in a rotation system they should be grown immediately after weed-suppressing crops such as winter rye.
- ✓ Crop rotation can alternate between Autumn and Spring crop plantings; this strategy is very effective in reducing weather risk, spreading work pressure and suppressing weeds.
- ✓ Try to cover the soil with crops as much as possible.
- ✓ Alternate leafy crops with straw crops to aid in weed suppression.

IMPORTANCE

- Crop rotation is one of the very basic building blocks of organic farming systems. The crop rotation in organic farming must provide the soil fertility required for maintaining productivity and it must prevent problems with weeds, pests and diseases.
- This is obtained through a proper sequence of crops in time and space and through the use of N2 fixing crops and cover crops
- This is contrary to conventional or integrated farming systems, where lack of soil fertility can be ameliorated by use of artificial fertilizers and weeds, pests and diseases can be controlled through use of agrochemicals. Much of the research on crop rotations must therefore be designed specifically for use in organic farming systems.

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